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THE EFFECT OF ACCOMPANYING EXPANDED OR COMPRESSED SPEECH TAPES ON THE COMPREHENSION AND EYE MOVEMENTS OF INCARCERATED UNDEREDUCATED ADULTS

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THE EFFECT OF ACCOMPANYING EXPANDED OR COMPRESSED SPEECH TAPES ON THE COMPREHENSION AND EYE MOVEMENTS OF INCARCERATED UNDEREDUCATED ADULTS

APPROVED BY

DISSERTATION COMMITTEE

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CHAPTER I

INTRODUCTION

There are currently some half million adults incarcerated in federal and state prisons in the United States.[1] The treatment and rehabilitation of these prisoners should be of vital concern to every thinking citizen. Prison riots such as those in Attica, New York, and McAlester, Oklahoma, have focused national attention upon our penal systems and their failures. It seems there is considerable justification, however, in the statement by Reagan et al. that:

> . . . in recent years, as a society, we have spent more energy publicizing our prison problems than we have in trying to understand them. We are spending more funds to cope with them than we are in researching basic questions about them.[2]

The close relationship between crime and illiteracy has been established by several studies. A study conducted

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[1]Michael V. Reagan et al., School Behind Bars--A Descriptive Overview of Correctional Education in the American Prison System (Syracuse, N.Y.: Policy Institute, 1973; Bethesda, Md.: ERIC Document Reproduction Service, ED 083 340, 1973), p. 69.

[2]Ibid., p. 294.

for the Ford Foundation[1] includes an unofficial estimate by the United States Bureau of Prisons indicating that twenty to fifty percent of the adults incarcerated in federal and state prisons can neither read nor write. This study also indicates that at least 50 percent of those over eighteen years of age have less than an eighth grade education. In some facilities for youthful offenders as many as eighty percent are illiterate.

Chall[2] has pointed out that the meaning of illiteracy in our society is changing. At one time fourth grade reading level was considered the criterion for literacy. More recently, attainment of eighth grade level proficiency has been a goal set by the Right to Read Programs. Anderson and Niemi[3] indicate that in view of increasing job specialization and expanding technology requiring higher education, the normal prerequisite for vocational training is currently set at the grade ten level of achievement. The Fleischmann Report on New York State Schools states:

> It is generally agreed that functional literacy means that a person is able to read materials of approximately a 10th to 12th grade level. Driver's manuals, income tax directions, "how to" instructions for home and job

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[1]Ibid., pp. 69-70.

[2]Jeanne Chall et al., "Illiteracy in America: A Symposium," Harvard Educational Review 40 (May 1970):264-276.

[3]Darrell Anderson and John A. Niemi, Adult Education and the Disadvantaged Adult (Syracuse: ERIC Clearinghouse on Adult Education, ED 029 160, 1969), p. 8.

projects and other information that the average citizen encounters daily are written at this level.[1]

It seems apparent that helping inmates improve their reading skills should be a major concern of those persons responsible for correctional education. Increasing the reading level of an inmate from that of bare literacy to that of ninth or tenth grade level makes possible a much wider variety of potential vocations for that inmate when he is released from prison. The attainment of higher level reading skills could also enhance efforts at social education and rehabilitation through the use of techniques such as bibliotherapy which require the ability to read a variety of books.

Relatively few studies have been concerned with helping the undereducated adult achieve added efficiency in reading. This is particularly true in regard to those adults who may have achieved what Robinson[2] refers to as "partial literacy," but have not achieved a level that enables them to function as effective, literate members of society. Specifically, few studies have been concerned with how, from an oculo-motor perspective, the functionally illiterate adult reads.

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[1]New York State Commission on the Quality, Cost, and Financing of Elementary and Secondary Education in New York State, The Fleischmann Report, 3 vols. (New York: Viking Press, 1973), 2:10.

[2]H. Alan Robinson, "Progress Toward Adult Literacy," in The Philosophical and Sociological Bases of Reading, ed. E. L. Thurston and L. E. Hafner (Milwaukee: National Reading Conference, 1965), pp. 33-40.

In recent years there has been increased interest in the effect of auditory input upon reading comprehension, with most studies indicating that combined auditory and visual input results in increased comprehension.[1] With the invention of techniques for expanding and compressing speech, new opportunities for varying the rate of presentation of auditory input have emerged. The use of compressed speech tapes as a means of pacing reading has been studied by such researchers as Orr[2] and Thames and Rossiter.[3] What effect such pacing would have upon the oculo-motor behavior and comprehension of undereducated adults is a problem that needs further study.

While it is true that some studies have been conducted in the use of accompanying tapes as pacing devices and as aids to comprehension, few studies were found in which the rate of the accompanying tape was related in a specified way to the reading rate of the individual. A study by Bryant et al.[4]

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[1]H. J. Hsia, "The Information Processing Capacity of Modality and Channel Performance," Audiovisual Communication Review 19 (Spring 1971):52.

[2]David B. Orr, "Recent Research on Reading and the Comprehension of Time-Compressed Speech," in Proceedings of College Reading Association, ed. Clay A. Ketcham, (Easton, Pa.: College Reading Association, 1966), 7:79-84.

[3]Kenneth H. Thames and Charles M. Rossiter, Jr., "The Effects of Reading Practice with Compressed Speech on Reading Rate and Listening Comprehension," Audiovisual Communication Review 20 (Spring 1972):35-42.

[4]Antusa S. Bryant, et al., "The Effectiveness of Taped Reading Instruction in Increasing the Reading Rate and Comprehension of Undereducated Adults," Adult Education Journal 21 (Summer 1971):246-252.

indicates the possibility that the use of accompanying tapes recorded at inappropriate rates, especially rates that are too slow, may have a detrimental effect on the comprehension and reading rate of undereducated adults.

In the past several years recordings that accompany printed material have grown in popularity and publishers have found an expanding market for such aids at all levels of reading and in several content areas. Recently, commercial reading programs utilizing compressed speech tapes as aids to the development of comprehension and reading efficiency have been produced. If such devices are to be used to greatest advantage in the individualization of instruction, it seems important to consider some of the problems that may arise as a result of using tapes having varying relationships to the individual's normal reading rate. Specifically, it seems important to investigate the effects upon eye movements and comprehension when such tapes are employed as reading aids.

Problems of the Study

The problems with which this study were concerned are:

1. Will differences exist between the eye movements and comprehension of subjects when they read printed material and when they read printed material while listening to a tape recording of that material presented at a rate having

a specified relationship to their normal reading rates?

2. Will the rate of presentation, which will be in terms of a specified relationship to the individual's normal reading rate, produce differences among the groups in regard to eye movement and comprehension?

Purposes of the Study

The purposes of the study were:

1. To contribute knowledge in the area of reading research related to incarcerated undereducated adults.

2. To compare the eye movements and comprehension of subjects when they read printed material and when they read printed material accompanied by an audio tape of that material recorded at a rate having a specified relationship to their normal reading rates.

3. To compare measurements among the various treatments of the study; especially to determine if there is a specified relationship between an individual's normal reading rate and the rate of the taped presentation which produces significantly more desirable results in regard to comprehension and eye movement measurements.

Significance of the Study

The use of accompanying tapes as pacing devices and as aids to comprehension has become increasingly widespread during the past few years. Recently, however, studies have

been conducted indicating that the effectiveness or lack of effectiveness of such tapes may depend in part upon the relationship between rate of presentation and the individual's normal reading rate.

One of the major purposes of this study was to compare the eye movements and comprehension of undereducated adults when they read printed material and when they read printed material while listening to an accompanying tape of that material recorded at a rate that has a specified relationship to the individual's normal reading rate. This will provide data on the effect of listening on reading when the presentation rate bears a specific relationship to the normal reading rate.

Another purpose of the study was to compare measurements among the various treatments to determine if there is a specified relationship between an individual's normal rate of reading and the rate of the taped presentation which produces significantly more desirable results in regard to comprehension and eye movement measurements. Such data should provide a basis for much-needed individualization of instruction for undereducated adults, and for the effective utilization of accompanying taped presentations for the purpose of improving reading efficiency.

Finally, since the population selected was that of incarcerated undereducated adults, the data secured from the study should contribute to an area of research that has

received relatively little attention; that is, the area of correctional education.

Definition of Terms

1. Fixation.--A fixation is the stop that the eye makes in order to react to printed material. It is the period during which the eyeball is stationary.

2. Regression.--A regression is a reverse fixation; that is, it is a fixation immediately following a right-to-left saccade or movement.

3. Span of recognition.--The span of recognition refers to the number of words and/or parts of words the reader is able to perceive during one fixation. The average span of recognition is computed through dividing the number of words read by the number of fixations.

4. Duration of fixation.--The duration of fixation is the amount of time a reader's eyes pause during a fixation. The average duration of fixation is computed through dividing the total reading time by the number of fixations per one hundred words.

5. Rate of reading.--Rate of reading refers to the time required to read a given selection. The rate is reported in terms of the number of words read per minute.

6. Normal rate of reading.--For the purposes of this study the normal rate of reading will refer to the rate of reading achieved by the individual on the Rate section of the

Traxler Silent Reading Test.[1]

7. Presentation rate of material.--Presentation rate refers to the number of words per minute at which the audio tape material is presented.

8. Time compressed speech.--Time compressed speech is tape recorded speech which has been altered, through the use of a speech compressor, to increase the rate of speech without accompanying changes in vocal pitch.

9. Time expanded speech.--Time expanded speech, or decelerated speech, is tape recorded speech which has been altered, through the use of a speech expander, to decrease the rate of speech without accompanying changes in vocal pitch.

Statement of Hypotheses

The following null hypotheses were tested in the study:

1. There are no differences in the specific measurements of eye movements of subjects when they read a printed selection (read condition) and when they read a printed selection accompanied by a tape recording of that selection (read-listen condition) which is presented at 50 wpm below each subject's normal reading rate (NRR-50 wpm).

   1a. There are no differences in fixations under the read condition and under the read-listen condition of NRR-50 wpm.

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[1]Arthur E. Traxler, Traxler Silent Reading Test (Indianapolis: Bobbs-Merrill Co., 1969).

1b. There are no differences in regressions under the read condition and under the read-listen condition of NRR-50wpm.

1c. There are no differences in span of recognition under the read condition and under the read-listen condition of NRR-50 wpm.

1d. There are no differences in duration of fixation under the read condition and under the read-listen condition of NRR-50 wpm.

1e. There are no differences in rate of reading under the read condition and under the read-listen condition of NRR-50 wpm.

2. There are no differences in specific measurements of eye movements of subjects when they read a printed selection (read condition) and when they read a printed selection accompanied by a tape recording of that selection (read-listen condition) which is presented at each subject's normal reading rate (NRR).

2a. There are no differences in fixations under the read condition and under the read-listen condition of NRR.

2b. There are no differences in regressions under the read condition and under the read-listen condition of NRR.

2c. There are no differences in span of recognition under the read condition and under the read-listen condition of NRR.

2d. There are no differences in duration of fixation under the read condition and under the read-listen condition of NRR.

2e. There are no differences in rate of reading under the read condition and under the read-listen condition of NRR.

3. There are no differences in specific measurements of eye movements of subjects when they read a printed selection (read condition) and when they read a printed selection accompanied by a tape recording of that selection (read-listen condition) which is presented at 50 wpm above each subject's normal reading rate (NRR + 50 wpm).

3a. There are no differences in fixations under the read condition and under the read-listen condition of NRR + 50 wpm.

3b. There are no differences in regressions under the read condition and under the read-listen condition of NRR + 50 wpm.

3c. There are no differences in span of recognition under the read condition and under the read-listen condition of NRR + 50 wpm.

3d. There are no differences in duration of fixation under the read condition and under the read-listen condition of NRR + 50 wpm.

3e. There are no differences in rate of reading under the read condition and under the read-listen condition of NRR + 50 wpm.

4. There are no differences in specific measurements of eye movements of subjects when they read a printed selection (read condition) and then they read a printed selection accompanied by a tape recording of that selection (read-listen condition) which is presented at 100 wpm above each subject's normal reading rate (NRR + 100 wpm).

4a. There are no differences in fixations under the read condition and under the read-listen condition of NRR + 100 wpm.

4b. There are no differences in regressions under the read condition and under the read-listen condition of NRR + 100 wpm.

4c. There are no differences in span of recognition under the read condition and under the read-listen condition of NRR + 100 wpm.

4d. There are no differences in duration of fixation under the read condition and under the read-listen condition of NRR + 100 wpm.

4e. There are no differences in rate of reading under the read condition and under the read-listen condition of NRR + 100 wpm.

5. There are no differences in the comprehension of subjects when they read a printed selection and when they read a printed selection accompanied by a tape

recording of that selection which is presented at 50 wpm below each subject's normal rate of reading.

6. There are no differences in the comprehension of subjects when they read a printed selection and when they read a printed selection accompanied by a tape recording of that selection which is presented at each subject's normal rate of reading.

7. There are no differences in the comprehension of subjects when they read a printed selection and when they read a printed selection accompanied by a tape recording of that selection which is presented at 50 wpm above each subject's normal rate of reading.

8. There are no differences in the comprehension of subjects when they read a printed selection and when they read a printed selection accompanied by a tape recording of that selection which is presented at 100 wpm above each subject's normal rate of reading.

9. There are no differences in comprehension gain scores among the four treatment groups resulting from the use of accompanying tapes of specified rates.

10. There are no differences in the specific eye movement gain scores among the four treatment groups resulting from the use of accompanying tapes of specified rates.

    10a. There are no differences in fixation gain scores.

    10b. There are no differences in regression gain scores.

    10c. There are no differences in span of recognition gain scores.

    10d. There are no differences in duration of fixation gain scores.

    10e. There are no differences in rate of reading gain scores.

The .05 statistical level of significance was selected; that is, an obtained result significant at this level could occur by chance only five times in 100 trials.

Limitations of the Study

Several limitations of the study should be noted:

1. The study was limited to male inmates of the El Reno Federal Reformatory whose ages ranged from 18 to 26.

2. The study was limited to inmates who scored between 6.0 and 8.9 grade level on the Reading Comprehension Section of the Stanford Achievement Test which was administered during their orientation period to the El Reno Federal Reformatory.

3. From the population described in (2) above, 170 subjects were randomly selected. These subjects were administered the Traxler Silent Reading Test to determine if they were reading in the 6.0 to 8.9 grade level range and to determine their normal rates of reading. The following subjects were eliminated from the study: (a) those subjects who indicate unwillingness to participate in the study; (b) those subjects falling below 6.0 or above 8.9 grade level on the Traxler Silent Reading Test; (c) subjects reading at a rate below 100 words per minute. The study was limited to 88 subjects, with those qualifying from the original 170 but not included in the 88 subjects being placed on a list of alternates.

CHAPTER II

REVIEW OF RELATED LITERATURE

A major purpose of this study was to determine the effect of accompanying tapes of varied rates upon the eye movements and comprehension of incarcerated undereducated adults by comparing eye movement measures and comprehension levels when these subjects read printed material and when they read printed material while listening to tapes of that material recorded at specified rates. The study also attempted to determine if there is a specified relationship between an individual's normal reading rate and the rate of the taped presentation which produces significantly more desirable results in regard to comprehension and eye movement measures.

The review of related literature includes historical background and research related to reading education in penal institutions. It also includes studies which involved eye movements in reading, research which compared bimodal (audio-print) and monomodal (audio or print) transmission of information, and research concerned with the use of compressed and expanded speech tapes as reading aids. At the conclusion of the chapter a theoretical model for the simultaneous transmission of information through audio-print channels is

presented.

Reading Education in Penal Institutions

The earliest efforts toward literacy education in penal institutions were brought about by interest in the religious and moral instruction of inmates. Chaplains working with prisoners soon discovered that many of them were unable to read the Bible and religious tracts brought for their instruction. As a result, chaplains frequently became teachers of reading, using the Bible as the first book of instruction. Lewis[1] reports the efforts of a chaplain at Sing Sing to teach reading to an illiterate convict. The chaplain kept a detailed record of his efforts, beginning with "February 22, 1829. Began the first verse of Genesis and learned 4 letters," and ending with "March 29. Read correctly the first chapter of Genesis."

According to Chenault,[2] the Quakers were the first lay persons to advocate education for criminals. Opposition to the concept of prisoner education was not infrequent. Lewis[3] notes that Elan Lynds, warden of Auburn Prison in 1824,

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[1]Orlando F. Lewis, The Development of American Prisons and Prison Customs, 1776-1845 (Albany: Prison Association of New York, 1922; reprint ed., Montclair, N.J.: Patterson Smith, 1967), p. 112.

[2]Price Chenault, "Education," in Contemporary Correction, ed. Paul Tappan (New York: McGraw-Hill Book Co., 1951), p. 224.

[3]Lewis, Development of American Prisons, p. 95.

successfully opposed efforts to teach younger convicts to read and write. He recommended that such efforts be abandoned on the grounds that an educated convict posed increased danger to society.

Efforts to teach illiterates were also handicapped because of the widespread use of solitary confinement as a major policy in penal institutions up to the middle of the nineteenth century. This system was called the Pennsylvania System because of its origin in institutions in that state, but was widely practiced in other states as well.

Barnes[1] notes that the Cherry Hill Penitentiary in Philadelphia employed a special teacher for illiterates from the early years of its beginnings. Efforts of such teachers were greatly handicapped, however, by the system of solitary confinement which, until 1913, forbade the congregation of prisoners for educational as well as for religious and industrial purposes. This meant that private lessons in separate cells comprised the major method of instruction. With only one teacher for all the prisoners, this method proved to be a highly inefficient approach.

According to Sutherland and Cressey,[2] the greatest stimulation to the development of prison schools came after

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[1]Harry E. Barnes, The Evolution of Penology in Pennsylvania (Indianapolis: Bobbs-Merrill Co., 1927, reprint ed., Montclair, N.J.: Patterson Smith, 1968), p. 357.

[2]Edwin H. Sutherland and Donald R. Cressey, Criminology, 8th ed. (Philadelphia: J. B. Lippincott Co., 1970).

the civil war with the movement toward a treatment reaction to crime. The opening of the Elmira Reformatory in 1876, with its "school of letters" and its trade school, marked the beginning of correctional education as it is known today. With the reformatory movement came the concept of confining younger felons in a separate institution and providing them with a more extensive educational program than existed in most other prisons. Later, the concept of increased educational opportunities was extended to other penal institutions.

A survey of correctional education was conducted in 1927-28 by MacCormick. With the exception of three institutions, he visited every prison and reformatory for men and women in the United States, making a special study of educational and library work. He concluded that "Not a single complete and well-rounded educational program, adequately financed and staffed, was encountered, in all the prisons in the country."[1]

MacCormick stressed the importance of individualizing instruction for inmates and of using materials and methods suitable for adults. He emphasized the importance of reading education for inmates in the following statement:

> Of all the subjects that may well be taught in the prison reading holds first place in usefulness and desirability. Without ability to read progress in

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[1]Austin MacCormick, The Education of Adult Prisoners (New York: National Society of Penal Information, 1931), p. 38.

> other studies, both academic and vocational, is barred to the prisoner. He may get along in life with imperfect and restricted speech. He may never have occasion to write a letter as long as he lives. But if he cannot read he is indeed a "poor ignorant man." If with limited time at our disposal, we had to choose one thing to teach any unschooled man we would probably say, "Teach him to read."[1]

The close relationship between crime and illiteracy has been well established. The effectiveness of prison schools in eradicating illiteracy and in contributing to the successful rehabilitation of inmates has not been so clearly established. While the lack of research in this area has been deplored by such writers as Reagan[2] and Glaser,[3] several studies have been conducted related to the effectiveness of prison education in general and to the effectiveness of specific techniques and materials in reading instruction.

One of the most thorough investigations of the relationship between the educational treatment of prisoners and recidivism was conducted by Schnur[4] at the Wisconsin State Prison. His sample consisted of 1,762 men paroled from the prison in 1936-1941. The experimental group, consisting of those who had been enrolled in at least one day-school class,

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[1]Ibid., p. 67.

[2]Reagan, School Behind Bars.

[3]Daniel Glaser, "The Effectiveness of Correctional Education," American Journal of Corrections 28 (March-April 1966):4-6.

[4]Alfred C. Schnur, "The Educational Treatment of Prisoners and Recidivism," American Journal of Sociology 54 (September 1948):142-47.

was divided into six subgroups according to the length of time they had attended the prison school. Recidivism rates were found to be significantly lower for men who had been enrolled, even after controlling separately on ten different characteristics on which students and nonstudents differed. It was noted, however, that training for less than six months appeared to have no effect on recidivism. Schnur recommended that admission for less than six months should be discouraged, especially if such admission would require the exclusion of men who could attend for a longer period of time.

Bowyer,[1] through the use of historical materials and an educational questionnaire, attempted to investigate the philosophy and practice of correctional education in the United States. He concluded that major obstacles to corrective education are lack of public sympathy and understanding and lack of adequate financing. He recommended the establishment of compulsory education for both penal and correctional institutions because of the small minority who participate in programs.

An investigation by Zink[2] was undertaken to determine if participation in the academic school program at the New

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[1]Carlton H. Bowyer, "Correctional Education in Penal and Correctional Education in the United States," (Ph.D. dissertation, University of Missouri, 1958).

[2]Theodore M. Zink, "A Study of the Effect of Prison Education on Societal Adjustment," (Ed.D. dissertation, Temple University, 1962).

Castle Correctional Institution, Wilmington, Delaware, produced any significant effect upon post-release recidivism. An experimental group of 110 inmates who had attended school for at least two months while in prison between 1950-58, was compared with a control group of 110 non-school inmates who were in prison during that period of time. In all areas of measurement consistent differences in post-release criminality existed favoring the school group members, with four of the nine relationships proving statistically significant. A significantly greater number of men who attended prison school did succeed in society at the three, four, and five year post-release follow up periods.

Glenn[1] studied the status and effectiveness of general and vocational education programs in Missouri correctional institutions. Inmates confined in correctional institutions at the time of the study claimed to have completed a mean of 8.4 years in school, but Stanford Achievement Test scores revealed a mean level of achievement of only 6.29. Over three-fourths of this inmate population were less than 25 years old. More than seventy-five percent had sentences of less than five years.

Glenn reported a definite need for both general and vocational upgrading of inmate education. On the basis of

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[1]John W. Glenn, "Status and Effectiveness of General and Vocational Education Programs in Correctional Institutions of Missouri," (Ph.D. dissertation, University of Missouri, 1966).

follow-up interviews and educational and personnel records, he concluded that parolees who had participated in educational programs during confinement had a significantly smaller percentage of recidivism and received a significantly fewer number of weeks of unemployment compensation.

Beadle[1] interviewed thirty-nine former inmates of the State Prison of Southern Michigan who had participated in the educational program of that institution. He found that employment rates after release were higher than those prior to incarceration. There was general acceptance of the educational program as such, with need for vocational expansion indicated. Ninety-two percent of those interviewed stated that the program at the institution should be continued and expanded. Beadle recommended a two-fold approach for improvement which included both (1) expansion of vocational programs, and (2) a "new look" at the period of incarceration as one of treatment rather than punishment, providing a better effect on both the "giver" and the "receiver" of the treatment.

Another study concerned with inmate education at the State Prison of Southern Michigan was conducted by Hershey.[2]

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[1]James Beadle, "A Survey and Analysis of the Educational Program of the Academic School of the State Prison of Southern Michigan, Jackson, Michigan, and Its Implications for the Rehabilitation of Released Inmates," (Ph.D. dissertation, Michigan State University, 1965).

[2]Harvey Hershey, "Adult Education and Personality of Inmates of the State Prison of Southern Michigan" (Ph.D. dissertation, Michigan State University, 1966).

He attempted to ascertain personality differences between participators and non-participators in the adult education programs of that institution. Based upon the results of the Sixteen Personality Factor Questionnaire, participators were found to be significantly more rigid, undependable and conventional than the non-participators. The non-participators were found to be significantly more easy-going, conscientious, and imaginative than the participators. Hershey recommended that the significant differences found in his study should be kept in mind by the adult educator when trying to recruit the non-participator, or when trying to meet his needs once he tries to become a participator.

Whipple[1] was also concerned in his study with relationships between correctional education and personality. He investigated the effect of group bibliotherapy on academic achievement in biological science and on personality. Subjects were 104 inmate students enrolled in a biological science course at the Granite, Oklahoma, reformatory. All groups in the study used the same textbook, materials, and laboratory equipment. The experimental group was altered in that one hour per day was spent in bibliotherapy. The bibliotherapy included the utilization of psychological-social articles and books supplementary to the textbook, as well as

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[1]Charles M. Whipple, Jr., "The Effect of Short Term Classroom Bibliotherapy on the Personality and Academic Achievement of Reformatory Inmate Students" (Ed.D. dissertation, University of Oklahoma, 1968).

other library resources such as films, filmstrips, tapes, and bulletin board items. Therapy procedures were inculcated into regular classroom work. Improvement of the bibliotherapy group in biological information was significantly greater than that for the control group, as measured by the Nelson Biology Test. The improvement of the bibliotherapy group was significantly greater than the improvement of the control group on the following scales of the Minnesota Multiphasic Personality Inventory: Pd (psychopathic deviate), Sc (schizophrenia), and Ma (hypomania). Bibliotherapy proved least effective on scales Hs (hypochondriasis), D (depression), and Pt (psychasthenia).

In contrast to the studies showing benefits accruing from prison education, a startling study by Glaser of 1,015 federal releasees for 1956, found that inmates who had been enrolled in federal prison schools had higher recidivism rates than those who had not been enrolled. These results were so contrary to earlier research and so unexpected that Glaser tried to speculate as to what could have caused such results. His speculations are briefly summarized below:

1. Officials make great efforts to place in school inmates who are academically retarded below their presumed mental capacity, especially those who have not gone through the eighth grade. These inmates may be especially poor risks because of low prospects for legitimate employment.

2. Sometimes education competes with other activities (such as prison industries) which may be more rehabilitative than school.

3. A large number of those who enroll may do so mainly to impress the parole board; such inmates are insincere and relatively poor parole risks.

4. A prison education may markedly raise an inmate's vocational aspirations without increasing his ability to satisfy those aspirations upon release.[1]

Patrick,[2] in studying factors associated with the success of vocational trainees and parolees at the Federal Reformatory, El Reno, Oklahoma, found a slight tendency for vocational training successes to be parole successes, but this relationship was not statistically significant. Of ten factors studied, only three were found to be significant in regard to vocational training success and parole success. These were: mental age (greater success for those above the mean of 16 years); chronological age (greater success for those above the mean of 20.1 years of age); and release destination (greater success for those released to their home communities).

Interest in the use of programmed instruction in correctional education has received considerable impetus from the studies conducted by McKee at the Draper Correctional Center, Montgomery, Alabama. In a study conducted by McKee

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[1]Daniel Glaser, The Effectiveness of a Prison and Parole System (Indianapolis: Bobbs-Merrill Co., 1964), pp. 275-76.

[2]Ernest W. Patrick, "Significant Factors Associated with the Success of Vocational Trainees and Parolees at the Federal Reformatory, El Reno, Oklahoma" (Ed.D. dissertation, Oklahoma State University, 1958).

and reported by Anderson and Niemi,[1] programmed instruction and teaching machines were used with an experimental group which received 40 hours of reading instruction along with 160 hours of remedial instruction. The mean gains in reading level were 2.39 for the experimental group compared to .27 for the control group. In total gain, the experimental group achieved a 1.37 mean grade gain compared to 1.05 for the control group, a statistically significant difference.

Carson[2] studied the effects of programmed instruction as a supplementary teaching aid in Adult Basic Education classes at the Ohio State Reformatory. Inmates at the Mansfield, Ohio, institution participated in the experimental study while inmates at the correctional institution at Lebanon, Ohio, served as a control group. On the basis of scores from the Test of Adult Basic Education, subjects were divided into the following three levels: Easy, Medium, and Difficult. Significant differences favoring the experimental group were found for the Easy and Difficult levels for reading comprehension, and for total reading scores at the Easy level. No significant differences were found at any levels for reading vocabulary between the two groups. Carson concluded that programmed instruction can be effectively used as a supple-

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[1]Anderson and Niemi, Adult Education, p. 42.

[2]James E. Carson, "The Effects of Programmed Instruction as a Supplementary Teaching Aid in Adult Basic Education Classes at the Ohio State Reformatory, Mansfield, Ohio," (Ph.D. dissertation, Ohio State University, 1970).

mentary teaching aid in penal institutions with Easy and Difficult level inmates. He suggested that high motivation can be maintained if programmed materials are not overused, and that student-teacher relationships must be maintained for the successful use of programmed materials. He recommended that inmates be pretested and given programmed materials appropriate to their levels.

Using a programmed linguistic spelling kit with an experimental group and a traditional approach with a control group, Metcalf[1] examined a new approach to the teaching of functionally illiterate incarcerated adults. No significant differences were found for the two groups on any of the aspects measured.

Although Henney[2] was not concerned with programmed instruction in his study, he did seek to determine whether group or individual instruction would exert the greater influence on progress in reading performance. He devised the Family Phonics System in an effort to determine the effectiveness of such a phonics system with illiterate adults. Differences between the use of the system in group teaching and

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[1]Richard J. Metcalf, "A Study to Compare the Effectiveness of a Programmed Linguistic Spelling Kit with Traditional Methods of Teaching Spelling to Functionally Illiterate Adults in Correctional Institutions: (Ph.D. dissertation, Florida State University, 1971).

[2]Robert L. Henney, "Reading Instruction by a Phonic Method for Functionally Illiterate Adults at the Indiana Reformatory: (Ph.D. dissertation, Indiana University, 1964).

in individual instruction were not statistically significant. He concluded that group instruction was just as effective with this system as was teaching on a one-to-one basis. There was a statistically significant difference in the gains made by the experimental group over those made by the control group which had continued in the regular program of the elementary school at the reformatory.

The need for additional research related to reading education in penal institutions is apparent. As noted, few studies have dealt specifically with this problem, and fewer still have considered the "higher levels of illiteracy." Glaser makes an excellent case for the need of research in correctional education when he states:

> While research is worthwhile in any school, it is not always as essential as it is in prison schools. Most schools can learn the answers to their questions by studying the published reports of research done elsewhere or with pupils comparable to theirs. In correctional education there is not enough research literature available to meet the needs of prison schools.[1]

Eye-Movement Research

The study of eye movements has made a major contribution to objective knowledge of the reading process. Tinker has said that "No serious student of the psychology and pedagogy of reading can neglect the contributions of eye-

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[1]Glaser, Effectiveness of Correctional Education, p. 6.

movement studies."[1]

According to Spache,[2] interest in eye movement in the act of reading dates back to the early part of the nineteenth century. Early techniques included the use of mirrors and a variety of devices attached to the eyeball. Later a corneal reflection method was used, and a number of corneal reflection cameras were developed at various universities and reading centers. Many of these cameras were quite elaborate and tremendous in size. In 1932 a small semi-portable camera called the Opthalmograph was invented. The use of electrical methods for recording eye movements began to gain in popularity in the late 1930's. Tinker[3] noted the trend toward the use of an electrical rather than a corneal reflection method. He indicated the advantages of the electrical method in experimental situations where continuous records must be taken for long reading periods. He concluded however, that for use in reading investigations, the corneal reflection method was probably superior to electrical recording. Much of the research related to eye-movement studies took place

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[1]Miles A. Tinker, "Eye Movements in Reading," Journal of Educational Research 30 (December, 1936), p. 241.

[2]George D. Spache, "Evaluation of Eye-Movement Photography in Reading Diagnosis and Reading Training," in Research and Evaluation in College Reading, ed. Oscar S. Causey and Emery P. Bliesmer (Fort Worth: Texas Christian University Press, 1960), p. 98.

[3]Miles A. Tinker, "The Study of Eye Movements in Reading," Psychological Bulletin 43 (March 1946):93-120.

during the period from 1930 to 1950. In his 1958 review of the literature, Tinker[1] noted a decline in the number of studies done in the area during the period from 1947 to 1958.

During 1959, a new, completely portable, simplified camera called the Reading Eye was devised by Stanford Taylor for the Educational Laboratories of Huntington, New York. Spache,[2] very enthusiastic about the Reading Eye, suggested that it reopened the possibilities of research in eye movements.

Some ten years later the Reading Eye II, which utilized a photoelectric method, was developed. This instrument is compared to the earlier model Reading Eye by Brickner in the following statement:

> Subsequent development of a portable binocular eye-movement camera made nonclinical use of the technique more feasible, but difficulty of camera use, the film development process, and delayed feedback of results have limited general classroom or reading laboratory acceptance. An instrument designed by Biometrics, Inc., and introduced in 1969, makes tracking of eye movements far easier, faster, and more economical. With this instrument, the corneal reflection is monitored by independent pairs of photocells and the signals are amplified and recorded on heat-sensitive graph paper by two heat pens.[3]

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[1]Idem, "Recent Studies of Eye Movements in Reading," Psychological Bulletin 55 (July 1958):215-23.

[2]Spache, "Evaluation of Eye-Movement Photography," p. 99.

[3]C. Ann Brickner, "The Analysis of Eye-Movement Recordings from Samples of Underachieving Secondary and Primary Students," Audiovisual Communications Review 18 (Winter 1970): 414-15.

In considering the value of eye-movement records, it is important to know something about the reliability and validity of eye-movement measures. Morse[1] summarized the results of earlier studies dealing with the reliability of eye-movement measurement scores. He criticized some of the studies for use of the split-half method and the odd-even method, since they are likely to yield higher correlations than the test-retest method. He concluded, however, that the eye-movement technique would yield reliable scores if an adequate amount of material is used.

Tinker[2] found that eye-movement measures, even for reading selections of 5 or 6 lines, had adequate reliability for group comparisons. For individual diagnosis, twenty or more lines are required for adequate reliability. When 23 lines of easy prose and 39 lines of hard prose were used the test-retest reliabilities ranged from .72 to .88 with an average of .82.

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[1]William C. Morse, "A Comparison of the Eye-Movements of Average Fifty-and Seventh-Grade Pupils Reading Materials of Corresponding Difficulty," in William C. Morse, Francis A. Ballantine, and W. Robert Dixon, Studies in the Psychology of Reading (Ann Arbor: University of Michigan Press, 1951; reprint ed., New York: Greenwood Press, Publishers, 1968), p. 30.

[2]Miles A. Tinker, "Reliability and Validity of Eye-Movement Measures of Reading," Journal of Experimental Psychology 19 (December 1936):732-46.

The importance of passage length to reliability has been well established. Studies by Stone,[1] Seibert,[2] and Ledbetter[3] point to the importance of position of the passage to be analyzed. Each of these researchers used three 100-word selections in their studies. Stone, whose subjects were college freshmen, found that for all measures except pause duration the third hundred words were read most efficiently, and the second hundred words in the most representative way. Seibert, repeating Stone's experiment with eighth grade subjects, found greatest efficiency of eye-movements during the third hundred words, with the most representative sample being the second hundred words.

Ledbetter's study of eleventh grade students found slightly different results, with some measures proving more efficient on the second 100-word passage and some proving more efficient on the third 100-word passage. She concluded that selections of at least two hundred words or longer provide a fairer test of the student's abilities as measured by

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[1]Lewis G. Stone, "Reading Reactions for Varied Types of Subject Matter: An Analytical Study of the Eye-Movements of College Freshmen," Journal of Experimental Education 10 (September 1941):64-77.

[2]Earl W. Seibert, "Reading Reactions for Varied Types of Subject Matter: An Analytical Study of Eye Movements of Eighth Grade Pupils," Journal of Experimental Education 12 (September 1943):37-46.

[3]Frances G. Ledbetter, "Reading Reactions for Varied Types of Subject Matter: An Analytical Study of the Eye Movements of Eleventh Grade Pupils," Journal of Educational Research 41 (October 1947):102-118.

film records than do shorter selections.

One of the important problems related to the validity of eye-movement measures is the probability that reading will follow a normal course during such testing. It has been suggested that the testing situation is so distracting that it is impossible to get a normal reading performance. Tinker had college students read one form of the Chapman Cook reading test before the camera, and an alternate form away from the camera. He found no significant differences between the two situations, concluding that his subjects "gave an entirely typical performance in the photographic situation."[1] He was, however, careful to establish rapport with his subjects in the camera situation by explaining how the camera worked and by letting them practice before the camera.

Gilbert and Gilbert conducted a similar study with fifth-grade students, and found that "the conditions imposed by the photographic apparatus and technique brought about significant changes in neither rate nor understanding." They also stressed the importance of good relationships between the examiner and the subjects, concluding: "Establishing rapport is not merely legitimate; it is essential."[2]

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[1]Miles A. Tinker, "Reliability and Validity," p. 742.

[2]Luther C. Gilbert and Doris W. Gilbert, "Reading before the Eye-Movement Camera Versus Reading Away from It," Elementary School Journal 42 (February 1942):447.

Richardson[1] observed that validity for eye-movement coefficients have been computed from three criteria: correlations with standardized reading tests, correlations of internal consistency, and contrasting groups.

Correlations with scores on reading tests yield very low validity coefficients. Tinker[2] has pointed out that this test of validity is unsatisfactory since it is well known that reading scores derived from different reading situations are not related or yield only low correlations. He found that when the test material read before the camera is strictly comparable to that in the performance tests, the validity coefficient for fixation frequency varied between -.80 and -.99 and for perception time between -.87 and -.90. (The negative coefficients indicate that the reading score increased as the fixation frequency and perception time decreased.)

Internal consistency measures are found by correlating eye movement measures with measures for comprehension and speed on the material read. Simpson[3] found the average number of fixations and the average number of regressions

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[1]Joy B. Richardson, "The Differential Timing of Discrete Eye Movements of Readers Differing in Levels of Comprehension" (Ph.D. dissertation, University of California, 1960). p. 12.

[2]Tinker, Eye Movements, p. 266.

[3]R. G. Simpson, "The Relationship of Certain Functions to Eye-Movement Habits," Journal of Educational Psychology 25 (February 1934):97-98.

per line to correlate respectively, -.80 and -.69 with rate of reading as measured by the eye movement camera. Tinker and Frandensen found certain trends in intercorrelation of eye-movement measures which are summarized below:

1. Fixation frequency consistently correlates high with perception time.
2. Pause duration shows only a slight to moderate sized correlation with perception time.
3. Regression frequency yields a fair correlation with perception time. Although not a good measure of speed of reading, it is somewhat better than pause duration.
4. Pause duration is not diagnostic of either fixation frequency or regression frequency.
5. Regression frequency correlates rather high with fixation frequency.[1]

Seibert, analyzing the eye movements of eighth grade pupils as they read varied types of subject matter, concluded:

> There is little relationship between comprehension scores and eye-movement measures. Number of fixations, number of regressions, duration of fixation, span of recognition, or rate of reading can not be predicted on the basis of the scores in comprehension. Reading comprehension and eye-movement measures are two different phases of the complex process of reading.[2]

The data from contrasted groups provide further indication of the validity of eye-movement measures. Anderson[3] compared the eye-movement patterns of 50 good and 50 poor readers to find how such readers adjust to changes in the

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[1]Miles A. Tinker and Arden Frandensen, "Evaluation of Photographic Measures of Reading," Journal of Educational Psychology 25 (February 1934):97-98.

[2]Seibert, "Reading Reactions," p. 38.

[3]Irving H. Anderson, "Studies in the Eye-Movements of Good and Poor Readers," Psychological Monographs, 48, 3 (1937), 1-35.

difficulty of the reading material and to reading for different purposes. Every measure of eye movements, except for mean size of duration, distinguished good from poor readers at every level of difficulty. Good readers made fewer fixations and fewer regressions, had wider spans of perception, had shorter duration of fixations, and read more words per minute than poor readers. Good readers showed a greater flexibility in eye movements than did poor readers. Anderson concluded that difficulty of material read and purpose for reading were two important determinants of regularity in eye movements.

Taylor, using the Reading Eye camera, reported on two studies of the validity of eye-movement photography as a measurement of reading performance. In the first study, he compared the reading rate of 90 subjects taken in random samples of 30 each from the 4th, 7th, and 10th grade levels on the Reading Eye and the rate section of the appropriate form of the Survey Section of the Diagnostic Reading Tests. He concluded that:

> . . . A comparison of the performance on the rate test of the Survey Section, Diagnostic Reading Test and rate of reading as determined with an eye-movement photograph shows relatively high correlation, indicating that apparently similar functions are being measured. This supports the conclusion that eye-movement photography tests can be used as a valid measurement of rate.[1]

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[1]Stanford E. Taylor, "A Report on Two Studies of the Validity of Eye-Movement Photography as a Measurement of Reading Performance," in Reading in a Changing Society, ed. J. A. Figurel (Newark: International Reading Association, 1959), p. 242.

In a second study, the following hypothesis was tested:

> That the components measured by eye-movement photography will prove to be largely independent of the degree of difficulty of the content, the reader's degree of interest in the material read, and the reader's conscious control over his performance.[1]

Taylor concluded that difficulty of content did not materially disturb the pattern of eye-movement characteristics when the material was at or below grade level. Significant differences were found when the material read was more than two grade levels above the reader's ability. No significant differences were found in the eye-movement habits that could be attributed to interest in the selection. Finally, it was found that subjects were able to vary their rates to some extent, but not without a significant loss of comprehension.

In regard to the validity and reliability of eye-movement photography, Taylor concluded:

> . . . . These experiments reaffirm earlier studies which concluded that eye-movement photography is a valid measurement of reading proficiency, especially with regard to rate.
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> . . . . These studies support the fact that eye-movement measures are reliable, provided, of course, that sufficient care is taken in the preparation of the test selections and in the testing procedure.[2]

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[1] Ibid.

[2] Ibid., p. 245.

Brown[1] studied the effect of selected purposes on the eye movements and comprehension of third and seventh grade students of fifth grade reading ability. His sample population consisted of 30 advanced and 31 retarded students of at least average mental ability. Subjects were directed to read for each of three selected purposes: (1) read in usual manner; (2) read for main idea; (3) read for detailed information.

He concluded that the advanced third graders read with significantly lower comprehension than the seventh graders, but excelled them in reading rate and oculo-motor reading efficiency. He also found that the direction to "read for the main idea" produced the highest comprehension for both advanced and retarded readers. Retarded readers read with greatest efficiency from an oculo-motor standpoint when directed to read in the usual manner, while advanced readers read most efficiently when asked to read for the main idea.

Brown's study points out several important concepts related to eye-movements and reading. First, dramatic differences may exist in the oculo-motor behavior of subjects reading at the same grade level as measured by standardized tests. A grade level score does not indicate the efficiency

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[1]Don A. Brown, "The Effect of Selected Purposes on the Oculo-Motor Behavior and Comprehension of Third and Seventh Grade Students of Fifth Grade Reading Ability" (Ed.D. dissertation, University of Oregon, 1964).

or lack of efficiency with which material is read. Second, comprehension and eye-measurement scores reflect two different aspects of reading. We cannot really tell much about comprehension from eye-movement measures. Third, setting purpose for reading may influence the way in which a selection is read, in terms of relative emphasis placed upon comprehension and rate.

Palmer[1] analyzed the results of eye movements of adults at three reading levels while decoding unfamiliar words. Adults reading at grade levels 3-4; 6-7; and 9-10, were photographed with a Reading Eye camera while decoding nine words from a graded vocabulary list. He concluded that subjects in each of the levels tended to use individual letters as the initial point of word decoding. He also concluded that the better readers were more successful in their first attempts at decoding than the poorer readers since the better readers used significantly fewer regressions. Palmer's study is significant because it is one of the few eye-movement studies of undereducated adults conducted in recent years.

Singer[2] studied the effect of varying visual and auditory modalities on the eye movements, reading comprehen-

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[1]Robert E. Palmer, "An Analysis of the Eye Movements of Adults at Three Levels of Reading Ability when Decoding Isolated Unfamiliar Words" (Ph.D. dissertation, Florida State University, 1969).

[2]Caroll R. Singer, "Eye Movements, Reading Comprehension, and Vocabulary as Effected by Varying Visual and Auditory Modalities in College Students" (Ed.D. dissertation, New Mexico State University, 1970).

sion, and vocabulary of 42 college students. She found that in regard to comprehension under the three conditions tested, listening produced the lowest comprehension, while reading and reading paired with listening yielded comparable results. She also found that when reading was paired with listening, the subjects made more regressions per 100 words, that they had smaller spans of recognition, that duration of fixations were longer, and that the rate of reading was decreased. She recommended that further study using compressed speech paired with reading be made to determine if the increase in speech speed would affect eye movements and comprehension.

Hoover[1] studied three methods of acquiring information: by reading, reading-listening, and listening. He compared comprehension and eye movements as subjects read at four levels of difficulty. He also compared comprehension and eye movements as subjects read-listened (a) at three presentation rates and (b) across four levels of difficulty. His subjects were seventh grade students reading at least two years below grade level.

Hoover found that reading comprehension and reading-listening comprehension were significantly different, with reading-listening comprehension higher than reading comprehension. He also found that eye movements were significantly

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[1]Dean Hoover, "The Effect of Method of Material Presentation upon Eye Movements and Comprehension" (Ph.D. dissertation, University of Oklahoma, 1973).

different as subjects read and as they read-listened. Highly significant differences existed when reading was compared with reading-listening at the presentation rates of 125 wpm and 225 wpm, but not at the 175 wpm presentation rate, which was very close to the average rate of reading for these subjects. When reading was compared with reading-listening at the 125 wpm presentation rate, subjects made more fixations and regressions for the reading-listening treatment. When reading was compared with reading-listening at the 225 wpm presentation rate, subjects made fewer fixations and regressions for the reading-listening treatment. Hoover concluded that these differences in regard to presentation rate indicate the dominant effect that the auditory modality has upon visual performance when reading-listening activities are combined.

Hoover's study poses some interesting but yet unanswered questions. It should be noted that no significant differences were found in comprehension as the result of varying presentation rates. If increasing the rate of presentation results in no significant loss in comprehension, and if eye movements are more efficient at higher rates of presentation, it would seem that methods using rates of presentation well in excess of the individual's normal rate of reading might prove beneficial. At what point might such presentations cause decreased comprehension? Is it possible that rates that are too slow might cause loss in comprehension

by some individuals? Is it possible that rates that are much slower than the person's normal reading rate might result in increased comprehension for some individuals? What is the most desirable relationship between a person's normal rate of reading and rate of presentation for accompanying tapes? Does the use of accompanying tapes for undereducated adults produce similar results to those obtained for remedial readers in elementary school? Such questions point to the need for additional research in this area.

Bimodal Versus Monomodal Transmission of Information

The studies by Singer and Hoover point up the contradictory findings in research related to the value of bimodal versus monomodal presentation of verbal material. Jones has said that:

> One of the most controversial issues in the field of communications today concerns the relative value of presenting redundant verbal material through one channel (audio or print) as opposed to several channels (audio and print).[1]

Day and Beach,[2] reviewing thirty-four studies involving material presented aurally and visually, found that about half of the studies favored the aural method of presentation

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[1]John P. Jones, Intersensory Transfer, Perceptual Shifting, Modal Preference, and Reading (Newark, Del.: International Reading Association, 1972), p. 23.

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

and about half the visual. Most studies, however, found that a combination of visual and auditory presentation of information was better than the presentation of information through either modality alone.

In a later review of the research in this area, Hartman considered the effectiveness of pictorial, auditory, verbal, and print channels used singly and in various combinations. He concluded that in single channel presentation ". . . the effectiveness of print relative to audio increases as the difficulty or complexity of the material increases provided the subjects are literate."[1] This generalization was found to be applicable for nonsense syllables, digits, meaningful words and meaningful prose.

Based on a study which he had conducted earlier, Hartman[2] concluded that in regard to multiple presentation combinations of pictorial, print, and audio channels, the audio-print combination was the most consistently effective of seven possible combinations. He also concluded that the simultaneous presentation of redundant materials through audio and print channels is more effective than single channel presentation through either modality alone.

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[1]Frank R. Hartman, "Single and Multiple Channel Communication: A Review of Research and a Proposed Model," Audiovisual Communication Review 9 (November-December 1961): 235-262.

[2]Idem, "Recognition Learning under Multiple Channel Presentation and Testing Conditions," Audiovisual Communication Review 9 (November-December 1961):24-45.

Hartman joined the two concepts of cue summation and stimulus generalization in an effort to provide a model for predicting outcomes in single and multiple-channel transmission of information. He states:

> . . . the cue summation and the stimulus generalization-iconicity theories would seem to reduce to two sides of a coin. Together, they predict that an increase in the number of cues available in the presentation of information increases the recognition or discrimination of that information, provided the cues are also available in the situation wherein the discrimination is tested.[1]

From his review of the experimental literature, Hartman[2] concluded that certain major generalizations appear valid. Those most pertinent to the question of the relative value of single channel (audio or print) presentation as opposed to multi-channel (audio and print) presentation are summarized below:

1. Comparing the channels individually as transmittors of information:
   a. the print channel is more effective than the audio when the information presented is difficult and the subjects are reasonably literate.
   b. the audio channel is more effective than the print channel when less difficult material is used and when the subjects are illiterate.
2. The learning of information presented in several channels is more likely to be demonstrated if it is tested on several channels.
3. Summation of cues, or facilitation--an increase of learning with increasing information provided by multiple channels--will take place under certain conditions:
   a. when redundant information is presented simultaneously in print and audio channels the facilitation of simultaneously hearing and

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[1]Ibid., p. 29.

[2]Hartman, "Single and Multiple Channel," pp. 254-55.

reading a verbal message may be demonstrated in tests on either channel alone--a fact contradictory to the stimulus generalization hypothesis noted above.

b. when the additional cues are also present in the testing of the information.

4. Interference among information simultaneously presented by multiple channels may be expected when:
   a. the information in the various channels is unrelated or contradictory.
   b. the cognitive difficulty or rate of presentation is such that successful alternation of attention among channels is not possible.

Severin[1] questioned whether the use of audio and print channels simultaneously presenting redundant material actually provides additional cues. He hypothesized that for literate people the addition of totally redundant information through audio and print channels would provide no additional cues over a single channel presentation. In a later study, Severin[2] found no significant differences between the use of the audio-print combination and print alone. He did find both the print alone treatment and audio-print treatment to be superior to the audio alone treatment.

Van Mondfrans and Travers[3] have been highly critical of the early research investigating the relative efficiency

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[1]Werner Severin, "Another Look at Cue Summation," Audio-visual Communication Review 15 (Fall 1967):233-245.

[2]Idem, "The Effectiveness of Relevant Pictures in Multiple-Channel Communications," Audiovisual Communications Review 15 (Winter 1967):386-401.

[3]Adrian P. Van Mondfrans and Robert M. W. Travers, "Learning of Redundant Material through Two Sensory Modalities," Perceptual and Motor Skills 19 (December 1964): 743-51.

of an audio-visual presentation of redundant information with the efficiencies of the audio and visual channels alone. They point out that none of the studies reviewed by Day and Beach reported levels of significance and many of the observed differences were slight.

Broadbent's[1] model of the perceptual system was used by Van Mondfrans and Travers as an argument against the concept of superiority of simultaneous presentation of redundant information. The "Filter Theory" of attention was presented as an explanation of how the central nervous system processes sensory information. Major components of this theory include a short-term storage system (S-system), a selective filter, and an information utilization channel (P-system). The S-system has no definite limit on its capacity, but the P-system is viewed as a limited capacity system. Information enters the S-system through a number of parallel input sensory channels. It is the function of the filter system to select one of the input lines and allow its information access to the P-system. Other lines which are not allowed access to the P-system hold their messages in the short term store until the channel is cleared or until fading occurs, with a subsequent deterioration or complete loss of the message.

It should be noted that Broadbent's theory was meant to apply to unrelated, nonredundant auditory messages origi-

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[1]Donald E. Broadbent, Perception and Communication (London: Pergamon Press, 1958).

nating from two or more sources. Van Mondfrans and Travers attempted to extend the theory to simultaneous multi-channel presentation of redundant material. They examined (1) the relative effectiveness of monomodal and bimodal presentations of materials varying in meaningfulness and redundancy and (2) whether simultaneous presentation of redundant materials through audiovisual modalities resulted in perceptual interference, with exposure rates as the independent variable. College students were presented lists of nonsense syllables, words, or words with constraint, using visual, auditory and audiovisual modes of presentation at rates varying from one stimulus each four seconds to one each .6 seconds. After each presentation subjects were asked to write as many of the sixteen items as could be recalled within ninety seconds.

No significant differences were found among the three modes of presentation except in the instance of nonsense syllables. When nonsense syllables were used, the visual as well as the visual+auditory presentations were significantly superior to the auditory presentations. Perceptual interference in the audiovisual presentation was not demonstrated in either of the two experiments conducted.

Van Mondfrans and Travers speculated that:

> . . . . One would not expect multiple-channel inputs of redundant information to facilitate learning. The possible exception to this is the situation in which information is transmitted at such a slow rate that the learner can switch from channel to channel, and hence,

> perhaps, can increase his learning by having what amounts to an additional trial.[1]

A study by Bryant et al. would seem to contradict the speculations of Van Mondfrans and Travers in regard to rate of presentation and relative effectiveness of simultaneous presentation of redundant material through audio-print channels. The Bryant study was concerned with the effectiveness of taped reading instruction in increasing the reading rate and comprehension of undereducated adults. It was found that when these subjects were allowed to listen to accompanying tapes of material as they read it, both their rate of reading and comprehension increased significantly as compared to these measures when they read the printed material only. Bryant noted an exception to this trend:

> . . . While this research suggests that tapes are beneficial, it also indicates that reading material that is taped at speeds slower than the adult student normally reads may interfere with both the speed and the comprehension of the learner. There is a need for additional research to determine the most efficient speed to record materials for students reading at specified rates and grade levels.[2]

Bryant's study is in agreement with the findings of Singer for college students and Hoover for remedial seventh grade students in regard to rate, but not in regard to comprehension. Neither Singer nor Hoover found that rates of presentation below the individual's normal reading rate resulted

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[1]Van Mondfrans and Travers, "Effectiveness," p. 744.

[2]Bryant, "Effectiveness," p. 250.

in loss of comprehension. This poses an interesting question. If Van Mondfrans and Travers are correct in their assumptions, slower rates of presentation should produce the most beneficial results for comprehension measures, with faster rates showing less benefit or decrement in results.

The question of bimodal versus monomodal superiority in the transmission of information is still an unanswered one. Hsia, in a recent review of the literature in this area, contended: "The only conclusion that can be drawn from nearly a thousand studies surveyed is: no secure general proposition can yet be stated."[1]

Hsia points out that in the majority of studies on the comparative effectiveness of auditory, visual, and audiovisual presentation, a major point of contention is whether or not a human being is capable of handling the simultaneous presentation of audiovisual stimuli. He then contrasts the positions taken by Broadbent and Garner.[2]

With the Broadbent theory the "single communication channel" concept of human information processing is expounded. Audio and visual stimuli arriving simultaneously would cause information jamming. Hsia points out that Broadbent's theory does not consider the amount of information and redundancy.

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[1]Hsia, "Information Processing," p. 52.

[2]Wendell R. Garner, Uncertainty and Structure as Psychological Concepts (New York: John Wiley and Sons, 1962).

He contends that jamming would occur only when information to be processed exceeds the information processing capacity of the central nervous system.

In contrast to the viewpoint expressed in the Broadbent model, Garner contends that increased dimensionality of information increases information transmission and reception. He questions the validity of a single channel concept by stating that "a simple channel capacity is clearly inappropriate."[1]

Hsia attempts to reconcile the divergent viewpoints of Broadbent and Garner by suggesting:

> . . . . The seemingly divergent views on the information processing rate held by Garner and Broadbent may not be incompatible after all. Man is a multiple-channel organism when input is optimal. In other words, he is capable of processing information through multi-channels so long as the inflow is within the limit of his information processing capacity. When input is far beyond his information processing capacity, it is possible that man may act as a "single communication channel."[2]

A more recent theory of attention proposed by Kahneman[3] would accommodate the viewpoint suggested by Hsia. Kahneman proposes a capacity model for attention which assumes that there is a general limit on man's capacity to perform mental work, but this limited capacity can be

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[1]Ibid., p. 135.

[2]Hsia, "Information Processing," p. 65.

[3]Daniel Kahneman, Attention and Effort (Englewood Cliffs, N.J.: Prentice Hall, 1973).

allocated with considerable freedom among concurrent activities. An allocation policy and evaluation of demands on the limited capacity are central elements of the model. The evaluation of demands is the governor that causes capacity (or effort) to be supplied, as dictated by the activities selected by the allocation policy. The policy in turn is controlled by the four factors summarized below:

1. Enduring dispositions reflecting the rules of involuntary attention (e.g. allocate attention to novel stimuli, to an object in sudden motion, etc.).
2. Momentary intentions (e.g. listen to the voice on the right earphone, read for the main idea, etc.).
3. The evaluation of demands: when two activities demand more capacity than is available, one tends to be completed.
4. Effects of arousal (both under-arousal and over-arousal result in lowered performance).

Kahneman included the allocation policy from his capacity model for attention in a schematic model for perception and attention. In the final chapter of his book he concludes:

> . . . The main attributes of attention are the following:
>
> 1. Attention is limited, but the limit is variable from moment to moment. Physiological indices of arousal provide a measure that is correlated to the momentary limit.
> 2. The amount of attention or effort exerted at any time depends primarily on the demands of current activities. While the investment of attention increases with demands, the increase is typically insufficient to fully compensate for the effects of increased task complexity.
> 3. Attention is divisible. The allocation of attention is a matter of degree. At high levels of task load, however, attention becomes more nearly unitary.
> 4. Attention is selective, or controllable. It can be allocated to facilitate the processing of selected

> units of performance. The policy of allocation reflects permanent dispositions and temporary intentions.[1]

If Kahneman's theory is correct, we may assume that an individual is capable of parallel processing of material under certain conditions, but under other conditions may resort to serial processing. This theory has direct application to bimodal transmission of information. In the audio-print situation, subjects would be able to process information from both channels so long as the material is not too demanding in terms of content or rate of presentation. How the allocation policy would be applied by individuals under conditions of competing attention from audio and print channels could be determined to some extent by data obtained from eye-movement records and comprehension tests.

Compressed and Expanded Speech Tapes as Reading Aids

The use of compressed and expanded speech tapes as reading aids is a specialized aspect of the bimodal transmission of information. The invention of workable techniques for expanding and compressing speech has made possible many new areas of research in communications. Orr, in a symposium on compressed speech, suggested that "The study of interaction between reading and listening, as a communication phenomenon, can now begin to be studied through the use of compressed

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[1]Ibid., p. 201.

speech as a research tool."[1]

The intelligibility and comprehension of compressed speech has been a major research concern since the early stages of its development. Foulke, in an effort to consolidate earlier research on the topic, combined the results of several studies. He reports:

> Within the range extending from 126 to 172 wpm, Diehl, White, and Burk found listening comprehension to be unaffected by changes in word rate. In the range extending from 125 to 225 wpm, Nelson and Harwood found a slight, but significant loss in comprehension as word rate was increased. Fairbanks, Guttman, and Miron found little difference in the comprehension of listening selections presented at 141, 201, and 282 wpm. Thereafter, comprehension, as indicated by percent of test questions correctly answered, declined from 58% correct at 282 wpm to 26% at 470 wpm. Foulke, Amster, Nolan, and Bixler, using both technical and literary listening selections, found comprehension to be only slightly affected by increasing word rate up to 275 wpm. However, in the range extending from 275 to 375 wpm, they found an accelerated decrease in comprehension as word rate was increased. Foulke and Sticht, using the STEP Listening Test found a decrease in comprehension of 6% between 225 and 325 wpm, and a decrease of 14% between 325 and 425 wpm.[2]

Using college students as subjects, Foulke[3] varied word rate in increments of 25 wpm from 125 wpm by means of the sampling method for compressing or expanding recorded speech. Comprehension was not seriously affected by increas-

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[1]H. H. Cramer et al., "Symposium on Rate Controlled Speech and Listening Comprehension," in The Psychology of Reading Behavior, ed. G. B. Schick and M. M. May (Milwaukee: National Reading Conference, 1969):141.

[2]Emerson Foulke, "Listening Comprehension as a Function of Word Rate," Journal of Communication 18 (September 1968):199.

[3]Ibid., pp. 198-206.

ing word rate from 125 to 250 wpm, but it declined rapidly thereafter, indicating that significant loss in comprehension may occur at lower rates of compression than previously reported.

Certain listener variables tend to affect the comprehension of compressed speech. Watts[1] found higher educational level to be positively related to attainment on tests over material presented at 250 wpm. Stitch[2] found a significant relationship between intelligence and ability to comprehend compressed speech. Orr, Friedman, and Williams[3] found a significant positive correlation between reading rate and the ability to comprehend accelerated speech. There is some indication that ability to comprehend compressed speech can be improved with practice, although Orr[4] points out that the results are not without ambiguity.

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[1]Meredith W. Watts, "Differences in Educational Level and Subject Matter Difficulty in the Use of Compressed Speech with Adult Military Students," Adult Education Journal 21 (Winter 1971):27-36.

[2]Thomas G. Stitch, "Some Relationships of Mental Aptitude, Reading Ability, and Listening Ability Using Normal and Time-Compressed Speech," Journal of Communication 18 (September 1968):243-58.

[3]David B. Orr, Herbert L. Friedman, and Jane C. Williams, "Trainability of Listening Comprehension of Speeded Discourse," Journal of Educational Psychology 56 (June 1965): 148-156.

[4]David B. Orr, "Time Compressed Speech--A Perspective," Journal of Communication 18 (September 1968):288-92.

Few studies have been concerned with the comprehension of expanded speech. Altshuler[1] examined the responses to expanded speech of hard of hearing aged subjects. Thirty-six male subjects were classified into four experimental groups of nine subjects each:

1. a group of young adult subjects with normal hearing.
2. young adult hard of hearing subjects.
3. aged subjects without phonemic regression.
4. aged subjects with phonemic regression.

Altshuler found that all the experimental subjects on the test for factual information in experimental passages performed better at the 20% and 30% time-expansion levels over the 10% expansion level. He found that performance for all subjects on the test for factual information increased as rate of expansion increased.

Staffen[2] investigated the comprehension of expanded and compressed speech by emotionally disturbed children. The variables included rate of presentation, type of emotional disturbance, and period of retention. She found the statistical results were nonsignificant, but trends suggest that the hyper-active subjects preferred and learned best at the rate of 228 wpm. The withdrawn subjects seemed to prefer the expanded and normal rates.

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[1]Morton W. Altshuler, "Responses to Expanded Speech by Hard-of-Hearing Aged Subjects" (Ed.D. dissertation, Boston University, 1964).

[2]Patricia M. Staffen, "Comprehension of Compressed and Expanded Speech by Emotionally Disturbed Children" (Ed.D. dissertation, George Peabody College for Teachers, 1968).

Orr[1] investigated the retention in educable mentally retarded children of material presented by simultaneous reading and listening. With one group printed material accompanied by expanded speech tapes presented at about 80 wpm was used. In a second group printed material was accompanied by the teacher reading at his normal speed. In the third group subjects listened to the expanded speech tapes unaccompanied by printed material. Significant differences were found favoring the group using printed material accompanied by expanded speech tapes. Printed material accompanied by the teacher reading the material was found to be more effective than use of the expanded speech tape alone.

In a study designed to determine the relative effectiveness of bimodal and monomodal presentation of meaningful prose, Jester and Travers used three parallel forms of the Davis Reading Tests for subjects in three experimental groups. The presentation conditions were: single channel auditory, single channel visual and dual channel audio-visual. At speeds up to 200 words per minute, college students comprehended the audio versions, the video versions, and the audio-visual versions at about the same level. At higher speeds auditory comprehension declined much more rapidly

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[1]David B. Orr, "Retention in Educable Mentally Retarded Children of Material Presented by Simultaneous Reading and Listening," in Forging Ahead in Reading, ed. J. Allen Figurel (Newark, Del.: International Reading Association, 1968):447-453.

than visual comprehension, and audio-visual presentation showed an increasing advantage over either one of the single channel presentations.[1]

Orr[2] used compressed speech as a pacer and found it successful in increasing the reading rates of ten male college-preparatory students between the ages of 19 and 21. While the number of subjects was small, the researcher found the mean improvement for the experimental group to be 90 wpm (from 238 to 328 wpm) as compared to a mean increase of only 10 wpm. He concluded that the difference between experimental and control increment was significant at the .01 level in spite of the small number of subjects.

Thames and Rossiter[3] examined the effectiveness of compressed speech tapes as pacing devices for high school sophomores. Each of two groups was randomly assigned to either the experimental or the control group. During the practice session the experimental group read while a recording of the story was played as a pacer. Each of the subjects read one story per class day. For the experimental group the

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[1]Robert Jester and Robert Travers, "Comprehension of Connected Meaningful Discourse as a Function of Rate and Mode of Presentation," Journal of Educational Research 59 (March 1966):297-302.

[2]Orr, "Recent Research," pp. 79-84.

[3]Kenneth H. Thames and Charles M. Rossiter, Jr., "The Effects of Reading Practice with Compressed Speech on Reading Rate and Listening Comprehension," Audiovisual Communications Review 20 (Spring 1972):35-42.

accompanying tape of the stories was presented at a rate of 150 wpm on the first two days. The rate was increased in 50 word increments every day until on the last two days the experimental group read to the accompaniment of recordings compressed to 350 wpm. The control group merely read the ten stories. A short comprehension test was administered after each practice session. It was concluded that reading practice with accompanying speech tapes as pacers resulted in a significantly greater increase in reading rate without an accompanying loss in comprehension for the experimental group when compared with the control group.

Reid[1] examined the effect on reading achievement of second grade students when paced by compressed speech tapes. Experimental groups read and listened to compressed tapes of the reading material at one of three rates: 125, 175, or 225 wpm, while control groups listened to the taped narrations only. It was found that auditory discrimination mean gain scores were significantly greater for groups listening at the 175 wpm rate. Vocabulary scores significantly increased in the read-listen groups. No significant differences occurred in regard to reading comprehension, syllabication, beginning and ending sounds, blending and sound discrimination. Reid suggested that other evidence of preference for wpm rates would be desirable.

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[1]Saralou L. Reid, "Effect on Reading Achievement of Reading Paced by Compressed Speech" (Ed.D. dissertation, Indiana University, 1971).

A study by Johnson[1] compared the relative effectiveness of two methods designed to improve the reading rate of fourth grade subjects. A control group remained in the classroom while the two experimental groups were sent to a special room to read. Members of the compressed speech group were artificially paced beginning at rates of 150 wpm and increasing to 275 wpm. Students in the timed-test group used no tape recordings but were timed on stories read. Johnson found no significant treatment effects for reading rate or comprehension.

A study by Reiland[2] was concerned with the effect of compressed speech on reading and listening abilities of sixth grade students. Each of the following three experimental groups was composed of seven classrooms: (1) the R-L group, which read and listened simultaneously to stories compressed at rates beginning at 175 wpm and increasing to 300 wpm; (s) the L-Only group, which listened to the same stories at the same word rates; (3) the R-Only group, which simply read the stories. No significant differences were found among the three experimental treatments on any of the measured dependent

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[1]Janet M. Johnson, "The Effects of Compressed Speech on the Reading Rate, Comprehension Level, and Attitudes of Fourth Grade Students" (Ed.D. dissertation, University of Colorado, 1971).

[2]Mary L. Reiland, "The Effect of Compressed Speech on Reading and Listening Abilities of Sixth-Grade Children" (Ed.D. dissertation, Rutgers University, The State University of New Jersey, 1970).

variables. For the simultaneous reading-and-listening group there was a tendency to perform better than the other groups when reading comprehension was measured.

Walker[1] compared two techniques for increasing the rate of reading of sixth grade gifted students. A Compressed Speech Group read passages from the Landmark Book Series. Four subgroups were used, with members of each group reading at approximately the same rate. They listened to a tape compressed to the rate of that particular subgroup. On the basis of comprehension checks and other feedback, compression of the tapes was increased, causing subjects to read faster to keep up with the tapes. The experimental period for all groups consisted of fifteen minutes of practice each morning for six weeks. The Preston-Botel Group used a self-improvement program in which pupils timed themselves and kept a visual graph indicating how many pages were read during each experimental period. This group read the same Landmark passages as the Compressed Speech group. A control group did seatwork activities during the fifteen minute experimental period. It was found that the average of the two experimental groups was significantly better than the average of the control group. The Preston-Botel method was signif-

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[1]Charles R. Walker, "A Comparison of Two Techniques for Increasing the Rate of Reading of Sixth-Grade Gifted Pupils: The Compressed Speech Machine and the Self-Improvement Methods," in Proceedings of the Second Louisville Conference on Rate and/or Frequency-Controlled Speech, ed. Emerson Foulke (Louisville, Ky.: University of Louisville, 1971).

icantly better than the compressed speech method. In his conclusions, Walker pointed out:

> This was the first study, to the investigator's knowledge, where an attempt was made to individualize the tapes in accordance with the reading rates of the pupils. It is important that more studies be conducted with this in mind if realistic results are to be obtained.[1]

Walker's point is a valid one. In all the other studies reviewed, presentation rates were simply specified at certain wpm rates without regard to the relationship of rate of presentation to the individual's normal reading rate. It would seem important to investigate the effect that accompanying tapes have on reading efficiency and comprehension when such tapes are presented at rates having a specified relationship to the individual's normal rate of reading.

Theoretical Model for Simultaneous Transmission of Information through Audio and Print Channels

The situation in which an individual reads printed material while listening to a tape recording of that material is comparable to the situation in which a child, while learning to read, looks at a book and "follows along" as a teacher, parent, or other child reads. In both situations the auditory channel is likely to be the dominant one, with eye movements affected by the rate of the presentation.

In trying to understand what occurs when an individual attempts to process redundant material presented simultane-

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[1]Ibid., p. 259.

ously through audio and print channels, it is helpful to look at the Mackworth[1] model of the reading process. Mackworth considers reading to be a three way synthesis among meaning, the spoken word, and the written word.

In a schematic model (see Figure 1) of the reading process, Mackworth outlines the systems that operate in processing the reading stimuli. The visual input, which takes place during the fixation pause, involves selection, attention, expectancy and prediction. It is very brief and appears to last only for a quarter of a second. The information contained in the trace is processed in parallel prior to its destruction from the next fixation. The second stage of visual processing is the iconic image which results from the matching of the input with stored data. It lasts for one to two seconds and is capable of holding several inputs simultaneously. From the iconic store, words are coded into short-term memory by motor speech programs. Such programs activate the sensory associations and verbal probabilities that arouse verbal expectancies. Short-term memory has a temporal capacity of several seconds but a limited informational capacity. The information is finally stored in long-term memory, which is connected to all prior processing through feedback systems. The auditory pathway operates

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[1]Jane F. Mackworth, "Some Models of the Reading Process: Learners and Skilled Readers," in The Literature of Research in Reading with Emphasis on Models, ed. Frederick B. Davis (East Brunswick, N.J.: Iris Corporation, 1971), pp. 8-67-92.

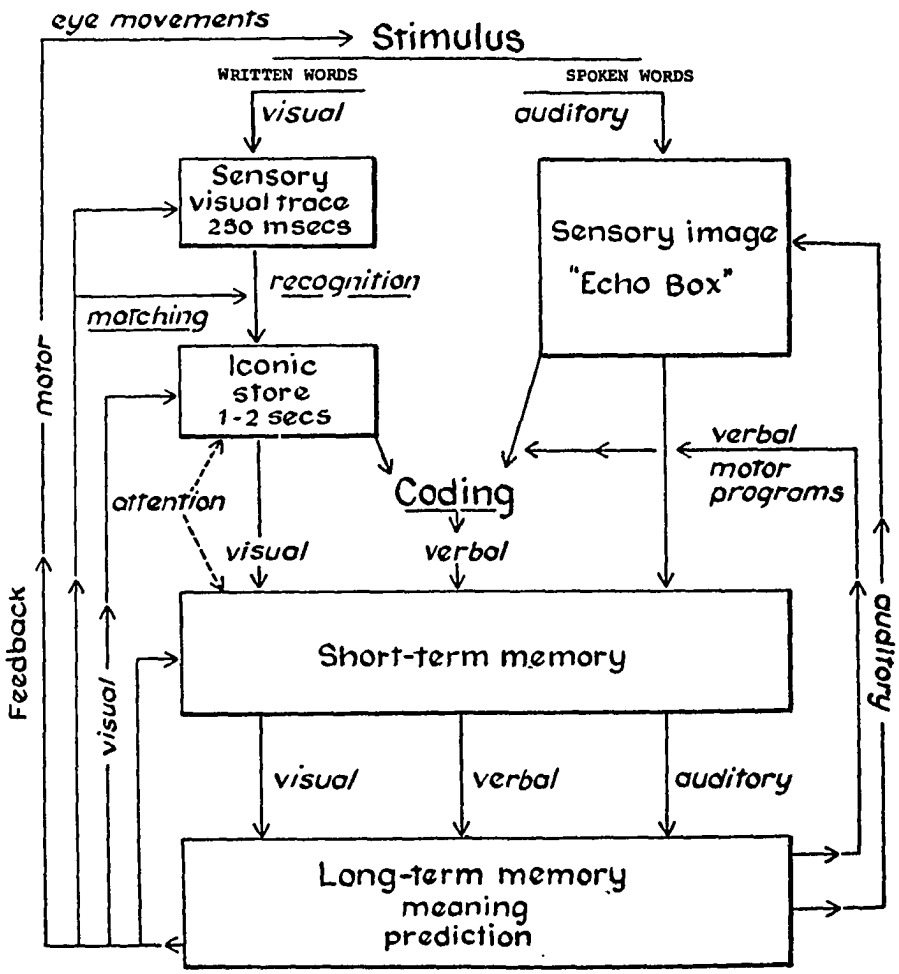

Fig. 1. J. Mackworth's Model of Reading Process

with a sensory image "echo box" and the same short- and long-term memory systems. It plays an important role in learning to read and a lesser role in skilled reading.

It can be theorized that under conditions of simultaneous presentation of redundant material through audio and print channels, the auditory pathway plays an important role similar to that in learning to read. Thus the Mackworth model of the reading process provides also a theoretical model for simultaneous transmission of information through audio and print channels.

CHAPTER III

DESIGN OF THE STUDY

The use of accompanying tapes as aids to comprehension, vocabulary development, and reading efficiency has been suggested in several of the studies previously reviewed. With the invention of mechanical devices making possible the compression and expansion of speech to an infinite variety of rates, the flexibility of presentation rates has increased enormously.

Eye-movement recording has made it possible to collect an objective record of reading performance. Efficient and inefficient approaches to reading are reflected in eye-movement patterns. Through the comparison of such records it is possible to observe changes in behavior in individuals under specified circumstances as well as to compare performances between different individuals.

This study was designed to secure information on eye movements and comprehension as undereducated adults read printed material and as they read printed material while listening to an accompanying tape recorded at a specified rate. This study was also designed to secure information in regard to the most effective presentation rate in relation to the individual's normal reading rate.

Population

Subjects for this study were selected from all inmates at the El Reno Federal Reformatory who achieved between 6.0 and 8.9 grade level on the Paragraph Meaning section of the Stanford Achievement Test, administered at the time of their admission to the reformatory. A search of the records conducted by the investigator in August, 1973, indicated approximately 300 inmates scoring in the 6.0 to 8.9 category at the time of their admission.

The total population[1] of inmates at the reformatory as of May 2, 1974, was 962. Ages of inmates range from 17 to 31, with a median age of 23. Highest grade completed figures were available for 849 inmates, with the following percentages reported:

Grades 2-5	3.2
Grades 6-8	20.2
Grades 9-12	76.7

IQ scores were available for 751 inmates, with the following percentages reported:

Superior (120 and above)	10.4
High Average (111-119)	21.3
Average (91-110)	52.1
Low Average (81-90)	11.2
Inferior (80 and Below)	5.1

Racial composition was approximately 50 percent white, 35 percent black, 9 percent Spanish American, and 4 percent Indian. Geographical distribution by state of legal residence indicates

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[1]El Reno Federal Reformatory, Population Data as of May 2, 1974.

that inmates at the reformatory come from 45 states and the District of Columbia. The following six states account for more than fifty percent of legal residences of inmates: Texas, Missouri, Oklahoma, Kansas, Louisiana, and Colorado.

The following three categories of offenses account for more than fifty percent of the violations for which inmates were incarcerated: violation of drug laws; violation of the National Motor Vehicle Theft Act; bank robbery. In regard to length of sentences, the following percentages were reported:

Less than 2.5 years	10.8
2.5 to 5 years	15.8
5 to 10 years	55.2
10 years and over	18.1

Criteria for Selection of Subjects

Criteria for selecting subjects for the study included the following: that they were inmates of the El Reno Federal Reformatory; that they scored between 6.0 and 8.9 grade level on the Traxler Silent Reading Test; that their reading rate as measured by the Rate section of the Traxler Silent Reading Test was 100 wpm or above; that they were between 18 and 26 years of age at the time of testing; and that they were willing to participate in the study.

Tests and Procedures Used to Select Subjects

In order to locate inmates who were likely to fall in the 6.0 to 8.9 grade level in reading comprehension at the

time of the study, a search of the permanent record folders kept for all inmates in the reformatory was made. The names of all inmates who scored at these levels on the Stanford Achievement Test, Paragraph Meaning, were recorded. Inmates younger than 18 or older than 26 were eliminated from this population. Identification numbers ranging from 001 to 298 were assigned to the names recorded.

It was determined that between 88 and 96 subjects would be needed for this study. Using a formula suggested by Kirk[1] and specifying a desired power of .80, a standard deviation of 1, an alpha of .05, and 4 as the number of groups, it was found that for n=25, the probability of rejecting a false null hypothesis is just beyond the .80 level. It was considered desirable to have an even number of subjects in order that pretest selections and posttest selections could be counterbalanced, with half of the subjects in each group using Form A as the pretest and Form B as the posttest, and the other half using Form B as the pretest and Form A as the posttest. It was decided that 24 subjects would be selected for each of the four groups. After the assignment of identification numbers to the 298 names, a table of random numbers was used for the placement of 31 subjects into four groups. The plan was to rank order numbers 25 through 31

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[1]Roger E. Kirk, Experimental Design: Procedures for the Behavioral Sciences (Belmont, Calif.: Brooks/Cole Publishing Company, 1968), pp. 109-110.

according to their selection from the table of random numbers, and to place these subjects on reserve as substitutes in the event that any of the original 24 subjects had to drop out of the study. The technique for selection and placement followed that given by Kerlinger[1] for random sampling and random placement in groups. The 124 names were selected for the experiment in blocks of 31, using four separate pages of a large table of random numbers, the pages themselves being selected at random by entering the entire table anywhere and choosing four numbers at random. Thirty-one three digit numbers were chosen from the first page selected, with choices limited to numbers 001 to 298. Similar procedures were followed for the second, third, and fourth pages selected, until 31 names were placed in each of the four groups.

Several difficulties were encountered by the investigator in attempting to follow the procedure outlined above. First, it became apparent that in some instances the permanent record folders were not up to date. That is, some inmates who had recently been transferred from the institution still had permanent records in the education department files. Second, some of the inmates selected for study had been placed in disciplinary cells and were not available for testing. Third, many of the inmates selected for study were unwilling to participate in the study. Finally, upon testing it became obvious that many of the inmates who had tested at

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[1]Fred N. Kerlinger, Foundations of Behavioral Research (New York: Holt, Rinehart and Winston, 1964), pp. 57-58.

the 6.0 to 8.9 level upon entering the institution no longer tested at this level. This was perhaps due to the fact that many had participated in reading programs taught by the education department of the institution.

When it became apparent that the required number of subjects could not be obtained by the selection of the original 124 names, a second group of 124 names was compiled in the same fashion. When this still did not yield the necessary number of subjects, the remaining fifty names were placed on call for testing, so that in effect, the total population of 298 names was utilized.

One hundred seventy subjects, those who were available for testing and were willing to participate, were administered the Traxler Silent Reading Test, Form 1. Testing was begun on October 21, 1974, and completed on December 13, 1974, with 23 separate testing sessions held. Of the 170 subjects tested, 104 met the stated criteria, and 66 were rejected. This meant that only 26 subjects were available for each group, but since the population available for testing had been exhausted, the investigator concluded that it would be best to proceed with that number.

The second stage of the testing procedure was begun on December 30, 1974, and concluded on January 6, 1975. By the time the second stage of the study was begun, several of the inmates selected for this part of the study had been released from the institution. Further, one inmate had been

placed in a disciplinary cell and could not be released for testing. For these reasons, it was necessary to lower the number of subjects to be included in the study. It will be recalled that the Kirk formula indicated that between 88 and 96 subjects would be needed for the desired power of .80. While it was not possible to include 96 subjects in the study as originally planned, there were 88 subjects still available for study, and this was the number utilized.

Tests and Procedures Used to Collect Data

The Reading Eye II was used to record eye movements. In describing the instrument, Morris states:

> The Reading Eye II was designed by Biometrics, Inc., a Cambridge, Massachusetts, company that specializes in instrumentation for biology and medicine. It was developed to ensure the closest possible correlation with the Reading Eye I, so that data derived through the use of the Reading Eye I is equally applicable to the Reading Eye II.
>
> The Reading Eye II, an electronic instrument, employs a photoelectric method which makes possible the instantaneous recording of eye movement. Twin photoelectric cells monitor horizontal movements by responding to the contrast between the eye white (sclera) and colored portion (iris). The photocell signals are amplified and recorded by heated pens on heat-sensitive paper. The recording is presented to the examiner as the subject reads. Since it needs no further processing, the recording can be analyzed immediately.[1]

In each of the four treatment groups subjects were asked to read Form A or Form B (Basic) of the Reading Versa-

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[1]Helen Frackenpohl Morris, Manual for the EDL/Biometrics Reading Eye II (New York: Educational Developmental Laboratories, 1973), p. 11.

tility Test, Part 2.[1] The form designed for use with the Reading Eye was used. It should be noted that this form is no longer commercially available, although the booklet forms are still available. Educational Developmental Laboratories was able to supply the writer with the tests designed for use with the Reading Eye, but noted that they are no longer generally available.

The Reading Versatility Test consists of four reading selections differing in style, theme, and difficulty. The Basic Test, which was used in this study, is designed for students reading on grade levels five through eight. Alternate forms of the test, Form A and Form B, were used in the pretest and posttest situations. Part 2 of the test, which was the only part used in this study, consists of an approximately 300-word fiction selection. It should be noted that passages of this length have been found to be reliable for either group or individual diagnosis.

Comprehension was measured by the printed multiple-choice test, consisting of ten questions over the passage read, which was developed by the test authors. It should be recalled that Hartman[2] found the audio-print condition to be an exception to his stimulus generalization theory which

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[1]Arthur S. McDonald, Sister M. Alodia, and Stanford E. Taylor, Reading Versatility Test (Basic), For Use with the Reading Eye (Huntington, N.Y.: Educational Developmental Laboratories, 1962).

[2]Hartman, "Single and Multiple Channel," p. 255.

requires the testing of multi-channel presentations through all channels used in the learning situation. Hartman found the audio-print condition to be testable on either channel alone.

The preparation of the accompanying tapes to be used in the treatment groups was accomplished by recording the passages from the Reading Versatility Test, Part 2, Forms A and B, on separate tapes at 126 wpm. The rate of 126 wpm was selected for several reasons. First, 126 wpm is one of the rate scores yielded from the Traxler test when raw scores are converted to scores in terms of words per minute. Second, this rate is very close to the 125 wpm found by Nichols and Stevens[1] to be an average conversational rate. Finally, this rate lends itself well to both time compression and time expansion.

A professional male reader from the Speech Communication Department, Oklahoma State University, recorded the master tapes from which all other tapes were compressed or expanded. A study by Beasley and Zemlin[2] points to the preference of male voices rather than female voices by listeners to compressed speech. This preference is thought to be the

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[1]Ralph G. Nichols and Leonard A. Stevens, Are You Listening? (New York: McGraw Hill Book Co., 1957), p. 78.

[2]Daniel S. Beasley and Willard R. Zemlin, "Perturbations of Sex Judgments with Time Compressed and Frequency-Altered Speech," Proceedings of the Second Louisville Conference on Rate and/or Frequency-Controlled Speech (Louisville, Ky.: University of Kentucky, 1967), p. 43.

result of changes during compression which tend to make female voices sound like effeminate male voices.

After the original recordings were completed, the necessary compression and expansion to the desired rates were accomplished through the use of PKM Corporation's VOCOM-I Speech Compressor/Expander and Lexicon Corporation's VARI-SPEECH 1. Fifty-seven tapes were produced, with the specified relationship to each subject's normal reading rate being taken into account in the production of each tape. It will be noted that it was not necessary to make a separate tape for each of the 88 subjects since some subjects in the same sub-groups scored the same reading rates on the Traxler Silent Reading Test. Mr. Clyde Loftis, audiovisual specialist at Oklahoma State University, was responsible for the production of the expanded or compressed speech tapes used in the study.

In summary, subjects in each group were asked to read a printed selection (Form A or Form B of the Reading Versatility Test) before Reading Eye II. Eye movements were recorded during the reading of this test, and a printed test was administered immediately following the reading of the selection. The record of the eye movements and the results of the comprehension test were regarded as pretest scores.

In Treatment I, each subject was asked to listen to an accompanying tape of the printed selection he was reading. This tape was presented at 50 wpm below the subject's normal

reading rate. Normal reading rate was defined as the rate of reading score, reported in words per minute, achieved on the Traxler Silent Reading Test. The rate of 50 wpm below the normal reading rate was achieved by compressing or expanding the original tape to the desired rate. Each subject listened to the tape as he read the printed selection and as his eye movements were recorded by Reading Eye II. This selection was an alternate form of the selection read for the pretest. In order to account for possible differences in interest, difficulty, or other extraneous factors, half of Group I, or 11 subjects, read Form A as the pretest and Form B as the posttest. The other half of the group read Form B as the pretest and Form A as the posttest. A printed test consisting of ten multiple-choice questions (questions that follow Part 2 of the Reading Versatility Test) was administered, and the results of this test, together with the eye movement records, were regarded as posttest scores. Each subject was also asked to complete the Self-Report Questionnaire, a copy of which is included in the Appendix. This instrument was used to ascertain the manner of utilization of the accompanying tapes by subjects, and to gain information about their reactions to the presentation rates employed.

In Treatments II, III, and IV, conditions were the same as for Treatment I, except in regard to presentation rate. In Treatment II, presentation rate was at the normal reading rate; in Treatment III, at 50 wpm above each subject's

normal reading rate; and in Treatment IV at 100 wpm above each subject's normal reading rate.

Experimental Design

Variables

Dependent Variable--Comprehension. Determined by scores on printed multiple-choice tests.

Dependent Variable--Eye movements. Determined by eye-movement recordings which yield the following data:

1. number of fixations per 100 words.
2. number of regressions per 100 words.
3. span of fixation.
4. duration of fixation.
5. rate in wpm.

Independent Variable--Presentation rate of taped material. Controlled by the assignment of given rate relationships to selected groupings of subjects.

Assignment of subjects to groups

From a master list of inmates with reading scores ranging from grade level equivalents of 6.0 to 8.9, 88 inmates were randomly selected and assigned to the following treatment groups, 22 subjects per group.

Treatment Group I	Presentation rate = 50 wpm below normal reading rate (NRR).
Treatment Group II	Presentation rate = NRR.
Treatment Group III	Presentation rate = NRR + 50 wpm.
Treatment Group IV	Presentation rate = NRR + 100 wpm.

Experimental design paradigm

The research design could be presented diagramatically in the following manner:

R	Y_a	X_1	Y_b
R	Y_a	X_2	Y_b
R	Y_a	X_3	Y_b
R	Y_a	X_4	Y_b

Where

Y_a = pretest

Y_b = posttest

X_1, X_2, X_3, X_4 = experimental treatments

R = random selection and random assignment to treatment groups.

It should be noted that the above design includes the concept of control. Kerlinger states:

> Whenever there is more than one experimental group and any two groups are given different treatment, control is present in the sense of comparison previously mentioned. As long as there is an attempt to make two groups systematically different on a dependent variable, a comparison is possible. Thus the traditional notion that an experimental group should receive the treatment not given to a control group is a special case of the more general rule that comparison groups are necessary for the internal validity of any scientific research.[1]

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[1]Kerlinger, Foundations, p. 306.

CHAPTER IV

PRESENTATION OF DATA

Chapter IV presents data from the ten hypotheses tested. Eye movement data were collected as subjects read printed material and as they read printed material while listening to a tape recording of that material having a specified relationship to their normal reading rates. Comprehension measurements were secured after subjects read under each of the two previously specified conditions. A Self-Report Questionnaire was completed by each subject at the conclusion of the testing procedure.

Analysis of Data

A first step in the analysis of data was to describe the data by calculating means and standard deviations for each of the four treatment groups on each of the measures. This information is presented in Table 1.

Preliminary analyses of variance for repeated measures were made to determine if significant differences existed among the four treatment groups in regard to eye movements and comprehension when read conditions (pretest) were compared with read-listen conditions (posttest). The analysis of variance for repeated measures was judged to be the most

TABLE 1

MEANS AND STANDARD DEVIATIONS PRETEST AND POSTTEST EYE MOVEMENT AND COMPREHENSION MEASUREMENTS

	Fixation A (Read)	Fixation B (Read-Listen)	Regression A (Read)	Regression B (Read-Listen)	Span A (Read)	Span B (Read-Listen)	Duration A (Read)	Duration B (Read-Listen)	Rate A (Read)	Rate B (Read-Listen)	Comprehension A (Read)	Comprehension B (Read-Listen)
Group I (NRR - 50 wpm)												
M	117.40	138.88	22.03	30.45	.862	.741	.288	.314	181.59	143.23	7.27	8.00
SD	12.14	22.99	6.64	9.36	.100	.133	.039	.037	30.32	30.84	1.83	1.15
Group II (NRR)												
M	107.79	118.65	16.96	21.20	.956	.860	.289	.310	201.23	168.96	7.86	7.59
SD	19.90	16.90	7.85	6.20	.176	.127	.040	.040	37.52	35.19	1.49	1.14
Group III (NRR + 50 wpm)												
M	107.53	105.93	21.29	23.16	.956	.977	.288	.308	201.23	194.41	7.05	8.14
SD	17.97	20.04	9.64	10.81	.179	.188	.025	.028	43.90	36.28	1.76	1.04
Group IV (NRR + 100 wpm)												
M	113.47	95.11	21.44	16.37	.906	1.068	.286	.277	193.55	232.09	7.86	7.36
SD	20.50	11.99	9.07	6.56	.146	.145	.031	.031	44.66	27.27	1.49	1.56

appropriate statistical technique for analysis since all subjects in the study participated in both pretest and posttest conditions, but the posttest conditions were different for each of the four groups.

A test for significant main effect for conditions was a product of the analysis, but is not pertinent to the hypotheses being tested. A significant main effect for trials or for interaction indicates that an important difference exists at one or more of the levels. The analysis of variance for each of the specific eye movement measurements and for comprehension measurements are presented in Tables 6, 8, 10, 12, 14, and 16. It will be noted that each of these analyses revealed differences among the groups at the .05 (or greater) level of significance.

After determining that significant differences existed among the treatment groups in regard to each of the specific eye movement measures and in regard to comprehension measures, post hoc analyses of means were utilized to determine where the significant differences occurred. Tukey's[1] Honestly Significant Difference (HSD) test was selected as most appropriate for these pairwise comparisons. Results of these tests are reported in Tables 7, 9, 11, 13, 15, and 17. Summary tables for eye movement measures for each of the groups are presented in Tables 2-5.

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[1]Kirk, Experimental Design, 88-89.

In addition to the analyses of variance for repeated measures which have been previously described, gain scores for each of the four treatment groups on comprehension measures and on each of the eye movement measures were analyzed using a one way analysis of variance. Gain scores were obtained by subtracting the pretest score from the posttest score of each subject in each treatment group for eye movement and comprehension measures. Information from these analyses are presented in Table 18.

Because significant differences were found in each of the analyses, a post hoc analysis was used to identify significant differences between treatment groups. Again, Tukey's HSD test was selected for pairwise comparisons. These comparisons are presented in Tables 19-24.

Pretest comprehension scores on Part 2 of the Reading Versatility Tests, Form A and Form B, were analyzed using the Kuder-Richardson[1] Formula 20 (KR-20). For Form A, r_{tt}=.42; for Form B, r_{tt}=.62. These correlation coefficients indicate low reliability in regard to internal consistency for both forms of this test which were used as comprehension measures for the study.

As previously noted, a Self-Report Questionnaire was completed by each subject at the conclusion of the testing

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[1]Frederick G. Brown, Principles of Educational and Psychological Testing (Hinsdale, Ill.: Dryden Press, Inc., 1970), pp. 78-81.

procedure. A copy of the questionnaire and a chart summarizing responses to each question are included in the appendix.

Tests of the Hypotheses

Hypothesis 1 was concerned with the comparison of eye movements of subjects when they read printed material and when they read printed material while listening to a tape recording of that material presented at 50 wpm below their normal reading rates. To test the hypothesis the pairwise comparisons dealing with this treatment group was selected from each analysis of eye movement. For example, from Table 7 the pairwise comparison for Treatment Group I (NRR-50 wpm) was used. Similarly, the comparisons for Treatment Group I were selected from Tables 9, 11, 13, and 15. The five comparisons for Hypothesis 1 are summarized in Table 2.

TABLE 2

SUMMARY TABLE OF SELECTED MEANS FOR EYE MOVEMENT MEASUREMENTS (Read vs. Read-Listen at NRR-50 wpm)

Eye Movement Measurement	Read	Read-Listen at NRR-50 wpm	Difference
Fixations	117.40	138.88	21.48*
Regressions	22.03	30.45	8.42*
Span	.862	.741	-.121*
Duration	.288	.314	.026*
Rate	181.59	143.23	-38.36*

*$p < .05$

Stated in null form, the hypothesis is as follows:

Hypothesis 1.--There are no differences in the specific measurements of eye movements of subjects when they read a printed selection (read condition) and when they read a printed selection accompanied by a tape recording of that selection (read-listen condition) which is presented at 50 wpm below each subject's normal reading rate (NRR-50 wpm).

1a. There are no differences in fixations under the read condition and under the read-listen condition of NRR-50 wpm.

1b. There are no differences in regressions under the read condition and under the read-listen condition of NRR-50 wpm.

1c. There are no differences in span of recognition under the read condition and under the read-listen condition of NRR-50 wpm.

1d. There are no differences in duration of fixation under the read condition and under the read-listen condition of NRR-50 wpm.

1e. There are no differences in rate of reading under the read condition and under the read-listen condition of NRR-50 wpm.

An inspection of Table 2 reveals that significant differences were found in all eye movement measures when the read condition was compared with the read-listen condition. The changes in eye movements included more fixations, more regressions, a shorter recognition span, a longer duration of fixation, and a slower reading rate under the read-listen condition of NRR-50 wpm than under the read condition. Because of the significant differences between the two conditions in regard to each of the five eye movement components,

Hypothesis 1 must be rejected in its entirety.

Hypothesis 2.--There are no differences in specific measurements of eye movements of subjects when they read a printed selection (read condition) and when they read a printed selection accompanied by a tape recording of that selection (read-listen condition) which is presented at each subject's normal reading rate (NRR).

2a. There are no differences in fixations under the read condition and under the read-listen condition of NRR.

2b. There are no differences in regressions under the read condition and under the read-listen condition of NRR.

2c. There are no differences in span of recognition under the read condition and under the read-listen condition of NRR.

2d. There are no differences in duration of fixation under the read condition and under the read-listen condition of NRR.

2e. There are no differences in rate of reading under the read condition and under the read-listen condition of NRR.

An inspection of Table 3 reveals significant differences in regard to some, but not all, of the eye movement measures of subjects when they read printed material only and when they read printed material accompanied by a tape recording of that material presented at their normal reading rates. Significant differences were detected in regard to regressions, duration of fixation, and rate. These differences indicate more regressions, a longer duration of fixation, and a slower reading rate under the read-listen condition of tape

presentation at the normal reading rate.

TABLE 3

SUMMARY TABLE OF SELECTED MEANS FOR EYE MOVEMENT MEASUREMENTS (Read vs. Read-Listen at NRR)

Eye Movement Measurement	Read	Read-Listen at NRR	Difference
Fixations	107.79	118.65	10.86
Regressions	16.96	21.20	4.24*
Span	.956	.860	-.096
Duration	.289	.310	.021*
Rate	201.23	168.96	-32.27*

*$p < .05$

While the differences in fixations and span of recognition under the two conditions did not achieve significance at the level specified for this study, the differences pointed toward more fixations and a shorter span of recognition under the read-listen condition for Treatment Group II.

In regard to Hypothesis 2, then, we can conclude that Hypotheses 2a and 2c, stating respectively no differences in fixations and no differences in span of recognition, cannot be rejected. Because of significant differences in regressions, duration of fixation, and rate of reading, Hypotheses 2b, 2d, and 2e must be rejected.

Hypotheses 3.--There are no differences in specific measurements of eye movements of subjects when they read a printed selection (read condition) and when they read a

printed selection accompanied by a tape recording of that selection (read-listen condition) which is presented at 50 wpm above each subject's normal reading rate (NRR + 50 wpm).

3a. There are no differences in fixations under the read condition and under the read-listen condition of NRR + 50 wpm.

3b. There are no differences in regressions under the read condition and under the read-listen condition of NRR + 50 wpm.

3c. There are no differences in span of recognition under the read condition and under the read-listen condition of NRR + 50 wpm.

3d. There are no differences in duration of fixation under the read condition and under the read-listen condition of NRR + 50 wpm.

3e. There are no differences in rate of reading under the read condition and under the read-listen condition of NRR + 50 wpm.

Subjects in Treatment Group III, in which a presentation rate of 50 wpm above the normal reading rate was utilized, showed little difference in eye movement measures under the read and read-listen conditions. An inspection of Table 4 reveals that only in regard to duration of fixation were significant differences found in the eye movements of subjects under the two conditions. Apparently, except for a significantly longer duration of fixation, subjects listening to a tape recording with this rate relationship read in much the same way they did when reading printed material without an accompanying tape.

Hypothesis 3d, then, should be rejected, but all other sub-hypotheses listed under Hypotheses 3 cannot be rejected.

TABLE 4

SUMMARY TABLE OF SELECTED MEANS FOR EYE MOVEMENT MEASUREMENTS (Read vs. Read-Listen at NRR + 50 wpm)

Eye Movement Measurement	Read	Read-Listen at NRR + 50 wpm	Difference
Fixations	107.53	105.93	-1.60
Regressions	21.29	23.16	1.87
Span	.956	.977	.021
Duration	.288	.308	.020*
Rate	201.23	194.41	-6.82

*$p < .05$

Hypothesis 4.--There are no differences in specific measurements of eye movements of subjects when they read a printed selection (read condition) and when they read a printed selection accompanied by a tape recording of that selection (read-listen condition) which is presented at 100 wpm above each subject's normal reading rate.

4a. There are no differences in fixations under the read condition and under the read-listen condition of NRR + 100 wpm.

4b. There are no differences in regressions under the read condition and under the read-listen condition of NRR + 100 wpm.

4c. There are no differences in span of recognition under the read condition and under the read-listen condition of NRR + 100 wpm.

4d. There are no differences in duration of fixation under the read condition and under the read-listen condition of NRR + 100 wpm.

4e. There are no differences in rate of reading under the read condition and under the read-listen condition of NRR + 100 wpm.

Subjects in Treatment Group IV showed significant differences in regard to all eye movement measures except duration of fixation when the read condition was compared with the read-listen condition in which tape presentation was at 100 wpm above the normal reading rate.

An inspection of Table 5 reveals increased eye movement efficiency under the read-listen condition as evidenced by fewer fixations and regressions, increased span of recognition and increased rate, all at significant levels. Difference in duration of fixation under the two conditions points toward a shorter duration under the read-listen condition, but this difference does not achieve significance.

TABLE 5

SUMMARY TABLE OF SELECTED MEANS FOR EYE MOVEMENT MEASUREMENTS
(Read vs. Read-Listen at NRR + 100 wpm)

Eye Movement Measurement	Read	Read-Listen at NRR + 100 wpm	Difference
Fixations	113.47	95.11	-18.36*
Regressions	21.44	16.37	- 5.07*
Span	.906	1.068	.162*
Duration	.286	.277	- .009
Rate	193.55	232.09	38.54*

*$p < .05$

With the exception of sub-hypothesis 4d, regarding duration of fixation, Hypothesis 4 must be rejected, since significant differences were found for all other eye movement

measures. Sub-hypothesis 4d, however, cannot be rejected.

TABLE 6

ANALYSIS OF VARIANCE FOR FIXATIONS
(Read vs. Read-Listen)

Source	SS	df	MS	F
Total	80,776.21	175	--	--
Between subjects	54,709.52	87	--	--
Conditions	15,120.76	3	5,040.25	10.70*
Error between	39,588.76	84	471.29	--
Within subjects	26,066.69	88	296.21	--
Read/R-L	437.21	1	437.21	2.30
Read/R-L X Conditions	9,636.59	3	3,212.20	16.87*
Error within	15,992.89	84	190.39	--

*$p < .001$

TABLE 7

PAIRWISE ANALYSIS OF SELECTED MEANS
(Fixations)

Conditions	Read	Read-Listen	Difference
Group I (NRR - 50 wpm)	117.40	138.88	21.48*
Group II (NRR)	107.79	118.65	10.86
Group III (NRR + 50 wpm)	107.53	105.93	- 1.60
Group IV (NRR + 100 wpm)	113.47	95.11	-18.36*

*$p < .05$; HSD = 12.94

TABLE 8

ANALYSIS OF VARIANCE FOR REGRESSIONS
(Read vs. Read-Listen)

Source	SS	df	MS	F
Total	14,765.78	175	--	--
Between subjects	11,304.11	87	--	--
Conditions	1,563.64	3	521.21	4.49*
Error between	9,740.47	84	115.96	--
Within subjects	3,461.67	88	--	--
Read/R-L	246.30	1	246.30	9.56**
Read/R-L X Conditions	1,050.99	3	350.33	13.59***
Error within	2,164.38	84	25.77	--

*$p < .05$
**$p < .01$
***$p < .001$

TABLE 9

PAIRWISE ANALYSIS OF SELECTED MEANS
(Regressions)

Conditions	Read	Read-Listen	Difference
Group I (NRR - 50 wpm)	22.03	30.45	8.42*
Group II (NRR)	16.96	21.20	4.24*
Group III (NRR + 50 wpm)	21.29	23.16	1.87
Group IV (NRR + 100 wpm)	21.44	16.37	5.07*

*$p < .05$; HSD = 3.46

TABLE 10

ANALYSIS OF VARIANCE FOR AVERAGE SPAN OF RECOGNITION (Read vs. Read-Listen)

Source	SS	df	MS	F
Total	5.33	175	--	--
Between subjects	3.76	87	--	--
Conditions	.92	3	.307	9.029*
Error between	2.84	84	.034	--
Within subjects	1.41	88	--	--
Read/Read-Listen	.010	1	.010	.833
R/R-L X Conditions	.543	3	.181	15.083*
Error within	1.02	84	.012	--

*$p < .001$

TABLE 11

PAIRWISE ANALYSIS OF SELECTED MEANS (Average Span of Recognition)

Conditions	Read	Read-Listen	Difference
Group I (NRR - 50 wpm)	.862	.741	-.121*
Group II (NRR)	.956	.860	-.096
Group III (NRR + 50 wpm)	.956	.977	.021
Group IV (NRR + 100 wpm)	.906	1.068	.162*

*$p < .05$; HSD = .100

TABLE 12

ANALYSIS OF VARIANCE FOR DURATION OF FIXATION
(Read vs. Read-Listen)

Source	SS	df	MS	F
Total	.23	175	--	--
Between subjects	.18	87	--	--
Conditions	.01	3	.003	1.5
Error between	.17	84	.002	--
Within subjects	.05	88	--	--
Read/Read-Listen	.01	1	.01	33.33*
R/R-L X Conditions	.01	3	.003	10*
Error within	.03	84	.0003	--

*$p < .001$

TABLE 13

PAIRWISE ANALYSIS OF SELECTED MEANS
(Duration of Fixation)

Conditions	Read	Read-Listen	Difference
Group I (NRR - 50 wpm)	.288	.314	.026*
Group II (NRR)	.289	.310	.021*
Group III (NRR + 50 wpm)	.288	.308	.020*
Group IV (NRR + 100 wpm)	.286	.277	- .009

*$p < .05$; HSD = .016

TABLE 14

ANALYSIS OF VARIANCE FOR RATE
(Read vs. Read-Listen)

Source	SS	df	MS	F
Total	325,127.79	175	--	--
Between subjects	225,586.79	87	--	--
Conditions	60,116.43	3	20,038.81	10.17**
Error between	165,470.36	84	1,969.89	--
Within subjects	99,541	88	--	--
Read/Read-Listen	4,163.27	1	4,163.27	6.87*
R/R-L X Conditions	44,500.91	3	14,833.64	24.49**
Error within	50,876.82	84	605.68	--

*$p < .05$
**$p < .001$

TABLE 15

PAIRWISE ANALYSIS OF SELECTED MEANS
(Rate)

Conditions	Read	Read-Listen	Difference
Group I (NRR - 50)	181.59	143.23	-38.36*
Group II (NRR)	201.23	168.96	-32.27*
Group III (NRR + 50)	201.23	194.41	- 6.82
Group IV (NRR + 100)	193.55	232.09	38.54*

*$p < .05$; HSD = 23.08

TABLE 16

ANALYSIS OF VARIANCE FOR COMPREHENSION
(Read vs. Read-Listen)

Source	SS	df	MS	F
Total	370.45	175	--	--
Between subjects	229.95	87	--	--
Conditions	.47	3	.157	.057
Error between	229.48	84	2.73	--
Within subjects	140.5	88	--	--
Read/Read-Listen	3.01	1	3.01	2.21
R/R-L X Conditions	22.95	3	7.65	5.63*
Error within	114.54	84	1.36	--

*$p < .01$

TABLE 17

PAIRWISE ANALYSIS OF SELECTED MEANS
(Comprehension)

Conditions	Read	Read-Listen	Difference
Group I (NRR - 50)	7.27	8.00	.73
Group II (NRR)	7.86	7.59	- .27
Group III (NRR + 50)	7.05	8.14	1.09*
Group IV (NRR + 100)	7.86	7.36	- .50

*$p < .05$; HSD = 1.09

Hypothesis 5.--There are no differences in the comprehension of subjects when they read a printed selection and when they read a printed selection accompanied by a tape recording of that selection which is presented at 50 wpm below each subject's normal rate of reading.

An inspection of Table 17 shows that while subjects in Treatment Group I experienced an increase in comprehension under the read-listen condition of 50 wpm below the normal reading rate, this increase was not significant. Hypothesis 5, then, cannot be rejected.

Hypothesis 6.--There are no differences in the comprehension of subjects when they read a printed selection and when they read a printed selection accompanied by a tape recording of that selection which is presented at each subject's normal rate of reading.

Subjects in Treatment Group II showed no significant difference in comprehension means under the read condition and under the read-listen condition of tape presentation at the normal reading rate, as indicated in Table 17. While there was a slight decrease in comprehension under this read-listen condition, the difference was not significant. Hypothesis 6, therefore, cannot be rejected.

Hypothesis 7.--There are no differences in the comprehension of subjects when they read a printed selection and when they read a printed selection accompanied by a tape recording of that selection which is presented at 50 wpm above

each subject's normal rate of reading.

Subjects in Treatment Group III showed increased comprehension at a significant level under the read-listen condition of tape presentation at 50 wpm above the normal reading rate, as indicated in Table 17. Hypothesis 7 must therefore be rejected.

Hypothesis 8.--There are no differences in the comprehension of subjects when they read a printed selection and when they read a printed selection accompanied by a tape recording of that selection which is presented at 100 wpm above each subject's normal rate of reading.

Subjects in Treatment Group IV experienced a slight drop in comprehension from the read condition to the read-listen condition of tape presentation at 100 wpm above the normal reading rate. This difference, as revealed in Table 17 is not significant. Hypothesis 8 cannot be rejected.

Hypothesis 9.--There are no differences in comprehension gain scores among the four treatment groups resulting from the use of accompanying tapes of specified rates.

Hypothesis 9 is concerned with the relationship of comprehension gain scores among the four treatment groups. An inspection of Table 18 shows that significant differences exist among the four treatment groups in regard to comprehension gain scores. In Table 19, a comparison of the means reveal that significant differences exist in regard to the comprehension gain scores of Treatment Group III and Treat-

TABLE 18

ANALYSES OF VARIANCE: COMPREHENSION AND EYE MOVEMENT GAIN SCORES

Variable	Source	SS	df	MS	F
Compre-	Total	292.72	87	--	--
hension	Between groups	43.22	3	14.41	4.85*
	Within groups	249.50	84	2.97	
Fixation	Total	51,251.62	87	--	--
	Between groups	19,273.17	3	6,428.39	16.89**
	Within groups	31,978.45	84	380.70	
Regression	Total	6,426.42	87	--	--
	Between groups	2,102.02	3	700.67	13.61**
	Within groups	4,324.40	84	51.48	
Span	Total	3	87	--	--
	Between groups	1.114	3	.371	16.86**
	Within groups	1.886	84	.022	
Duration	Total	.053	87	--	--
	Between groups	.014	3	.005	5.00*
	Within groups	.039	84	.001	
Rate	Total	191,655.78	87		
	Between groups	81,129.60	3	27,043.20	20.55**
	Within groups	110,526.18	84	1,315.78	

*$p < .01$

**$p < .001$

ment Groups IV and I. Treatment Group III, with its read-listen presentation rate of 50 wpm above the normal reading rate experienced the largest gain in comprehension of all the treatment groups. Treatment Group I (NRR - 50 wpm) showed the next largest gain in comprehension. Treatment Groups II (NRR) and IV (NRR + 100 wpm) showed negative gain scores, indicating a drop in comprehension from the read condition to the read-listen condition.

TABLE 19

PAIRWISE COMPARISONS OF DIFFERENCES BETWEEN MEANS FOR COMPREHENSION GAIN SCORES

	Means	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$
$\bar{X}_1$	- .500	-.227	1.409*	1.591*
$\bar{X}_2$	- .273		1.180	1.364
$\bar{X}_3$	.909			.182
$\bar{X}_4$	1.091			

*$p < .05$; HSD = 1.374

$\bar{X}_1$ = Treatment Group IV (NRR + 100 wpm)
$\bar{X}_2$ = Treatment Group II (NRR)
$\bar{X}_3$ = Treatment Group I (NRR - 50 wpm)
$\bar{X}_4$ = Treatment Group III (NRR + 50 wpm)

Because of the significant differences between the groups as described above, Hypothesis 9 must be rejected.

Hypothesis 10.--There are no differences in the specific eye movement gain scores among the four treatment groups resulting from the use of accompanying tapes of specified rates.

10a. There are no differences in fixation gain scores.

10b. There are no differences in regression gain scores.

10c. There are no differences in span of recognition gain scores.

10d. There are no differences in duration of fixation gain scores.

10e. There are no differences in rate of reading gain scores.

Significant differences were found among the four treatment groups in regard to the gain scores for each of the specific eye movement measures, as revealed in Table 18. Hypothesis 10 must therefore be rejected in its entirety.

Fixation Gain Scores

A comparison of the differences among means for fixation gain scores, as presented in Table 20, reveals that significant differences exist between the fixation gain scores of Treatment Group IV and Treatment Groups I, II, and III, and between Treatment Group I and Treatment Group III. Treatment Groups I and II showed an increase in fixations while Treatment Groups II and IV had negative gain scores, indicating a drop in number of fixations.

TABLE 20

PAIRWISE COMPARISONS OF DIFFERENCES BETWEEN MEANS FOR FIXATION GAIN SCORES

	Means	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$
$\bar{X}_1$	21.47	10.62	23.07*	39.72*
$\bar{X}_2$	10.85		12.45	29.10*
$\bar{X}_3$	- 1.60			16.65*
$\bar{X}_4$	-18.25			

*$p < .05$; HSD = 15.56

$\bar{X}_1$ = Treatment Group I (NRR - 50 wpm)

$\bar{X}_2$ = Treatment Group II (NRR)

$\bar{X}_3$ = Treatment Group III (NRR + 50 wpm)

$\bar{X}_4$ = Treatment Group IV (NRR + 100 wpm)

Regression Gain Scores

An inspection of Table 21 reveals significant differences between the regression gain scores of Treatment Group IV and Treatment Groups I, II, and III, and between Treatment Group I and Treatment Group III. Treatment Groups I, II, and III showed gain in number of regressions while Treatment Group IV had a negative gain score, indicating a drop in number of fixations.

TABLE 21

PAIRWISE COMPARISONS OF DIFFERENCES BETWEEN MEANS FOR REGRESSION GAIN SCORES

	Means	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$
$\bar{X}_1$	8.42	4.18	6.56*	12.48*
$\bar{X}_2$	4.24		2.38	9.30*
$\bar{X}_3$	1.86			6.92*
$\bar{X}_4$	-5.06			

*$p < .05$; HSD = 5.72

$\bar{X}_1$ = Treatment Group I (NRR - 50 wpm)

$\bar{X}_2$ = Treatment Group II (NRR)

$\bar{X}_3$ = Treatment Group III (NRR + 50 wpm)

$\bar{X}_4$ = Treatment Group IV (NRR + 100 wpm)

Span of Recognition Gain Scores

An inspection of Table 22 reveals significant differences between the span of recognition gain scores of Treatment Group IV and Treatment Groups I, II, and III. Significant differences also occurred between Treatment Group I and Treatment Group III, and between Treatment Groups II and III. Treatment Groups I and II had negative gain scores, indicating a decrease in span of recognition, while Treatment Groups III and IV experienced an increase in span of recognition.

TABLE 22

PAIRWISE COMPARISONS OF DIFFERENCES BETWEEN MEANS FOR SPAN OF RECOGNITION GAIN SCORES

	Means	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$
$\bar{X}_1$	-.120	-.021	-.140*	-.282*
$\bar{X}_2$	-.099		-.119*	-.261*
$\bar{X}_3$	.020			-.142*
$\bar{X}_4$	.162			

*$p < .05$; HSD = .118

$\bar{X}_1$ = Treatment Group I (NRR - 50 wpm)

$\bar{X}_2$ = Treatment Group II (NRR)

$\bar{X}_3$ = Treatment Group III (NRR + 50 wpm)

$\bar{X}_4$ = Treatment Group IV (NRR + 100 wpm)

Duration of Fixation Gain Scores

A comparison of duration of fixation gain scores reveals significant differences between Treatment Group IV and Treatment Groups I, II, and III, as indicated in Table 23. Treatment Groups I, II, and III have gain scores indicating increased duration of fixation, while Treatment Group IV has a negative gain score, indicating shortened duration of fixation.

TABLE 23

PAIRWISE COMPARISON OF DIFFERENCES BETWEEN MEANS FOR DURATION OF FIXATION GAIN SCORES

	Means	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$
$\bar{X}_1$	.026	.005	.006	.032*
$\bar{X}_2$	.021		.001	.027*
$\bar{X}_3$	.020			.026*
$\bar{X}_4$	-.006			

*$p < .05$; HSD = .019

$\bar{X}_1$ = Treatment Group I (NRR - 50 wpm)

$\bar{X}_2$ = Treatment Group II (NRR)

$\bar{X}_3$ = Treatment Group III (NRR + 50 wpm)

$\bar{X}_4$ = Treatment Group IV (NRR + 100 wpm)

Rate Gain Scores

An inspection of Table 24 reveals significant differences in rate gain scores between Treatment Group IV and Treatment Groups I, II, and III, and between Treatment Groups I and II. Treatment Groups I, II, and III have negative gain scores, indicating a decrease in reading rate, while Treatment Group IV shows a gain score indicating an increase in reading rate.

TABLE 24

PAIRWISE COMPARISONS OF DIFFERENCES BETWEEN MEANS FOR RATE GAIN SCORES

	Means	$\bar{X}_2$	$\bar{X}_3$	$\bar{X}_4$
$\bar{X}_1$	-38.36	-5.63	-31.54*	-76.91*
$\bar{X}_2$	-32.73		-25.91	-71.28*
$\bar{X}_3$	- 6.82			-45.37*
$\bar{X}_4$	38.55			

*$p < .05$; HSD = 28.91

$\bar{X}_1$ = Treatment Group I (NRR - 50 wpm)

$\bar{X}_2$ = Treatment Group II (NRR)

$\bar{X}_3$ = Treatment Group III (NRR + 50 wpm)

$\bar{X}_4$ = Treatment Group IV (NRR + 100 wpm)

In Chapter IV data from the ten hypotheses tested has been presented. A summary of the results is given below:

Summary of the Results of Tests of the Null Hypotheses

Hypothesis Tested	Results
Ho_1	
Ho_{1a}	Reject
Ho_{1b}	Reject
Ho_{1c}	Reject
Ho_{1d}	Reject
Ho_{1e}	Reject

Hypothesis Tested	Results
Ho_2	
Ho_{2a}	Do not reject
Ho_{2b}	Reject
Ho_{2c}	Do not reject
Ho_{2d}	Reject
Ho_{2e}	Reject
Ho_3	
Ho_{3a}	Do not reject
Ho_{3b}	Do not reject
Ho_{3c}	Do not reject
Ho_{3d}	Do not reject
Ho_{3e}	Do not reject
Ho_4	
Ho_{4a}	Reject
Ho_{4b}	Reject
Ho_{4c}	Reject
Ho_{4d}	Do not reject
Ho_{4e}	Reject
Ho_5	Do not reject
Ho_6	Do not reject
Ho_7	Reject
Ho_8	Do not reject
Ho_9	Reject
Ho_{10}	
Ho_{10a}	Reject
Ho_{10b}	Reject
Ho_{10c}	Reject
Ho_{10d}	Reject
Ho_{10e}	Reject

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Chapter V contains a summary, conclusions, and recommendations. The summary includes the objectives of the study and the hypotheses. The conclusions present interpretations from the data gathered. The recommendations clarify and supplement the findings of the study.

Summary

One objective of the study was to compare the eye movements and comprehension of undereducated adults when they read printed material (read condition) and when they read printed material accompanied by an audio tape of that material recorded at a rate having a specified relationship to their normal reading rates (read-listen condition). A second objective was to compare measurements among the various treatments of the study, especially to determine if there is a specified relationship between an individual's normal reading rate and the rate of the taped presentation which produces significantly more desirable results in regard to comprehension and eye movement measurements.

Hypotheses 1-4 were concerned with the comparison of the eye movements of subjects when they read printed material

and when they read printed material accompanied by a tape recording of that material having a specified rate relationship to the subject's normal reading rate.

Hypotheses 5-8 were concerned with the comparison of the comprehension of subjects when they read printed material and when they read printed material accompanied by a tape recording of that material having a specified rate relationship to the subject's normal reading rate.

Hypothesis 9 was concerned with a comparison of comprehension gain scores among the four treatment groups, while Hypothesis 10 was concerned with a comparison of eye movement gain scores among the four treatment groups.

Conclusions

The findings and specific conclusions are listed following the statement of each hypothesis tested in the study. These are followed by a discussion and summary of general conclusions.

Read versus Read-Listen Conditions

Eye movements: Effect of read-listen conditions by presentation rates

Presentation rate: NRR - 50 wpm

The specific null hypothesis stated. There are no differences in the specific measurements of eye movements of subjects when they read a printed selection (read condition) and when they read a printed selection accompanied by a tape recording of that selection (read-listen condition)

which is presented at 50 wpm below each subject's normal reading rate (NRR - 50 wpm).

Findings. Significant differences were found on all eye movement components when the read condition was compared with the read-listen condition in which the presentation rate was 50 wpm below the normal reading rate. More fixations and regressions, shorter recognition spans, longer durations of fixation and decreases in reading rate occurred under the read-listen condition.

Conclusions. Subjects read much less efficiently in regard to eye movements when the rate of presentation in the read-listen condition was 50 wpm below their normal reading rates than they did in the read condition. The effect of the accompanying tape in this read-listen condition was detrimental to eye movement efficiency.

Presentation rate: NRR

The specific null hypothesis stated. There are no differences in specific measurements of eye movements of subjects when they read a printed selection (read condition) and when they read a printed selection accompanied by a tape recording of that selection (read-listen condition) which is presented at each subject's normal reading rate. (NRR).

Findings. Significant differences were found on some, but not all, eye movement components when the read condition was compared to the read-listen condition in which presentation rate was at the normal reading rate. Subjects

had more fixations and regressions, a shorter span of recognition, a longer duration of fixation, and a slower reading rate under this read-listen condition than under the read condition. The increase in number of fixations and the decrease in span of recognition were not significant, but the decrease in reading rate, the increase in duration of fixation and the increase in number of regressions all occurred at significant levels.

Conclusions. The use of an accompanying tape presented at the subject's normal reading rate resulted in a decrease in eye movement efficiency. The decrease in efficiency in regard to fixations and span of recognition was not significant, but the decrease in reading rate, increase in duration of fixation, and increase in number of regressions were significant. It can be concluded that the overall effect of the accompanying tape in this read-listen condition was detrimental to eye movement efficiency.

Presentation rate: NRR + 50 wpm

The specific null hypothesis stated. There are no differences in specific measurements of eye movements of subjects when they read a printed selection (read condition) and when they read a printed selection accompanied by a tape recording of that selection (read-listen condition) which is presented at 50 wpm above each subject's normal reading rate (NRR + 50 wpm).

Findings. No significant differences were found in regard to eye movements except for duration of fixation, when the read condition was compared to the read-listen condition in which presentation rate was 50 wpm above the normal reading rate.

Conclusions. The use of an accompanying tape presented at 50 wpm above the subject's normal reading rate had little effect on eye movement efficiency, except in regard to producing a longer, less desirable duration of fixation. Subjects apparently read in about the same manner under this read-listen condition as they did under the read condition insofar as eye movement measurements were concerned. Since no beneficial results accrued from the use of the accompanying tape and since there was a lengthening of duration of fixation, it would seem that there is no plausible reason for using an accompanying tape presented at this rate if increased eye movement efficiency is the goal.

Presentation rate: NRR + 100 wpm

The specific null hypotheses stated. There are no differences in specific measurements of eye movements of subjects when they read a printed selection (read condition) and when they read a printed selection accompanied by a tape recording of that selection (read-listen condition) which is presented at 100 wpm above each subject's normal reading rate.

Findings. Significant differences were found on all eye movement measures except for rate of duration when the read condition was compared to the read-listen condition in which the presentation rate was 100 wpm above the normal reading rate.

Conclusions. The use of an accompanying tape presented at 100 wpm above the subject's normal reading rate resulted in increased eye movement efficiency. Fewer fixations and regressions, an increased span of recognition, a shorter duration of fixation, and a faster reading rate occurred under this read-listen condition than under the read condition. Except for the shorter duration of fixation, all differences occurred at a significant level. It can be concluded that the overall effect of an accompanying tape presented at 100 wpm above the subject's normal reading rate was beneficial to eye movement efficiency.

Comprehension: Effect of read-listen conditions by presentation rates

Presentation rate: NRR - 50 wpm

The specific null hypothesis stated. There are no differences in comprehension of subjects when they read a printed selection and when they read a printed selection accompanied by a tape recording of that selection which is presented at 50 wpm below each subject's normal rate of reading.

Findings. While no significant differences were found in the comprehension of subjects under the two conditions tested, the direction of change was toward one of increased comprehension under the read-listen condition of 50 wpm below the normal reading rate.

Conclusions. The use of an accompanying tape presented at 50 wpm below the subject's normal reading rate has no significant effect on comprehension. If the major purpose in using an accompanying tape is to increase comprehension, there is no justification in using this presentation rate.

Presentation rate: NRR

The specific null hypothesis stated. There are no differences in the comprehension of subjects when they read a printed selection and when they read a printed selection accompanied by a tape recording of that selection which is presented at each subject's normal rate of reading.

Findings. While no significant differences were found in regard to comprehension measurements under the read condition and under the read-listen condition in which the presentation rate was at the normal reading rate, the direction of change was toward one of decreased comprehension under the read-listen condition.

Conclusions. The use of an accompanying tape presented at the subject's normal reading rate has no significant effect on comprehension. If the major purpose in using an accompanying tape is to increase comprehension,

there would be no justification in using a tape with this presentation rate.

Presentation rate: NRR + 50 wpm

The specific null hypothesis stated. There are no differences in the comprehension of subjects when they read a printed selection and when they read a printed selection accompanied by a tape recording of that selection which is presented at 50 wpm above each subject's normal rate of reading.

Findings. Significant differences were found in regard to comprehension measurements when the read condition was compared to the read-listen condition in which the presentation rate was 50 wpm above the normal reading rate. Subjects showed significant increases in comprehension under this read-listen condition.

Conclusions. The use of an accompanying tape presented at 50 wpm above the subject's normal reading rate had a beneficial effect on reading comprehension. If the major purpose in using an accompanying tape is to increase comprehension, this would be an appropriate presentation rate.

Presentation rate: NRR + 100 wpm

The specific null hypothesis stated. There are no differences in the comprehension of subjects when they read a printed selection and when they read a printed selection accompanied by a tape recording of that selection which is

presented at 100 wpm above each subject's normal rate of reading.

Findings. While no significant differences were found in regard to comprehension measurements under the read condition and under the read-listen condition of 100 wpm, the direction of change was toward one of decreased comprehension under this read-listen condition.

Conclusions. The use of an accompanying tape presented at 100 wpm above the subject's normal reading rate had no significant effect on comprehension. If the major purpose in using an accompanying tape is to increase comprehension, there would be no justification in using this presentation rate.

A Comparison of Gain Scores among Treatment Groups

Comprehension gain scores

The specific null hypothesis stated. There are no differences in comprehension gain scores among the four treatment groups resulting from the use of accompanying tapes of specified rates.

Findings. Significant differences were found among the four treatment groups in regard to comprehension gain scores. Treatment Group I, in which the read-listen condition of NRR - 50 wpm was utilized, showed significantly greater gains in comprehension than did Treatment Group IV, in which the tape presentation was at 100 wpm above the

normal reading rate. Treatment Group III, in which the tape presentation was at 50 wpm above the normal reading rate, also showed greater gain in comprehension than did Treatment Group IV.

Conclusions. In terms of gain in comprehension, the most desirable rate relationship is that of 50 wpm above the normal reading rate.

The rather surprising result of comprehension gain in Treatment Group I requires further examination. The conditions of tape presentation perhaps had some bearing on this result. In order to maintain consistency in presentation across the four groups, each tape recording was played in its entirety for each subject. The investigator believed that failure to present each tape in its entirety might have given some groups advantages in comprehension over other groups. If, for example, the tape recording had been stopped at the conclusion of the subject's reading of the passage, those subjects listening to the higher presentation rates would probably have listened to all the recording, while those at the lower rates would have listened only to that portion of the tape that had been played by the time they finished reading.

It is possible, however, that by using the technique in which all subjects listened to the taped presentation in its entirety, Group I was given some advantage. The extremely slow presentation rate resulted in many subjects in Group I

listening to the tape recording for several minutes after they stopped reading. The resulting increase in comprehension may have been the product of additional listening time.

Eye movement gain scores

The specific null hypothesis stated. There are no differences in the specific eye movement gain scores among the four treatment groups resulting from the use of accompanying tapes of specified rates.

Findings. Significant differences were found among the four treatment groups in regard to gain scores for each of the five eye movement components. Subjects in Treatment Group IV showed significantly greater gain in regard to eye movement efficiency than did subjects in Treatment Groups I, II, or III. Treatment Group III showed significantly greater gain than Treatment Group I in regard to eye movement efficiency on all eye movement measures except duration of fixation. Treatment Group III also showed significantly greater gain than Treatment Group I in regard to gain in span of recognition.

Conclusions. In terms of gain in eye movement efficiency, the most desirable rate relationship is a presentation rate of 100 wpm above the normal reading rate.

General Conclusions

In addition to the specific conclusions previously presented, certain general conclusions resulted from examining the data as a whole.

In comparing all four treatment groups in the read vs. read-listen conditions, it became apparent that as the presentation rate of the read-listen condition (in terms of its relationship to the normal reading rate) increased, so did efficiency in eye movements. Group I had the least efficient eye movements, Group II showed some improvement over Group I, Group II showed improvement over Group III, and Group IV showed improvement over Group III. While not all of these differences achieved significance, the trend was toward increased efficiency with increased rate of presentation.

In considering the findings related both to eye movements and comprehension, certain general conclusions could be made in regard to total reading efficiency. When considering total reading efficiency, a balance between comprehension and eye movement efficiency is desirable.

If subjects read much more efficiently in regard to eye movement efficiency under the read-listen condition of NRR + 100 wpm, and show no significant loss in comprehension, as was the case in this study, then it seems apparent that this is the most desirable rate relationship insofar as total reading efficiency is concerned.

If, on the other hand, one considers the total effect of an accompanying tape at NRR - 50 wpm, an entirely different conclusion would be reached. Treatment Group I showed significantly greater gain in comprehension than did Treat-

ment Group IV. When the loss in eye movement efficiency is taken into account, however, it seems apparent that there would be no justification for using a tape at this presentation rate. Further, if the major concern is that of increased comprehension, even at the expense of some eye movement efficiency, the rate of NRR + 50 wpm would be a more reasonable rate to use, since this rate produced the greatest gain in comprehension among the treatment groups and with far less loss in eye movement efficiency than occurred in Treatment Group I.

While not a part of the experimental design for this study, one incidental finding seems significant enough to be included as a part of the results of the study. The normal reading rate as defined in this study was determined by the subject's rate score on the Traxler Silent Reading Test, translated into rate in words per minute. In comparing the normal reading rates (NRR) of subjects in this study with their reading rates on the pretest, it became apparent that the NRR was striking lower than the pretest rate. Table 26 in the appendix contains, for each subject in each treatment group, the NRR, the tape presentation rate, the pretest rate (read condition) and the posttest rate (read-listen condition). An examination of the means for Group I reveals that the mean NRR for this group was about 47 wpm below the pretest rate. If we consider the pretest rate as the specific reading rate (SRR), in the sense of being specific to this

situation, the relationship of the mean presentation rate to the mean specific reading rate is SRR - 97 wpm. For Group II this relationship is SRR - 65 wpm; for Group III, SRR - 14 wpm; for Group IV, SRR + 39 wpm.

The reasons for this striking difference in the two reading rates are difficult to determine. Research findings of no significant difference in reading before the eye movement camera and in reading away from it do not seem to hold true for this population of incarcerated undereducated adults. It is possible, however, that differences in the difficulty level of the Traxler Silent Reading Test and the Reading Versatility Test might have contributed to this difference. Motivational factors favoring the individual testing situation over the group testing situation may have been operable. At any rate, this finding seems to point to the generalization made by such reading experts as Shores[1] that reading rate tends to be specific to individual purpose, motivation, and difficulty level of the material.

Summary statement of general conclusions

1. The use of an accompanying tape can result in a significant decrease in eye movement efficiency. In this study presentation rates of NRR and NRR - 50 wpm produced such a decrease.

2. The use of an accompanying tape to increase eye movement efficiency is not justified unless the

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[1]J. Harlan Shores, "Dimensions of Reading Speed and Comprehension," Elementary English 45 (January 1968):23-28.

presentation rate is suitable. In this study the only presentation rate that produced increased eye movement efficiency from the read condition to the read-listen condition was that of NRR + 100 wpm.

3. The use of an accompanying tape to increase comprehension is not justified unless the presentation rate is suitable. In this study the only presentation rate that produced a significant increase in comprehension from the read condition to the read-listen condition was that of NRR + 50 wpm..

4. As the presentation rate of the four read-listen conditions increased (in terms of its relation to NRR) so did efficiency in eye movements.

5. The most desirable rate relationship found in this study for total reading efficiency was that of NRR + 100, since this rate produced greatest eye movement efficiency with no significant loss in comprehension.

6. The normal reading rate (NRR) of subjects in this study was much lower than their pretest (read condition) reading rate.

After considering the results of this study, certain recommendations related to the topic of using compressed and expanded speech tapes for incarcerated undereducated adults seem appropriate. A list of these recommendations follows.

Recommendations

1. Results of this study point to the beneficial effects of utilizing compressed speech tapes as reading aids for undereducated adults, since greatest total reading efficiency occurred when presentation rates of NRR + 100 wpm were utilized.

2. Additional studies should be performed employing accompanying tapes compressed at higher rates than those used in this study to determine their effect on the reading efficiency of undereducated adults. Since the highest rate utilized in this study was 284 wpm, other, higher rates, at which intelligibility drops, should be used to determine their effectiveness as reading aids for undereducated adults. Further, such studies could determine at what rate relationship comprehension begins to drop significantly. In this study there was a drop in comprehension at NRR + 100, but the drop was not significant.

3. Additional studies should be performed in which the rate relationship of the accompanying tape is established using the specific reading rate (SRR) as the base point. This could perhaps be accomplished by using one of the four alternate forms of the Reading Versatility Test with the Reading Eye II to establish specific reading rate. Other forms of the test could then be used in the pretest and post-test siguations.

4. Additional studies should be performed using other populations of undereducated adults to determine if results from this study are generalizable to other, non-incarcerated groups of undereducated adults.

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APPENDIX

SELF-REPORT QUESTIONNAIRE

1. During the time you listened to the tape recording and read the story, how much attention did you pay to the recording?

   a. I ignored the recording and read as I normally would.

   b. I used the recording to help me pace my reading.

   c. I ignored the printed material and listened to the tape recording.

   d. None of the above. (Explain) _____

   _____

2. During the time you listened to the tape recording and read the story, how much information did you get from each source--that is, from the printed material and from the tape recording?

   a. I got most of the information from the tape recording.

   b. I got most of the information from the printed material.

   c. I got some of the information from the tape recording and some from the printed material.

   d. None of the above. (Explain) _____

   _____

3. How did you feel about listening to the tape recording while reading the printed material?

   a. It bothered me because the rate of the recording was too slow for my reading.

   b. It bothered me because the rate of the recording was too fast for my reading.

   c. It was helpful to me in pacing my reading.

   d. None of the above. (Explain) _____

   _____

TABLE 25

SUMMARY OF RESPONSES TO SELF-REPORT QUESTIONNAIRE

Condition	Possible Response	No. of Ss Giving Response to Question 1	No. of Ss Giving Response to Question 2	No. of Ss Giving Response to Question 3
Group I (NRR-50)	A	13	1	16
	B	3	11	1
	C	0	8	4
	D	6	2	1
Group II (NRR)	A	6	3	14
	B	10	7	0
	C	0	11	7
	D	6	1	1
Group III (NRR+50)	A	1	2	6
	B	15	6	3
	C	4	13	11
	D	2	1	2
Group IV (NRR+100)	A	2	4	2
	B	16	1	4
	C	0	16	14
	D	4	1	2

TABLE 26

SUMMARY OF RATE RELATIONSHIPS

Group I (NRR-50)

Subject	NRR	Tape Presentation Rate (NRR-50)	Pretest Rate	Posttest Rate
1	102	52	156	125
2	108	58	145	111
3	162	112	211	114
4	114	64	135	141
5	102	52	197	174
6	138	88	158	91
7	192	142	222	190
8	114	64	179	171
9	108	58	171	148
10	156	106	235	109
11	156	106	250	211
12	102	52	143	107
13	132	82	211	132
14	156	106	160	114
15	132	82	160	158
16	102	52	188	124
17	180	130	188	176
18	180	130	160	150
19	114	64	171	154
20	168	118	179	124
21	132	82	197	160
22	114	64	179	167
	$\bar{X}$=134.72	$\bar{X}$=84.72	$\bar{X}$=181.59	$\bar{X}$=143.227

TABLE 26--Continued

Group II (NRR)

Subject	NRR	Tape Presentation Rate (NRR)	Pretest Rate	Posttest Rate
23	132	132	245	152
24	102	102	214	148
25	138	138	250	179
26	168	168	250	167
27	174	174	218	218
28	132	132	190	176
29	132	132	200	136
30	132	132	150	133
31	126	126	164	129
32	138	138	222	203
33	216	216	222	214
34	138	138	222	164
35	156	156	156	160
36	102	102	152	136
37	222	222	235	231
38	114	114	255	218
39	138	138	119	118
40	108	108	214	218
41	102	102	164	141
42	102	102	188	150
43	126	126	197	132
44	108	108	200	194
	$\bar{X}$=136.64	$\bar{X}$=136.64	$\bar{X}$=201.23	$\bar{X}$=168.95

TABLE 26--Continued

Group III (NRR+50)

Subject	NRR	Tape Presentation Rate (NRR+50)	Pretest Rate	Posttest Rate
45	138	188	190	194
46	102	152	138	156
47	234	284	300	286
48	126	176	214	197
49	168	218	182	226
50	138	188	136	145
51	126	176	222	231
52	132	182	235	185
53	126	176	162	185
54	102	152	226	160
55	168	218	235	231
56	114	164	190	169
57	108	158	141	169
58	102	152	185	136
59	126	176	182	185
60	156	206	218	231
61	180	230	235	235
62	114	164	185	167
63	120	170	158	174
64	120	170	169	179
65	162	212	279	218
66	162	212	245	218
	$\bar{X}$=137.45	$\bar{X}$=187.45	$\bar{X}$=201.23	$\bar{X}$=194.41

TABLE 26--Continued

Group IV (NRR+100)

Subject	NRR	Tape Presentation Rate (NRR+100)	Pretest Rate	Posttest Rate
67	108	208	171	218
68	126	226	197	267
69	102	202	129	207
70	120	220	218	218
71	114	214	267	211
72	144	244	135	261
73	102	202	138	203
74	108	208	179	214
75	114	214	130	226
76	102	202	218	218
77	102	202	156	211
78	126	226	267	207
79	114	214	197	231
80	120	220	226	222
81	180	280	182	279
82	126	226	194	226
83	132	232	211	218
84	102	202	197	207
85	144	244	138	255
86	132	232	203	235
87	180	280	279	293
88	168	268	226	279
	$\overline{X}$=125.73	$\overline{X}$=225.73	$\overline{X}$=193.54	$\overline{X}$=232.09