THE EFFECTS OF RATE OF PRESENTATION OF AUDIO TAPES UPON THE LISTENING COMPREHENSION OF FAST AND SLOW READERS

By

GEORGE EDWARD NIPPER II

Bachelor of Science in Education
Southern State College
Magnolia, Arkansas
1967

Master of Science
Louisiana Tech University
Ruston, Louisiana
1971

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
DOCTOR OF EDUCATION
May, 1976

Thesis
1976 D
N442e
Cop. 3

OKLAHOMA STATE UNIVERSITY LIBRARY

AUG 23 1976

THE EFFECTS OF RATE OF PRESENTATION OF AUDIO TAPES UPON THE LISTENING COMPREHENSION OF FAST AND SLOW READERS

Thesis Approved:

Kenneth L. King
Thesis Adviser

Kenneth E. Wiggins
Program Chairman

Lewis L. Post

Charles L. Smith

L. Herbert Breneman

N N Durham
Dean of the Graduate College

1138343

PREFACE

This study is concerned with the comprehension of time-compressed speech. The primary objective is to determine the effects of compressed speech upon the listening comprehension of fast and slow readers. It is hoped that the endeavors of this study will provide a basis for further investigation in this area.

The author wishes to express his gratitude to Dr. Kenneth E. Wiggins, chairman of the doctoral committee, for his guidance, assistance, and encouragement throughout the program of study. Appreciation is expressed to Dr. Kenneth L. King, major thesis advisor, for his enthusiasm, interest, expert advice, and patient counsel which made this task an educational as well as a rewarding experience. Appreciation is also expressed to the other committee members, Dr. Gene Post, Dr. Charles Smith, and Dr. Herb Bruneau, for their timely suggestions and invaluable assistance during the study.

A note of thanks is given to Floyd Loftiss, Dick Coup, James Bond, and Joe Stricklin for their assistance with various parts of the study. Special appreciation is extended to the typist, Cathy Patrick, who sacrificed many hours of her time to complete the typing of this manuscript.

A special note of thanks is given to my parents, Buster and Georgie Nipper, whose lifetime of encouragement and direction I am fortunate to have. Finally, special praise of gratitude and appreciation is expressed to my wife, Yvette, our daughters, Dana and Shannon, who sacrificed the most that this study might be made.

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

CHAPTER I

NATURE OF THE PROBLEM

Introduction

Perhaps no aspect of the human experience is more clearly requisite to survival than relationships with other people. Man learns early in his existence that others can help satisfy his needs and wants if he can only make them known. The child discovers that certain sounds or actions will result in subsequent actions or reactions from others. Eventually, through the imitative and educational process, the child learns that he can make his ideas readily known, and thus more accurately control or predict the reactions of others if he uses certain symbols in particular patterns. It is certainly here, if not before, that the advantages and importance of communication becomes apparent to the communicator.

In its broadest interpretation, interpersonal communication is the sharing of ideas and feelings. This transfer takes place through a system of symbols which may range all the way from spoken and written words to musical sounds, colors, designs, and motions. Most agree that the objective of the communicative act is to elicit a desired response from a recipient. The degree of success derived from the communication act depends upon the extent of the agreement between expressor and receptor as to the meaning of the symbols used. Effective communication,

then, seeks to promote a common understanding which is a prerequisite to success in most endeavors.

Verbal communication is generally perceived as involving four primary activities: reading, writing, speaking, and listening. A study by Paul T. Rankin (1926) points out that the average individual devotes approximately 70 percent of his waking hours in communication. Specifically, Rankin (1926) discovered that nine percent is spent writing, 16 percent is spent reading, 30 percent is spent talking, and 45 percent is spent listening. This study has been replicated by Breiter (1957) who conducted the study among housewives and Bird (1954) who conducted the same study of 110 dieticians and achieved the same basic results. Thus, it is evident from these studies that almost half of our communicative time is devoted to the act of listening.

In elementary, secondary, and higher education, the proportion of student time spent in listening provides an impressive justification for the increasing efforts, through research, to develop techniques for improving listening skills. In a study for the National Educational Association, Taylor (1964) found that over 50 percent of the class time in high schools and colleges was spent in listening. Listening is a fundamental precept of our lives and, as such, is basic in school and business alike.

Since such a great amount of time is devoted to the act of listening, it is no wonder that the nature of the listening process has become of increasing interest and importance to those working in the fields of education and mass communication. Ralph Nichols (1957) has been expounding for almost twenty years the theory that the listener's thought processes are able to operate much more rapidly than the speech

produced by the human vocal chords. Only in recent years has it become possible to subject his theory to empirical research and evaluation. Recent technological advances have made it possible to shorten the time required for presentation of recorded messages without significantly affecting comprehension or seriously distorting pitch quality. The technique is known as "time-compressed speech". The process is accomplished by playing a tape recording of the material to be compressed through a compression device at a pre-selected rate of speed which is faster than the original recording rate of the tape.

The significance of compressed speech was clearly stated by Orr (1968) in the statement,

> Basically, the significance of compressed speech lies primarily in two directions, one related to applied areas, and one related to basic research areas. Both of these avenues are of importance. . . . the use of compressed speech as a tool to study the basic nature of human information communication hitherto determined exclusively by natural conditions. . . . The applied dimension lies most clearly in the realm of education. Today's pressures on education, created by the burgeoning knowledge and culture to be transmitted to the next generation demand an efficient educational process. . . . It is clear that auditory educational methods are assuming a larger and larger role in our educational process since some children learn better auditorially; since the use of audio-visuals is growing; and since the new educational technologies such as computer-assisted instruction, dial-access tape lectures, telelectures, etc., involve auditory presentations (p. 6).

Statement of the Problem

The research problem of this study is directly related to the educational application dimension of compressed speech. Briefly, the problem of this study is the comprehension of time-compressed speech.

Statement of Purpose

The purpose of this study is to determine the effects of compressed speech upon the listening comprehension of fast and slow readers. The investigation is concerned with (1) the effects of varying rates of compression upon the comprehension of audio tape material and (2) the interactive effects of rate of compression and reading ability upon the comprehension of audio tape material.

Significance of the Study

The use of compressed speech has been frequently advocated because of its capacity to conserve time. In light of the growing demands on individuals listening to increasing oral communications, the conservation of time justifies the use of compressed speech. A large proportion of current research has addressed the problem of determining if, to what extent, and at what maximum rate learners can listen to compressed speech without major loss of comprehension. Few studies of compressed speech have been directed toward the reading ability of the learner. The perceptual and cognitive factors that are responsible for individual differences in reading rate may also be responsible for individual differences in the ability to comprehend compressed speech. This study will attempt to contribute additional information to this less developed area of time-compressed speech.

Statement of Hypotheses

The basic hypotheses of this study are:

1. There will be no significant effects of varying rates of compression upon the comprehension of audio tape material.

2. There will be no significant interactive effects of rate of compression and reading ability upon the comprehension of audio tape material.

Definition of Terms

Compressed Speech. Recorded speech which is reproduced in less than the original delivery time.

Zero Percent Compression. An audio tape message recorded at a speaking rate of 165 words per minute requiring 11.4 minutes for presentation.

Twenty Percent Compression. An audio tape message recorded at a rate of 208 words per minute requiring 9.1 minutes or 80 percent of the original time for presentation.

Forty Percent Compression. An audio tape message recorded at a rate of 266 words per minute requiring 7.1 minutes or 60 percent of the original time for presentation.

Selective Deletion. The process of speech compression whereby pauses are removed from a recorded discourse.

Systematic Deletion. The technique of speech compression which discards extremely small fragments of a recording at regular intervals.

VOCOM I. An electro-mechanical speech compression device which utilizes the technique of selective deletion to accomplish compression.

Varispeech I. An electronic speech compression device which utilizes the technique of systematic deletion to accomplish compression.

Fast Reader. An individual with a reading rate in the upper one-third of the population sampled with a 70 percent level of comprehension

(McGraw-Hill Reading Test).

Slow Reader. An individual with a reading rate in the lower one-third of the population sampled with a 70 percent level of comprehension (McGraw-Hill Reading Test).

Assumptions of the Study

To complete this study, the following assumptions were made:

1. The subjects participating in the study did not have any previous experience listening to time-compressed speech.
2. The subjects responded to the reading test and the listening comprehension test to the best of their ability.

Other aspects relevant to the execution of this study were coordinated by the investigator to ensure maximum effectiveness. Great care was taken to see that the subjects were not aware of their role in the experiment in an attempt to negate the "Hawthorne" effect. Each monitor was thoroughly briefed on the use of equipment necessary for data collection.

Limitations of the Study

This research was conducted with a test population composed of students enrolled in Utilization of Instructional Media classes during the spring semester of the 1976 academic year. The course is a predominantly junior level course required of all secondary and elementary education majors for teacher certification at Oklahoma State University. It also meets the Oklahoma State Department of Education requirement for media proficiency. Therefore, the course enrollment includes students from many different disciplines on the campus of Oklahoma State University.

The test subjects will be limited to fast and slow readers (previously defined, p. 5-6) from the Utilization of Instructional Media classes of the spring semester 1976. Generalizations from this study should, therefore, be limited to populations which have similar characteristics.

CHAPTER II

REVIEW OF SELECTED LITERATURE

Numerous attempts have been made during the past thirty years to reduce the time required for listening to recorded communication. It is only during the past few years, however, that intensive focus has been given to compressed speech, a technique for shortening the time required for presentation of recorded communications without significant distortion in pitch and quality.

The relatively slow initial impetus of the concept of compressed speech requires that a historical perspective be synthesized prior to an examination of research more closely related to the present study. The initial segment of this chapter, the historical perspective, was developed through a three-phase organization structure as follows: (1) research prior to 1951, (2) research from 1951 to 1960, (3) research from 1961 to the present.

Historical Perspective Research Prior to 1951

Fletcher (1929) conducted research dealing with time and frequency distortion at the Bell Telephone Laboratories. His work with the transmission of speech led him to the discovery that when a phonograph record was speeded up or slowed down, the frequency formants of the recorded speech would retain their original octave intervals. The frequency, in the case of an increase of speed, would be multiplied in

direct relation to the increase in speed. If the record was slowed down, the frequency formants would subsequently be reduced. This was found to be true of all frequency formants of the speech signal, including the harmonics.

Fletcher (1929) next recorded articulation lists which were played through a telephone circuit at various speeds. He found that changes of speed less than ten percent produced very little effect. For greater changes the articulation fell off rapidly. For example, a compression in time of approximately 33 percent resulted in a loss in articulation (intelligibility) of 40 percent or more.

Two Italian psychologists, Gemelli and Pastori, (1934) conducted a series of research projects to determine the minimum duration of a tone necessary for the perception of its pitch. It was found that only two complete vibrations were necessary for the sensation of tonality.

Steinberg (1936a) reported the results of speeding up recorded speech on recorded discs and sound film. In this study, the technique employed to speed up the recorded speech was to increase the speed of the sound film or disc above that used during the recording. He found that when all component frequencies of speech were multiplied by a common factor, such as is obtained when the rate of rotation of phonographic recordings is increased or decreased, intelligibility of speech did not drop below 80 percent until component frequencies were multiplied by a factor of less than 0.8 or more than 1.4.

Also, Steinberg (1936b) reported an experiment in which fractions of nonsense syllables were removed before their presentation to the listener. If the first half of the consonant of the nonsense syllable was removed, the subjects were still able to understand the syllable

correctly better than 50 percent of the time. If meaningful material was used, and the whole consonant was removed, the subjects were able to fill in the missing element and understand the speeds with approximately 90 percent efficiency.

In a study on the minimum duration required for vowel recognition, Peterson (1939) presented to a group of subjects several series of short vowel sounds of varying periods of duration for identification. The subjects were asked to identify the sounds and the duration of the sounds were reduced until recognition became exceedingly difficult. It was then assumed that the minimum duration necessary for the recognition of the given vowel had been approximately located. Peterson found the value of the minimum duration required for vowel recognition to be as low as five milliseconds. It hardly seems necessary to point out the importance of such a study in relationship to the intelligibility and comprehension of compressed speech. Certainly, knowledge of the minimum duration of any speech component set the limits to the degree of compression that would be possible without destroying intelligibility.

Goldstein (1940) was primarily concerned with a comparison of the efficacy of written and oral material. He postulated that one of the ways of reaching the best possible judgment concerning the relative effort on comprehension of visual and aural presentations would be to vary the rate. Such experimentation consisted of adjusting the rate of visual materials by varying the rate of projection on a screen; the rate of aural material by means of a combination of rapid speaking and playback at a rate more rapid than the recording rate. Among Goldstein's findings were the following: (1) listening comprehension

is superior in general to reading comprehension; (2) the relative superiority of listening comprehension is in inverse proportion to the intelligence and reading speed of the groups; (3) the relative superiority of listening declines with increased rate of presentation; (4) there is a decline of comprehension with increased rate in both reading and listening; (5) the decline of comprehension is progressive as faster rates are reached; and (6) the superiority of listening comprehension is greater for easy material than for difficult material.

An investigation conducted at the Howard Psycho-Acoustic Laboratory in which continuous speech was chopped by means of cutting the speech on and off with an electronic switch was reported by Miller (1946). It was found, with a chop rate of nine segments per second, that as much as 50 percent of the original speech could be removed with a loss of only 15 percent intelligibility. This finding suggested that if some means could be devised for chopping segments from the speech recorded, removing the unrecorded portions, then splicing together the remaining segments, the effect of speeding up the speech could be obtained without the usual frequency distortion.

Nelson (1948) used five newscasters to record five different messages at five different rates. A total of 250 college students listened to the recorded messages at rates varying from 125 to 250 words per minute. He found that rate was not a significant factor in recall, but the level of difficulty was a significant variable.

Black (1949) reported a study of the characteristics of mean vowel durations of 11 vowels, as spoken by 16 speakers, which established significant differences among some vowels in their natural duration. Durations were found to vary directly with the openness of the vowel.

Miller and Licklider (1950) reported the effects of interrupting speech waves--turning them on and off intermittently or masking them with intermittent noise--upon their intelligibility. The effects were studied with various rates of interruption and with the speech left undisturbed various percentages of the time. Tests were conducted (1) with speech turned on and off in quiet, (2) with continuous speech masked by interrupted with noise, and (3) with speech and noise interrupted alternately, the speech wave being turned on or the noise wave turned off and vise versa. The following results were reported: (1) When the speech wave was turned on and off infrequently, the percentage of the message that was missed was approximately the same as the percentage of time the speech was off. When the interruptions were periodic and occurred more often than 10,000 times per second, the interruptions did not interfere with the reception of the message. In the quiet it was easy to understand conversational speech so long as the interruptions occurred more than ten times per second. (2) When continuous speech waves were masked by noise that was interrupted more than 200 times per second, intelligibility was dependent on the interruption frequency and on the percentage of time the noise was on, provided the ratio of average speech power to average noise power was held constant. Interrupted masking noise impaired intelligibility least if the frequency of interruption was about 15 per second. (3) When interrupted speech and interrupted noise alternated at frequencies below ten alternations per second, the noise did not impair intelligibility. At higher frequencies of alternation, the temporal spread of masking became appreciable. The general features of these results were approximately the same whether the interruptions occurred periodically or at random.

Research from 1951 to 1960

Recognizing the shortcomings of available methods of speech acceleration, Garvey (1953) sought a more efficient method of speech compression. He introduced the "chop-splice" technique, a method involving the removal of minute segments of tape and a reuniting of remaining segments with adhesive tape. He found that speech remained intelligible until over one-half of the tape was removed, and concluded that rate of speech sounds together with the amount of the speech pattern removed were significant variables affecting intelligibility of compressed speech.

Kodman (1954) reported that intelligibility of time compressed speech was an inverse function of the amount of time compression. He also reported that intelligibility of speech was possible even when over two-thirds of the initial signal had been eliminated.

Fairbanks, Everitt, and Jaeger (1954) published a description of a device which could achieve mechanically what Garvey had achieved manually. The machine had the capability of presenting material in more or less than the original time without significant distortion of pitch or phonetic sounds.

Foulke (1971), in describing the Fairbanks device, stated that the amount of speech compression was dependent on the frequency with which tape segments were eliminated, which was in turn dependent upon the rotational speed of the cylinder. Foulke (1971) noted that in the Fairbanks model,

> . . . a continuous tape loop passes over a recording head used to place on the tape the signal that is to be compressed. It passes over the device used to reproduce samples of this signal. Finally, it passes over an erase head that removes

> the signal from the tape loop so that the tape can be re-recorded on the next cycle. The sampling device is a cylinder with playback heads embedded in it and equally spaced around its circumference. The tape, in passing over the curved surface of this cylinder, makes contact with approximately one quarter of its circumference. When the cylinder is stationary, and one of the playback heads is contacted by the moving tape, the signal on the tape is reproduced as recorded.
>
> When the apparatus is adjusted for some amount of compression, the cylinder bearing the four playback heads begins to rotate in the direction of the tape motion. Under these conditions, each of the four heads in turn makes and then loses contact with the tape. Each head reproduces the material on the portion of the tape with which it makes contact. When, as it rotates, the cylinder has arrived at a position at which one head is just losing contact with the tape, the segments of tape that are wrapped around the cylinder between these two heads never make contact with a reproducing head and are therefore not reproduced. The segment of tape eliminated is always the same length, one quarter of the circumference of the cylinder (p. 79).

The speech compression process as described above results in the production of recorded communications free from the distortion and frequency change normally accompanying other types of accelerated recordings.

A definition of the relationship between speed of delivery and intensity necessary for intelligibility was sought by Calearo and Lazzaroni (1957). They concluded that the redundancy of information contained in a speech message allows a complete neutralization of the negative effect due to the increased speed of delivery when such increase is contained within modest limits.

Fairbanks, Guttman, and Miron (1957) found little difference in the compression of listening selections presented at 141, 201, and 282 words per minute. It was found that good intelligibility was possible when speech was compressed to 50 percent of its original time length, but intelligibility rapidly declined after that point.

Enc and Stolurow (1960) reported the effect of two listening rates on blind school children tested for learning and comprehension. They found that practice increased listening efficiency and that the level of comprehension was acceptable at either speed.

Research from 1961 to Present

With the advent of the 1960's, there was burgeoning of research in the field of compressed speech, with some of the experimentation utilizing the "speed-changing" method of compression and some utilizing the "sampling" method of compression. The former method differs from the latter in that the speed-changing method changes word rate by the simple reproduction of recordings at different speeds, while the sampling method excludes small portions of a tape through a mechanical process such as the one described by Foulke (1971). (See p. 13.)

Utilizing the speed-changing method, Klump and Webster (1961) made the following observations:

> These studies suggest that it is not the brain of the listener that is overloaded by the speech speed up. The limit is apparently set by the ability of the ear to decode the frequency shifted patterns and not by the speed up, per se. Even with the frequency shift plus speed up, a listener can be pushed 50 percent faster than normal in comprehending messages with a relatively small sacrifice of intelligibility (p. 267).

The concept "intelligibility" can be differentiated from the concept "comprehension". The former requires only identification of a word or phrase while the latter requires an understanding of content or concepts.

Foulke and Sticht (1967a) noted that "when speech is accelerated in this (speed-changing) manner, there is a shift in the frequency

components of the voice signal that is proportional to the change in the tape or record speed" (p. 4).

Still another method of compression was reported by Scott (1967). Using a computer, he was able to discard certain segments of speech transduced to electrical form. The use of the computer has also been studied by Chapman (1967), Seo (1967), Reddy (1968), Foulke (1969), and Qureski (1974).

Little effort had been directed toward the special educational implications of rapid speech until Emerson Foulke began his work in the mid 1960's. One of the major contributions of Foulke (1967b) was made when he and Robert Bray organized the First Louisville Conference on Time Compressed Speech for the purpose to

> . . . determine the present status of research and development with respect to the production and use of rate controlled speech, inform interested people of its current status, and formulate plans relating to the future development of the area (p. 7).

Also under the leadership of Emerson Foulke, the Second Louisville Conference on Time Compressed Speech was held in October, 1969.

The American Institute for Research at Silver Spring, Maryland, has been an extraordinarily productive center for investigation and dissemination of information concerning time-compressed speech. The work there was begun under the leadership of David B. Orr and continued by Herbert L. Friedman. Other centers are located at a number of universities including: University of Illinois, Syracuse University, University of Utah, and Massachusetts Institute of Technology.

In 1969, the Whirling Dervish was introduced by Discerned Sound of California. This is an electro-mechanical compressor of the Fairbanks type that uses a rotating cylinder with four playback heads

to obtain samples from a continuous tape loop upon which the signal to be compressed or expanded is temporarily stored.

In the early 1970's, the VOCOM I was introduced. This compressor contains the samples that are represented in the compressed reproduction by starting and stopping a tape as the signal is being recorded on it. The decisions to stop the tape are based upon information obtained from the signal that is being copied. In one mode of operation, compression is achieved by stopping the tape recorder during the unfilled intervals that are distributed throughout fluent speech production. To obtain additional compression, the copying tape recorder may be set to sample vowel sound by stopping and starting repeatedly while they are occurring. The compressed signal is recorded on a cassette, and the cassette transport is an integral part of the equipment.

Varispeech-I, an electronic speech compressor developed by Professor Francis Lee, a member of the faculty of the Department of Electrical Engineering at the Massachusetts Institute of Technology, was also introduced in the early 1970's. The compressor includes a cassette transport on which the signal to be compressed is reproduced and a small, special-purpose computer which obtains from the output signal the samples that are reproduced consecutively in the compressed output. The device is also capable of speech expansion.

One of the biggest breakthroughs regarding compressed speech devices came in 1973. The Cambridge Research and Development Group announced the success of their efforts to incorporate the functions required for the electronic compression of speech in two integrated circuit chips. These chips are small enough to be included in even the smallest cassette recorders. Cambridge has estimated that the inclusion

of the chips in a cassette recorder would raise the cost by as little as $40.00.

The material presented in the preceeding pages constitutes a capsule perspective of significant developments in compressed speech from its inception to the present time. The following pages were designed to focus on literature more closely related to the present study and to complement the first part of this chapter with the addition of other significant developments.

Applicable Research

Comprehension of time-compressed speech is influenced by many factors relating to the listener and to the stimulus. Factors relating to the listener include such variables as age, sex, and intelligence. Stimulus factors include such variables as the amount and method of compression, the nature of material to be comprehended, and the characteristics of an oral reader's voice. This section of the review of selected literature of compressed speech was organized into five major areas: (1) research related to selected stimulus variables, (2) research related to selected listener variables, (3) research related to comprehension and retention, (4) research related to multimedia presentations, and (5) research related to the reading ability of the learner.

Stimulus Variables Affecting Comprehension

Effect of Compression

A myriad of studies have sought to uncover the effects of compression on the comprehension of material. One of the most important studies was reported by Fairbanks, Guttman, and Miron (1957):

> A pair of independent message-test units, each consisting of an extended exposition of technical information and a corresponding test of factual comprehension, were developed. The messages were read by an experienced speaker at 141 words per minute, recorded, and compressed automatically in time by various amounts. Independent groups of subjects, all Air Force trainees, were assigned to five experimental groups which represented a series of compressions ranging from 0 to 70 percent, and to a sixth test--only condition in which no message was used.
>
> The curve of comprehension as a function of message time was characteristically sigmoid. Response was approximately 50 percent of maximum when message time was 40 percent (60% compression, 353 wpm). When message time was 50 percent (282 wpm), the response per time was maximal. Analysis of variance indicated that time compression, listener aptitude, and message effectiveness all effect factual comprehension significantly, and afforded evidence that interaction of time compression and message effectiveness in the expected direction is significant (p. 18).

Thus, Fairbanks, Guttman, and Miron (1957) found little difference in the comprehension of listening selections presented at 141, 201, and 282 words per minute. The results of this study were highly significant, for it had become apparent that individuals possessed the ability to effectively comprehend machine-compressed speech.

Showing the adaptability of the listening mechanism, Diehl, White, and Burk (1959) presented a tape recording to matched groups of college freshmen and found listening comprehension to be unaffected within the range of 126 to 172 words per minute. The lecture varied for each of the groups only in rate as altered by increasing or reducing

pause time. At the conclusion of the lecture, group members completed a response sheet composed of simple-recall type completion questions based on the lecture content, and a rating scale in which the delivery of the lecture was judged.

Foulke and Sticht (1967b), using the STEP Listening Test and working with college students, found a decrease in comprehension of six percent between 225 and 325 words per minute and a decrease in comprehension of 14 percent between 325 and 425 words per minute.

In another study, twelve comparable groups of college students heard a listening selection at rates varying from 125 to 400 words per minute. Foulke (1968) reported that comprehension was not seriously affected by increasing the word rate from 125 to 250 words per minute, but it declined rapidly thereafter. The suggested explanation of these results is that time is required for the perception of words and that as word rate is increased beyond a certain point, the perception time available to the listener becomes inadequate and a rapid deterioration of listening comprehension commences.

Sarenpa (1971) reported the relative effect of two different rates of speech in tape-recorded instruction. The rates used were normal speaking and 60 percent compression. No significant difference was found in the effectiveness of the two types of tape in a college level self-study biology course. A 12.3 percent saving in time by the group using the compressed tapes was reported.

Speech at five rates, 175 to 375 words per minute, was administered to groups of 16 high school juniors from four curricula tracks. Langford (1974) reported listening performance decreased as words per minute exceeded 275 for all tracks although students in the highest ability track made the higher scores on comprehension tests.

An experiment was performed with college students using tapes compressed to 225 words per minute and tapes of 175 words per minute for instructional purposes. Gleason, Calloway, and Lakota (1974) found that there was no significant difference in comprehension and that therefore, the use of the compressed tape led to more efficient learning, because of its time-saving factor.

In another study, Short (1974) used compressed tapes (25 and 55%) in teaching part of an elementary course in Nutrition and Food Science. No significances were found between normal speed tape users and the two groups of compressed tape users on tests on the content of these tapes.

There have been a few studies which would give different results than reported thus far. Nolan (1967), using speeds of 175 and 225 words per minute, presented material on various school subjects to 360 legally blind secondary students with or without interruptions to allow time for active review of material heard up to that point. It was found in all subjects and under all experimental conditions that the uncompressed speech led to significantly higher scores on comprehension tests than the compressed speech. Adelson (1972) supports this finding when reporting that two hundred college students listened to an uninterrupted one-hour lecture composed of three equated passages presented at 275 words per minute. A 75-item, five-option, multiple-choice comprehension test was administered following each lecture. Statistical analysis of comprehension test results show significantly less comprehension at 275 than at 175 words per minute. In addition, Oakley (1970) presented pre-vocational information to 398 high school English pupils at 166, 266, 332, and 381 words per minute. It was found that comprehension decreased sharply at the compressed rates.

Rate Preference

In order to determine the preferred listening rate of college students, Foulke and Sticht (1966) tested subjects enrolled in introductory psychology classes. They discovered that naive college students preferred a listening rate of 207 words per minute, a rate well above the speech rates typically reported in the literature. In a similar study with 100 blind college students, Foulke (1966a) found that there was a preference for a 275 word rate, but those who had been in college for the longest period of time expressed a stronger preference for faster rates -- up to 350 words per minute.

Cain and Lass (1974) studied the listening rate preferences of 100 college students between 100, 125, 150, 175, 200, 225, 275, and 300 words per minute. It was reported that 175 words per minute was the most preferred rate. This approximate rate frequency appears in the literature as representative of the "average" or "normal" rate for oral readings. This finding is in disagreement with the results reported earlier by Foulke and Sticht (1966). Cain and Lass (1974) made the following observations:

> One possible explanation for this discrepancy is the methodological differences between the two studies. While only nine discrete rates were available to the subjects in the present investigation, Foulke and Sticht offered their subjects a range from 0 to 500 words per minute. In addition, the present study employed a paired comparison technique for rate preference evaluations, while a method of limits procedure, in which the subjects were allowed to manipulate the rate of the passage, was used in the Foulke and Sticht study. Furthermore, it should be noted that the rate used in the present study which came closest to Foulke and Sticht's figure of 207 was 200 words per minute, which in all four subject groups was the second most preferred rate (p. 678).

Comprehension and Method of Compression

The sampling method of compressing speech was previously differentiated from the speed changing method. (See p. 15.) McLain (1962) asked high school students to listen to a selection reproduced by each of these techniques. Each of two groups were given the stimulus materials, and a significant difference was discovered in favor of the sampling method at better than the five percent level of significance. Foulke (1966b) utilized sampling and speed changing methods in a similar experiment and he, too, found a significant difference in favor of the sampling method. Using blind students in still another experiment, Foulke (1964) found the method used to compress speech to be an insignificant variable.

Effect of Speaker's Style

There is evidence to support the contention that comprehension is affected by the speaker's voice and style. Foulke (1967a) designed a two-factor experiment in which rates of 175 and 300 words per minute, and three markedly different speakers, were used. Analysis of variance revealed the word rate variable and the reader variable to be significant and Foulke (1967a) concluded that "the choice of a reader does make a difference. However, it (the experiment) provides no information that would be useful in mediating that choice" (p. 66).

In a similar study, Zemlin, Daniloff, and Shriner (1968) presented speech samples at normal rates and at 20, 30, 40, and 50 percent compression. The speech samples were spoken by a male and a female to 40 normal college students. It was reported that difficulty began and accelerated as rates of compression went beyond 20 percent. At 50 percent,

the degree of difficulty was five times that of normal speech. As the degree of compression increased, the male's speech was progressively less difficult to comprehend than that of the female.

Nature of the Material to be Comprehended

Spicker (1963) reported with regard to the effects of passage difficulty on listening comprehension that subjects (all possessing fifth-grade listening ability) scored significantly lower on hard (grade nine/ten) listening passages than on the easy (grade three) or medium (grade five/six) passages. In a similar study, Reid (1968) presented compressed materials that differed in levels of grammatical complexity at various rates (175 to 375 words per minute) to a variety of subjects, 180 from each of two universities. In each instance, the grammatically simplified version resulted in greater average comprehension than the original.

Watts (1971), using both Officers and noncommissioned officers in an Air Force teacher education school, conducted experiments to determine the effects of compressed materials on student comprehension when different types of subject matter were employed. It was found that subject matter was an important variable, with large variations in achievement attributable to subject matter difficulty. It was concluded that compressed speech can be used effectively in an operational school setting, but that subjects of only moderate difficulty are most amendable to rate acceleration.

Foulke (1969) presented literary and scientific passages in Braille to blind students of the sixth through eighth grades and compressed at 175, 225, 275, 325, and 375 words per minute. Comparison

of mean comprehension scores for each group with comprehension scores of the Braille group indicated no significant loss in comprehension for literary material through 225 words per minute and up through 275 words per minute for the scientific material, but at faster rates the loss became significant. In another study, selections of technical and historical material were presented orally to subgroups from a population of 52 college students. The passages were spoken at 145, 120, and 160 words per minute. Ernest (1968) reported that those listening to technical material performed better on comprehension tests than did those listening to historical material.

The review of selected literature related to the concept of comprehension revealed four important concepts. First, while there was a loss in comprehension of compressed speech, the loss appeared insignificant up to about 250-280 words per minute. Thereafter, there was a rapid decline in comprehension (according to the majority of the studies cited). Second, the sex of the reader may be a significant factor in the comprehension of compressed speech. Third, the type of material and level of complexity were variables having a significant influence on comprehensibility. Finally, the preferred listening rate may have been underestimated.

Listener Variables Affecting Comprehension

Sex of the Listener

In three similar studies, comparisons of the comprehension test scores of male and female listeners have revealed no sex related differences in comprehension for word rates varying from 174 to 475 words per minute. Foulke and Sticht (1967b), Orr and Friedman (1964), and

Langford (1974). However, Hogben (1974) found that female subjects showed significantly better comprehension at high rates than did male subjects. In another study, Goldhaber (1968) reported that male subjects scored significantly higher than female subjects on a 20-item multiple choice test for passages spoken at 141 words per minute and subsequently compressed to 175, 325, 375, and 425 words per minute.

Listener's Age and Educational Experience

In the research relevant to this topic, school children have served as subjects, and their age and the amount of education have, of course, varied concomitantly. Therefore, the outcome of such experiments cannot, strictly speaking, be related to either age or amount of education alone. Fergen (1954) and Wood (1965) found a positive relationship between the grade level of school children and the comprehension of compressed speech. Together, their experiments included grades one, three, four, five, and six. In addition, Goldhaber (1970) conducted an experiment to determine the ability of students at two academic levels to comprehend compressed speech. An analysis of variance revealed significant differences within the main effects of rate and academic level of subjects.

Moll (1968) reported a study with elementary children that as the rate of presentation increased, comprehension decreased. Age seemed to be a significant factor in that fifth graders comprehended compressed speech much better than first graders.

Intelligence of the Listener

In the case of children, the evidence presently available is not

sufficient to permit a conclusion regarding the effect of intelligence on the comprehension of compressed speech. Fergen (1954) presented material spoken at 80, 130, 180, and 230 words per minute to intermediate grade children. He found no relationship between the IQ's of grade school children and their ability to comprehend compressed speech. However, it should be pointed out that 230 words per minute was the fastest word rate presented in the experiment.

Woodcock and Clark (1966a) administered three standardized listening passages to 162 elementary school children who were classified into three levels of intelligence. Results of the study revealed that listening rates of 228 and 328 words per minute were more efficient for learning and retention than was the normal rate of 178 words per minute. The most efficient rates for subjects of lower IQ's were slower than those for children of higher IQ's.

Foulke (1969) performed an experiment to determine the effect of IQ on listening for selections presented at the normal, and two accelerated word rates. Subjects were blind children drawn from the fifth, eighth, and eleventh grades. Their comprehension was assessed with the STEP Listening, the listening passages of which were presented at 175, 275, and 375 words per minute. Intelligence was assessed with the WISC, and with the Interim Hayes - Binet Test. The principle result of the experiment was the finding that the maximum word rate at which listening comprehension was preserved depended upon the IQ of the listener. For those subjects in middle and high IQ groups, listening comprehension did not begin to decline seriously until a word rate of 275 words per minute had been exceeded. For subjects in the low IQ group, listening comprehension began to decline when the normal word rate of 175 words per minute was exceeded.

A more definite conclusion regarding the effect of intelligence on the comprehension of accelerated speech is possible in the case of adults. Goldstein (1940), Nelson (1948), and Fairbanks, Guttman, and Miron (1957) concur in showing a positive relationship between the intelligence of the listener and the magnitude of the decline in listening comprehension as word rate is increased.

Visual Status of the Listener

There are prior grounds for expecting blind individuals to show better listening comprehension than sighted individuals. In general, blind people depend to a much greater extent than sighted people upon aural communication. Increasingly, blind students, and other blind people who read, do so by listening to recorded books. The practice afforded by such experience might be expected to improve listening ability and this ability should be advantageous to listening to compressed speech as well. Furthermore, whereas compressed speech may be little more than a curiosity to the average sighted person, it may be perceived by the blind person as a potential solution to the serious reading problem he experiences by virtue of the slow rate at which he reads ordinarily. When such a person serves as a subject in an experiment in which the comprehension of compressed speech is measured, he might be expected to maintain a more attentive adjustment.

The research related to this question is meager, and the results are conflicting. Foulke (1964) reported evidence for superior comprehension by blind subjects. In a direct comparison, Bellamy (1974) reported an experiment in which 31 blind and 26 sighted junior high school pupils listened to a scientific passage on blood circulation

compressed to a rate of 275 words per minute. Bellamy (1974) found no significant difference between blind and sighted subjects with respect to the comprehension of time compressed speech listening selections. Furthermore, in an experiment performed by Hartlage (1963), blind and sighted subjects did not differ with respect to their comprehension of listening selections presented at a normal word rate.

Improving Comprehension of Time-Compressed Speech

In an experiment performed by Fairbanks, Guttman, and Miron (1957), a mean comprehension score of 63.8 percent was obtained by subjects who listened to a selection presented at the uncompressed rate of 141 words per minute. Compressing this selection by 50 percent to a word rate of 282 words per minute resulted in a mean comprehension score of 58 percent. With two consecutive presentations of the selections at 282 words per minute, the mean comprehension score was 65.4 percent. Though the subjects who served in this experiment did not save any listening time, the two exposures did result in slightly improved comprehension.

Hopkins (1974) performed an experiment with 150 sophomore high school English students to determine the effect on the comprehension of presenting a passage from the Nelson-Denny Reading Test at 152, 304, and 456 words per minute. Certain subgroups heard the 456 words per minute material three successive times and the 304 words per minute material twice in succession. In general, comprehension decreased as the rate increased, but no significant difference was found between a group subjected to 152 words per minute and a group which was subjected to the 304 words per minute material twice. In a similar study,

Anderton (1970) reported an experiment in which no significant differences in learning were found at rates of 150, 200, 250, and 300 words per minute or between a presentation at 150 words per minute compared to two successive presentations at 300 words per minute. In respect to the value of review, Woodcock (1971) reported that a single pass through material is a more efficient use of available learning time than repeated exposures to the same material.

Thomas Sticht (1971) reported two experiments to determine whether using the time saved by the time compression process to repeat or extend information presented by audio tapes would increase the amount learned by listening to rapid speech. Neither repeating nor extending information improved learning over that obtained by listening to uncompressed information for an equal amount of time. This was true for high and low mental aptitude men. In a similar study, Gill (1975) worked with engineering students to determine whether using the time saved by compressed speech to reinforce information presented by audio tapes would increase the amount of information learned by the listener. Two groups of the subjects were allowed to record notes over the audio message during the time saved by compressed speech (compressed by 20 and 40 percent). Gill referred to this as an interim activity. When comparing with a control group, he found that listening time could be saved without significant loss of comprehension, but the interim activity did not aid in comprehension of the audio message.

A number of studies have sought to define the role of practice in the comprehension of compressed speech. Voor and Miller (1965) tested fifty college students who heard five stories delivered at a rate of 380 words per minute. A test of comprehension was administered after

each story, and the scores were subjected to analysis of variance. Interpretation revealed significant improvement in comprehension at the one percent level of confidence. Comprehension scores reached optimum level after a few minutes of exposure to compressed selections, indicating that practice increased the subjects' ability to comprehend accelerated speech.

Goldhaber (1974) reported that native speaking English, Navajo, and Spanish students' overall listening comprehension and ability to recall time compressed material improved significantly after a two-hour training period. No between-group differences were found.

As the result of an experiment with blind high school students, Resta (1971) reported that as little as a two hour period of practice in listening to frequency-shifted time-compressed speech made a significant change in comprehension of frequency-shifted speech as compared to a group not having had such practice. In direct contrast, Woodcock (1971) found that after an initial two or three exposures to rate-controlled recordings, practice produced little improvement in performance. In addition, Barnard (1970) conducted an experiment in which five stories were presented to subgroups of 92 sixth graders at 125, 200, and 275 words per minute. There was no significant gain in listening comprehension as a result of the training sessions using compressed speech.

Foulke (1964) performed two experiments to evaluate training methods. In one experiment, blind school children were trained by listening to uninterrupted speech. One group listened at a constant high word rate of 350 words per minute, while the other listened at an initially slow but increasing word rate. In the other experiment,

word rates were varied in the same way. However, the training passage was interrupted frequently and subjects were questioned about the material just heard. The exposure time was approximately 25 hours. The effectiveness of training was evaluated by comparing pre-training STEP Listening scores with post-training test scores from equivalent forms. While none of the four techniques yielded superior ability to comprehend, it was also apparent that some of the subjects showed superior comprehension without training.

Orr and Friedman (1967) also tested the effectiveness of time compressed speech technique in presenting material under conditions of mass practice. A small group of subjects received practice for seven hours per day for five consecutive days at rates of 2½ times the normal speaking rate (i.e., at 425 w.p.m.). Listening passages and corresponding tests were presented daily. Results showed that the comprehension increased from a mean of 40 percent of normal speed comprehension on the first day to a mean of 70 percent comprehension on the fifth day. Orr and Friedman (1967) commented, saying that "while effective, the mass-practice procedure produced no better performance in a total of 35 hours of practice than previous experiments using spaced practice in a total of 12-15 hours of practice" (p. 223).

Previously, Orr, Friedman, and Williams (1965) had divided thirty-two college students into two roughly matched groups. The experimental group practiced listening to compressed speech by spending several hours listening to novels. Orr, Friedman, and Williams (1965) concluded that:

> First, although controls may have been a slightly more able group, experimentals overtook them after the first week's practice and maintained or increased that advantage

> thenceforth; second, there was ample evidence of wide individual differences within both groups at all levels.
>
> Although there appeared to be a tendency for controls to be superior initially, there was no significant difference between experimentals and controls at either the 175 words per minute level or at the initial 475 words per minute level. No significant difference existed between experimental and control groups at 325 words per minute or 375 words per minute. However, sharply significant differences appeared at 425 words per minute which was the new passage introduced as a measure of experimental generalization of practice effects to new material. Further, there was also a significant difference between the two groups on the repeated high speed base-line passage. Thus, under the impact of practice, the experimental group was able to build a greater skill in listening comprehension at higher levels of speed than the control group was able to develop (p. 151).

Thus, practice may produce an advantage when high levels of comprehension are used, while at the lower levels of comprehension there may not be as much advantage to be gained through the introduction of practice procedures.

Friedman, Orr, Freedle, and Norris (1966) compared the comprehension test scores of subjects given 35 hours of mass practice in listening to accelerated speech with comprehension test scores of subjects given 12 to 14 hours of distributed practice in listening to accelerated speech. They concluded that the comprehension demonstrated by the distributed practice group was as good or better than the comprehension demonstrated by the massed practice group.

Finally, Friedman and Orr (1967) performed experiments at the American Institutes of Research concerning the effect of practice on compressed speech at listening rates up to 475 words per minute. It was concluded from the results of these experiments that comprehension of compressed speech can be improved by practice.

Evidence presently available from studies is not sufficient to permit a definite conclusion regarding the effect of the following

variables on comprehension of compressed speech: (1) sex of the listener, (2) intelligence of children, (3) visual status of the listener, and (4) training of the listener. However, there is evidence to support the conclusion that there is a positive relationship between intelligence of adults and comprehension of compressed speech.

Comprehension and Retention of Time Compressed Speech

The relationship revealed from a majority of the studies reviewed thus far is one in which comprehension, as indicated by test scores, decreased as word rate or the amount of comprehension is increased. However, outcome measures based upon test performance alone do not take into account the learning time that is saved when speech is presented at an accelerated word rate. Such an allowance may be made by dividing the comprehension score by the time required to present the message. This index of learning efficiency expresses the amount of learning per unit time. Using such an index as previously stated, Fairbanks (1957), Enc and Stolurow (1960), and Foulke (1969) found that learning efficiency increased as word rate was increased up to approximately 280 words per minute, and remained constant with further increases in word rate. Thus, although one who listens to a selection presented at 325 words per minute may not be able to demonstrate as much comprehension as one who listens at a normal rate, he may be learning more per unit time. Using the same logic, Enc and Stolurow (1960) have computed an index of the efficiency of retention.

The word rate at which a listening selection is presented apparently has no special effect on the rate at which forgetting occurs.

Enc and Stolurow (1960) worked with adolescent blind children. Material was spoken at 170 and 220 words per minute. There was no significant difference in comprehension and retention between the two rates after 24 hours. It was concluded that the faster rate was a more efficient learning device. Foulke (1966c) explored the retention of material presented at accelerated word rates. A two-factor experiment was performed in which word rate and retention intervals were varied. Word rates were 175, 225, 275, and 325 words per minute. Retention intervals were zero days, seven days, and 30 days. Three hundred fifteen junior high pupils were divided into 12 treatment groups; each group listened to a 2015 word selection at one of the four word rates used and was tested after the appropriate retention interval. Analysis of variance revealed an overall significance for both independent variables and their interaction. The results suggested that the retention of materials learned by listening to "rapid speech" was not different than the retention of material presented by conventional means.

Friedman, Orr, Freedle, and Norris (1966) reported an experiment with college students in which the subjects were recalled after different periods of time and asked to take tests on materials heard during the experiments in which they had formerly taken part. No differences were found in the degree of retention of material heard in the compressed form and materials heard at normal rates.

In another study, using the text of the Nelson-Denny Reading Test, George (1974) presented tapes to college freshmen at normal speaking rate and compressed rates of 275, 325, and 375 words per minute. A similar set of tapes was prepared using a rewritten simplified version of the same passage. The retention intervals were immediate, one day,

and one week. The rate of presentation variable was the only significant main effect. The fact that more forgetting occurred at the lowest rate than at the three highest rates is similar to the results reported by Foulke (1966c) and Friedman, Orr, Freedle, and Norris (1966). Of course, since more was comprehended at the lowest rate, there was potentially more forgetting at this rate than at the other rates. However, it will be recalled that there was no evidence that the percentage of material originally comprehended that was subsequently forgotten was differentially affected by the rate of presentation. This result is also consonant with the results of Foulke (1966c) and Friedman, Orr, Freedle, and Norris (1966).

Barabasy (1968) reported that a 21 minute college course compressed to 14 minutes was listened to without any significant greater loss in recall or retention than in the case of listening to the original recording. Woodcock (1971) administered three standardized listening passages to 162 elementary school children. Immediate and delayed (one week) retention data were collected. Results of the study indicated that listening rates of 228 and 328 words per minute were more efficient for learning and retention than was the normal rate of 178 words per minute. Loper (1974) worked with 121 under-graduate speech students. Subgroups heard a passage on meteorology at 141 words per minute and in compressed form at one-third and one-half the time of the original message. Presentations were followed by an immediate comprehension test or a two-weeks delayed test. In general, the finding was that retention was also such an inverse function, but only when the message was presented without visual augmentation.

An investigation of the literature related to retention revealed

that the word rate at which a listening selection is presented apparently has no special effect on the rate at which forgetting occurs. In general, the studies cited support the conclusion that differences in the course of forgetting are due to differences in original learning. Of course, as has already been shown, the amount of original learning is a function of the word rate at which a listening selection is presented.

Research Related to Multi-Media Presentations

A limited amount of research has been reported on the impact of a multimedia presentation on the comprehension and/or retention of compressed speech. Nonetheless, information related to the single-channel concept, to simultaneous reading and listening, to simultaneous presentation of aural messages and pictorial embllishments, and to the information of a general concept of multi-media presentations was considered pertinent to this section of the review of selected literature. It should be noted that the reported findings are somewhat contradictory.

Single-Channel Concept

The Broadbent (1957) model implied that the perceptual system operates on a single channel when it becomes overloaded. Furthermore, Broadbent (1957) asserted that the channel selected was dependent on the characteristics of the input:

> . . . the human perceptual system has a limited capacity, that in consequence a selective operation is performed upon all inputs to the system, and that this operation takes the form of selecting all inputs having some characteristics in common. Such an operation extracts little information from the signal and thus should be economical of nervous

> mechanism. Characteristics on which the selection can operate may be named "sensory channels." The particular selection made at any one time will depend partly on characteristics of the input itself (physical activity, earliness in time, absence of recent inputs on that channel, position of the channel in the hierarchy of all channels) and partly on information in a more permanent store. The change from one selection to another will take a determinate time (p. 205).

Thus, Broadbent recognized the importance of redundancy of information as well as the single-channel concept.

Jester (1974) presented materials to college students aurally, visually, and combining the two modes. Rates varied from 200 to 400 words per minute. Increasing the rates of presentation resulted in a reduction of comprehension. When the two modes are presented simultaneously, the individual selects the modality which is best for him, thus supporting Broadbent's conclusion that when the information processing capacity of the perceptual system is overloaded, it operates as a single-channel system.

Loper (1974) measured the relationships between a spoken message, the same spoken message visually augmented through the use of televised pictorials, and presentations of this material at the three levels of compression. One hundred twenty-one college students in seven groups were given an immediate and a two-weeks delayed test. He concluded that spoken messages were not aided by visual augmentation of compressed materials, but that visual augmentation decreased the amount of comprehension loss at the higher rates of compression. Loper also found that retention of information was not a function of rate when subjects were exposed to aural-only messages and that retention of information was a function of rate of compression when subjects were exposed to visually augmented compressed messages. Finally, Loper

concluded that visual augmentation of messages aids in the retention of information when the messages were originally presented at high rates of compression.

A study was designed by Boyle (1969) to investigate the effects of three variations of visual stimuli on comprehension of compressed speech. Using relevant pictorial visual stimulation, irrelevant and unstructured visual stimulation, and no visual stimulation, Boyle discovered that these variations did not produce significant differences in listening recall. He noted that differences in word rates produced a significant difference in recall, and that there was a significant decline in scores of subjects from immediate to delayed recall, regardless of word rate.

Anderton (1970) sought to determine if pictorial embellishments contributed to learning by employing four different speeds of presentation and the use or non-use of pictorial embellishments. Anderson (1970) discovered no significant difference in learning resulting from a combination tape and slide instructional program at different rates or from the presentation of instructional materials twice at high speeds rather than only once at normal rate.

> . . . Regarding pictorial embellishments, there was no significant difference in learning because of their use or non-use. There was also no significant differences in learning resulting from a presentation at faster rates, without pictorial embellishments, from the learning resulting from presentation of the original program (p. 2).

He also concluded that pictorial embellishments were not worth the time and expense of preparation, and considering the amount learned and the time involved, the repetition of messages at 300 words per minute did not appear to be beneficial.

Benz (1971) presented a college-level geography lesson on maps

aurally and aurally together with slides, at normal rates and at compressions of one-third and one-half. Subjects were 295 college students. He reported the following findings: (1) the one-third compressed aural-visual presentation was just as effective as the normal rate aural-visual; (2) comprehension of the aural-only presentation at the normal rate was significantly better than comprehension of the aural-only presentation at one-third compressed rate; (3) at corresponding rates, the aural-visual groups had higher scores than the corresponding aural-only groups; (4) presentations at the one-half compression rate were less effective than corresponding presentations at the two other rates; and (5) the one-half compression aural-visual version was nearly as effective as the normal rate aural-only presentation.

An experiment in which 141 educable mental retardates served as subjects was reported by Woodcock and Clark (1968a). The experiment was performed in order to compare the effectiveness of comprehension of material that was: (1) read only, (2) listened to with accompanying slides, or (3) listened to without any visual supplement. Listening materials were presented to subgroups at rates varying from 53 to 378 words per minute. The material consisted of the author's Standardized Listening Passages together with accompanying comprehension tests. Woodcock and Clark reported that both listening modes were significantly superior to the reading mode. The listening mode with slides was more effective than the listening-only mode.

Simultaneous Reading and Listening

Kling and Reiland (1968) conducted a pilot study using compressed speech and the simultaneous reading of the same passage in print. Using

the Gates Reading Survey and the STEP Listening Test, elementary students listened to compressed speech while simultaneously reading the passage, or listened to compressed speech alone, or only read the passages. All three experimental groups showed a significant gain in reading rate and those students who listened and simultaneously read the passages showed the greatest gain.

Parker (1970) reported the results of a study in which the purpose of the study was to determine the practicality of using time-compressed speech as an instructional technique at the junior college level. Secondary problems leading from this purpose were the determination of: (1) the degree of compression possible without significant loss of comprehension; (2) the degree to which simultaneous reading and listening would help or hinder comprehension at different degrees of compression; and (3) the effect of rate and mode of presentation on students of varying degrees of aptitude. Subjects were 429 college students and selections from the Nelson-Denny Reading Test were presented at normal rates, compressed one-third, and compressed one-half. The following results were reported, based on performance of the students on the comprehension test of the Nelson-Denny Reading Test: (1) there was no significant difference between the normal rate and one-third compression in any mode or for any aptitude level; (2) in the aural-only mode, one-half compression was significantly less satisfactory than one-third compression; and (3) except in the case of low aptitude students, the one-half compression in the aural-visual mode was as satisfactory as the one-third compression.

During a period of five weeks, groups of 20 elementary pupils organized by intelligence levels listened to 20 stories at normal rates

(178 w.p.m.), listened to the same stories at 37 percent compression (275 w.p.m.), read and listened at 178 w.p.m., and read and listened at 275 w.p.m. Comprehension tests followed each story. Bruland (1974) reported that: (1) there was no significant difference between the rates; (2) the reading and listening mode was consistently superior to the listening alone; and (3) the practice given had no ascertainable effects on the scores of the listening and reading tests.

Robinson (1966) conducted a 30-day experiment in which mentally retarded children were exposed to rate-controlled taped material alone and to such material with a visual copy which was viewed simultaneously, with or without teacher. He reported no significant differences were found among three experimental groups or between them and a comparable control group. Bimodal presentations showed some superiority especially at slowed speeds.

Reiland (1974) designed a study in order to give sixth grade children systematic practice in: (1) simultaneous reading and listening to compressed speech; (2) listening to compressed speech only; and (3) reading only. Gates-MacGinitie Reading Test and STEP Listening Test were used as pre-and post-test to measure differences in reading and listening comprehension. He reported that no significant differences were found between treatments for the entire group, for differing levels of intelligence, or for sex.

General Concept of Multi-Media Presentations

After observing students receiving information through hearing alone, through vision alone, and through vision and hearing, Travers (1964) made the following statement:

> At the slower speeds of 200 words per minute or less, no advantage was achieved through the audiovisual presentation, but at higher speeds two things begin to happen. First, many subjects took obvious steps to block one channel by closing the eyes or covering the ears, and second, despite this blocking of one channel, the audiovisual transmissions of information turned out to be superior to the single channel. Presumably, subjects tended to block the information channel which was of least value to them (p. 376).

Travers (1964) concluded that two sources of information can be processed successfully, provided the rate input is low. "At higher speeds, where the information from a single channel is more than the processing system can handle, switching from source to source may occupy a part of the time available to taking in information. The time required for switching seems to be time out from learning" (p. 376).

A majority of the studies cited in the immediately preceeding review of literature revealed that multi-media presentations caused subjects to select one channel for input of high speed presentations and block the other input channel. However, there are a minority of studies that would contradict this concept.

Reading Ability of the Learner

Those perceptual and cognitive factors, whatever they may be, that are responsible for individual differences in reading rate may also be responsible for individual differences in the ability to comprehend compressed speech. If this is true, fast readers should be able to comprehend speech at a faster word rate than slow readers. This hypothesis has been tested by Goldstein (1940) and by Orr, Friedman, and Williams (1965). In both experiments, a significant positive correlation was found between reading rate and the ability to comprehend time compressed speech. In both experiments, it was also found that practice

in listening to compressed speech resulted in an improvement in reading rate.

In support of this finding, Thames (1974) reported high school sophomores using compressed speech as pacing procedures improved significantly more on reading rate and vocabulary than did a comparable control group. This finding adds further support to the hypothesis that the two performances in question may be mediated, at least in part, by the same underlying factors. Nelson (1948) found no correlation between reading rate and the ability to comprehend compressed speech. However, his measures of reading rate were taken from college entrance examination data collected some time prior to his study, while Goldstein (1940) and Orr, Friedman, and Williams (1964) obtained their measures of reading rate during their investigations.

Goldstein (1940) and Jesters and Travers (1967) compared the comprehension resulting from listening to selections presented at several word rates with comprehension resulting from reading the same selections, presented at the same word rates. In both cases, comprehension declined as word rate was increased. Listening comprehension was superior to reading comprehension up to approximately 200 w.p.m. Above 200 w.p.m., reading comprehension was superior. Simultaneous reading and listening at 350 w.p.m. resulted in better comprehension than could be demonstrated with either mode of presentation alone. This finding further emphasizes the compatibility of the two processes.

The preceeding survey of selected literature was synthesized through a two-phase organizational structure. After a chronologically structured historical perspective, applicable research was presented as it applied to: (1) stimulus variables, (2) listener variables, (3)

comprehension and retention, (4) multimedia presentations, and (5) reading ability of the learner. The following chapter, Chapter III, was designed to describe the methods and procedures for collecting and treating data.

CHAPTER III

DESIGN AND METHODOLOGY

Introduction

The purpose of this chapter is to describe the design and methodology of the study. Included in this chapter are: (1) a description of the population that participated in the study, (2) a description of the reading test, (3) a description of the listening passage and listening comprehension test, (4) the procedures for preparing the audio tapes, (5) the procedures for collecting the data, and (6) the methods for analyzing the data.

Population Description

This research was conducted with a population composed of undergraduates enrolled in the Utilization of Instructional Media course C&IED 3122 during the spring semester of the 1976 academic year at Oklahoma State University. The population consisted of a total of 165 students representing seven sections of the Utilization of Instructional Media course C&IED 3122. The course is a predominantly junior level course required for teacher certification of all secondary and elementary education majors; it also meets the media proficiency requirement of the Oklahoma State Department of Education. Therefore, the course enrollment includes students from many different disciplines on the campus of Oklahoma State University.

The test subjects were limited to fast and slow readers (previously defined p. 5-6) enrolled in the seven sections of the Utilization of Instructional Media course C&IED 3122. Fast and slow readers were randomly assigned to each of the following compression groups: (1) zero percent compression (165 w.p.m.), (2) 20 percent compression (208 w.p.m.), and (3) 40 percent compression (266 w.p.m.). Students in the test population not meeting the criteria for fast and slow readers were given equal treatment, but their performances were not considered in the final data analysis.

A Description of the Reading Test

The McGraw-Hill Basic Skills System Reading Test, available in equivalent forms, was used in this investigation to classify students as fast and slow readers. A three-part test yielding scores for reading rate and comprehension, skimming and scanning, and paragraph comprehension, the McGraw-Hill Basic Skills System Reading Test is designed for college-bound and college students. The test is intended to measure the student's general level of competence in those reading skills which are most relevant to academic success. The reading selections used in the test were taken directly from college textbooks.

Since the present study was concerned with reading rate and comprehension, only the first section of the McGraw-Hill Basic Skills System Reading Test, Form A, was utilized for the reading exercise of the experiment. After consultation with a reading specialist, the selection entitled "The First Hudson River Tunnel" was selected as appropriate for the reading classification of subjects in this investigation. The material in the selection is at the difficulty level of most magazines, newspapers, and novels read by college-level students.

Concerning the content validity of the McGraw-Hill Basic Skills System Reading Test, the author, Alton Raygor (1970), states:

> test items could not be answered without reading the passage. The success rates of students "guessing" the answers were used in the final item selection. The final selection of the test items were based on . . . (1) success rates without reading, (2) point biserial correlation between item and the total score on the test, and (3) the difficulty level of the item (p. 31).

In regard to the reliability of the Reading Rate and Comprehension section of the McGraw-Hill Basic Skills System Reading Test, Form A, Raygor (1970) states that the split-half reliability is .65. Furthermore, the standard error of measurement for the Reading Rate and Comprehension section, Form A, is 2.00 standard score points.

A number of factors were responsible for the selection of the McGraw-Hill Basic Skills System Reading Test as the evaluation instrument for classifying subjects as fast and slow readers. First, the test was available in equivalent forms. Therefore, a selection of equal difficulty from Form B could be used for the listening passage. Second, the test was normed for college students, constructed and standardized by McGraw-Hill, and it measured the reading rate and comprehension skills relevant to this investigation. Third, and most importantly, the test was suitable to the time limits imposed by the investigator.

Description of the Listening Passage and Listening Comprehension Test

The passage entitled "Risks, Records, and Rescues" from the Reading Rate and Comprehension section of the McGraw-Hill Basic Skills System Reading Test, Form B, was chosen for the listening passage of

the study. There were three very important factors responsible for the selection of the particular passage for the listening exercise. First, material for the listening passage was at the same level of difficulty as the reading material used to classify subjects as fast and slow readers. Therefore, the difficulty level of the material should not be a confounding variable in the study. Second, the passage was of the appropriate length according to a review of the literature in which the majority of studies indicated that the optimum length of the listening passages is 11-14 minutes. The length of the listening passage recorded at 165 w.p.m. for this study was 11.4 minutes. Third, a ten item multiple-choice comprehension test, designed and produced by the McGraw-Hill staff, was available for use in this study.

The tem item multiple-choice test designed for the passage entitled "Risks, Records, and Rescues" was used to measure the subjects' listening comprehension of factual material after receiving an audio message in one of the following compression rates: (1) zero percent compression (165 w.p.m.), (2) 20 percent compression (208 w.p.m.), or 40 percent compression (266 w.p.m.).

Procedure for Preparing the Audio Tapes

One of the major problems encountered in all compressed speech research is defining terminology to be used in specifying the amount of compression. Carroll (1966) points out, "Measuring speech rate is not a simple matter of counting words per minute . . ." (p. 88). A resulting problem is that specifications such as 75 percent of normal listening time or 325 words per minute will not always represent speech at equivalent rates from one speaker to another. This problem stems

from the fact that output rate is dependent on the input rate, speaker vocabulary, rate of speaking, etc. Foulke and Sticht (1967a) point out that "There is no 'normal' word rate that can be assumed since there is considerable variability in the published estimates of normal word rate" (p. 17). Part of this variability is undoubtedly due to word rate and oral reading word rate.

Illustrative of this discrepancy, Nichols and Stevens (1957) found a conversational speaking rate of 125 words per minute while Johnson (1963) noted a median oral reading rate of 126.5 words per minute. Foulke (1968) found a mean oral reading rate of 174 words per minute. The oral reading rate is the word rate that is relevant to the issue under discussion since, in most cases, the speech that is compressed is recorded oral reading.

If compressed speech is to be specific in terms of percentage of compression or acceleration ratio, the word rate of the original production must be determined and reported. For the purposes of this research, the "normal" word rate was 165 words per minute. Rate specification may be expressed in one, or a combination, of the following units:

1. Percent
    a. Percent of the original time
    b. Percent compressed
2. Words per minute
3. Syllables per minute
4. Phonemes per minute

While Foulke and Sticht (1967a) and Carroll (1966) agree that syllables yield a more accurate specification of rate than words per

minute, they differ in their recommendation of a preferred unit of rate. Carroll endorses using syllables as the unit of rate, whereas Foulke encourages the use of words for most purposes. Carroll takes the position that phonemes are more accurate than syllables and syllables are more accurate units than words. He recommends the syllables, however, due to the difficulty associated with counting phonemes. Foulke and Sticht (1967a) use a similar argument in endorsing words per minute instead of syllables per minute. They state that "Specification in terms of syllable rate is even more precise, but in most cases, the gain in precision is not worth the cost in time and effort" (p. 6). They explain their preference for word rate as ". . . the most meaningful dimension in terms of the cognitive and perceptual processes of the listener" (p. 6).

For the purpose of this research, two units of rate were utilized. Time was an important factor. The most convenient means of expressing the proportion of listening time was percent compressed. In addition, words per minute was computed to satisfy the need for a specification of greater accuracy than percent and to provide greater comparability with other research studies. Furthermore, the time limit for each compression rate was also reported.

The preparation of the audio tape material began with the recording of the passage entitled "Risks, Records, and Rescues". A copy of the passage was given to an experienced reader in advance of the time of recording. The reader practiced until able to orally read the passage consistently at 165 words per minute. In an audio studio at Oklahoma State University, the passage was then recorded at 165 words per minute on a Sony reel-to-reel tape recorder. The "normal" rate

recording of 165 words per minute representing zero percent compression was free from errors in content, diction, and pronunciation, and no significant distortion or external noise was detected. The recording time for the audio passage was exactly 11.4 minutes.

The next step in the preparation of the audio tape materials was the recording of instructions for listening to the audio tapes. Verbal instructions at the time of testing were rejected in favor of recorded instructions preceding the taped message. This approach offered control of variables that would have otherwise been introduced through the presentation of like instructions in the three different testing groups. Since each listening group required different instructions for listening to the audio tape, three different sets of instructional information were prepared (see Appendix B). Each of these instructional messages was recorded at 165 words per minute by an experienced reader on the same tape and equipment as the listening passage. In addition, another recording at 165 words per minute was created for use as instructions for taking the listening comprehension test (see Appendix C). Since the test instructions for each of the three groups were the same, only one recording was produced. Again, the recording was produced by the same reader on the same tape and equipment that was used earlier. Therefore, the master reel-to-reel tape consisted of three sets of listening instructions, the listening message, and the test instructions.

Modes of Compression

For this research, a combination of two different modes or mechanisms of compression was utilized. There were two major considerations

in the decision to use both the VOCOM I and the Varispeech I for compression of the audio materials. First, both the VOCOM I and Varispeech I speech compressors were available at Oklahoma State University. Second, an evaluation of each mode and a combination of the modes was conducted as described in the following paragraph.

After listening to tapes compressed separately by VOCOM I and by Varispeech I machines, and by a combination of the two, it was determined that the best possible quality favored the combination of compressors. This was especially true at high compression rates.

Before describing briefly each of the speech compressors, it is pertinent to discuss types of deletion which may be utilized to affect comprehension. The types are "systematic" and "selective" deletion. The following explanation of the two techniques of deletion and the subsequent description of machines is not technical in nature; however, technical references are included when available.

Systematic deletion via an automatic electrical and mechanical process was the first mode developed to compress speech. It is a technique developed and refined by Fairbanks, Everitt and Jaeger (1954). In their patent Fairbanks, Everitt and Jaeger (1954) explain that the function of the recording device is:

> . . . to take information, such as connected speech or sounds and reproduce them by leaving out small fragments or portions occurring during very short time intervals. These are so small in time duration that they do not include a whole sound unit, or in other words, a whole syllable or even a sound in a syllable. What remains after the fragments are discarded is in effect, squeezed together. The final recording is thus made a continuous one from which the original speech or sounds may be played back in a shorter time than required for the original delivery. The shortened material may sound much faster in delivery, but the pitch is unchanged and comprehension is still easily possible . . . The purpose of the device of this invention is to sample discrete portions of a

> recording of connected speech and discard some of the portions so as to record less than the total number of portions. It is important that each discarded portion be so small that a sound unit could not be lost if that portion is discarded. The term 'sound unit' as used herein, means any portion of an expression, if missing, would interfere with the intelligibility of the whole expression. In case of human speech, the discarded portions or intervals are so short that words and syllables are not lost in the shortening effect. Each sound is reproduced in sufficient length to make it as intelligible as the original sound, but enough of the sounds are ommitted to greatly shorten the time of delivery (p. 10).

The key factor in systematic deletion is that the miniscule portions are discarded at regular intervals. The compression was a result of the machine's capacity to abut the modified sounds. The Fairbanks recorder is not on the market, but numerous compressors have been developed which utilize the Fairbanks principle.

The second type of deletion to be considered was "selective deletion" which involves the technique of shortening or removing pauses from a recorded message. Additional compression is made possible through the removal of selected vowel sounds. Systematic deletion is discussed further in the section describing the VOCOM-I compressor.

VOCOM-I

The PKM Corporation has made available a speech compression/expansion device which utilizes the technique of selective deletion to accomplish compression. VOCOM-I permits the operator to adjust the amount of pause retained from 30 milliseconds to 1.0 second. It has thus become possible via pause removal to compress a recorded message for playback in 60 percent of the original time. The exact amount of compression possible is dependent on the speech rate and pattern of the individual recording the message. Additional compression is

possible through the machine's capacity to sense and compress vowels using a sampling method. During pause compression, a high speed start-stop clutch is activated based upon information obtained from the signal being copied. The duration of vowel sounds is reduced by repeated stopping and starting of the transport which drives the cassette on which the signal is being copied, thus sampling the vowels while they are occurring.

The removal of pauses raises some important questions regarding its effect on the syntactic organization of a message and the listener's ability to understand the intentions of the speaker and the intended stress of important content. In one of the earliest studies on the effect of pause alteration, Diehl, White and Burk (1959) found that the relationship between pause time and phonation time in connected speech can apparently be altered with no appreciable loss in comprehension (p. 232).

In a recent study, Miron and Brown (1974) examined the effect of pauses as syntactical cues on compression. They indicate that:

> . . . when durational distortion (compression) is accomplished through reduction in the physical markers of syntactic organization (pause deletion), which preserves the proportionate distribution of the encoders intentions, the process of understanding those intentions suffers little or no disturbance (p. 555).

James Wilson (1969) reported the findings of a masters thesis in which he examined the comparative effects of the two types of deletions, selective and systematic. The study also examines the effects of compression rate on the immediate oral recall of word sequences. At each rate, the two methods of compression were utilized. Wilson reports finding no significant differences as a result of rate or method of compression.

The research identified has demonstrated that the type of compression possible via VOCOM-I is a viable technique of compressing speech. There were, however, some problems related to the use of VOCOM-I. Research studies examining the effect of word rate require tapes compressed to exact standards. It is difficult and time consuming to compress an original tape to an exact rate on VOCOM-I. This problem is related to the nature of selective deletion and the variations of pause duration in connected discourse. If all pauses in a discourse are of the same duration, it would be possible to compress to an exact rate on the first pass through VOCOM-I. Such uniformity of pause duration is not realistically possible. At a given moment, the VOCOM compressor will vary in the amount of compression being accomplished. A second limitation is that VOCOM-I cannot be used for listening to compressed speech without first making a compressed tape. It is not possible to monitor an original tape at varying rates prior to making a compressed copy.

Varispeech-I

Lexicon Incorporated manufactures and distributes the compressor-expander. The Varispeech-I is an electronic device whereas VOCOM-I is electro-mechanical, and it utilizes systematic sampling with discard intervals of under 60 milliseconds in range.

Compression is accomplished through a built-in pitch correction processor which employs digital integration circuits similar to those used in digital computers. The pitch correcting processor is constructed with modular printed circuit cards which facilitate servicing when required. When a tape is being compressed, the Varispeech-I

electronically adjusts the "exact amount" of discard thus making possible a one-time recording process. It is also possible to use Varispeech-I for compressed speech listening without first making a compressed copy of the tape.

Preparation of the Master Cassette Tapes

The first of three master cassette tapes was prepared by dubbing the listening instructions, the listening passage, and the test instructions, all recorded at 165 w.p.m., directly from the master reel-to-reel tape to a Maxell UD 60 master cassette tape. This represented the zero percent compression tape.

For the 20 percent compression tape, the listening instructions recorded at 165 w.p.m. were dubbed directly from the master reel-to-reel to a second Maxell UD 60 master cassette tape. In order to prevent a "shock effect" which causes some listeners not to near a message because of the mere phenomenon of words coming at a much faster rate than is customary to them, the listening instructions were first compressed ten percent by VOCOM I and then ten percent by Varispeech I resulting in a total compression rate of approximately 20 percent. This compressed version of the listening instructions served as an introduction to compressed speech at the 20 percent compression rate and was added to the master cassette tape immediately following the instructions at a normal rate. The listening passage was compressed in the same manner as just outlined resulting in a listening passage recorded at 208 words per minute. The listening passage was then dubbed onto the master cassette tape following the compressed version of the listening instructions. Next, the test instructions, recorded at

165 w.p.m., were added to the master cassette tape. Therefore, the 20 percent compression master tape consisted of listening instructions recorded at 165 w.p.m., the listening instructions compressed by 20 percent, the listening passage compressed by 20 percent, and the test instructions recorded at 165 w.p.m.

The 40 percent compression tape was prepared in the same manner as the 20 percent compression tape. The listening instructions recorded at 165 w.p.m. were dubbed directly from the master reel-to-reel tape to a third Maxell UD 60 master cassette tape. The listening instructions were first compressed 20 percent by VOCOM I and then 20 percent by Varispeech I resulting in a total compression rate of approximately 40 percent. Again, this compressed version of the listening instructions served as an introduction to compressed speech at the 40 percent compression rate. The compressed instructions were then added to the master cassette tape. The listening passage was compressed in the same manner as the listening instructions resulting in a listening passage recorded at 266 words per minute. The listening passage was then dubbed onto the master cassette tape following the compressed version of the listening instructions. Next, the test instructions recorded at 165 w.p.m. were added to the master cassette tape. Therefore, the 40 percent compression master tape consisted of listening instructions recorded at 165 words per minute, the listening instructions compressed by 40 percent, the listening passage compressed by 40 percent, and the test instructions recorded at 165 words per minute.

It should be pointed out at this time that the three master cassette tapes were produced by a technician experienced in speech

compression in the audio recording studio of the Audio Visual Department at Oklahoma State University. In addition, a technical supervisor monitored the production of the master cassette tapes.

Evaluation of the Master Tapes

Each of the master tapes was evaluated by the production technician, the technical monitor, and the investigator of this study. It was the opinion of all three that each of the tapes was comparable to the others and that all were of reasonably high quality. No significant distortion or external noise was detectable. There did not appear to be a significant loss in quality due to the dubbing process itself.

Procedure for Collection of Data

Administration of the McGraw-Hill Reading Test

One week prior to the listening sessions, students in each of seven sections of the Utilization of Instructional Media course C&IED 3122 were administered the Reading Rate and Comprehension section of the McGraw-Hill Basic Skills System Reading Test, Form A, in order to determine the reading rate and level of reading comprehension for each subject (see Appendix A). The test was administered during the last 15 minutes of each regularly scheduled class meeting during the fourth week of the spring semester of the 1976 academic year. Only the first selection entitled "The First Hudson River Tunnel" from the Reading Rate and Comprehension section of the McGraw-Hill Basic Skills System Reading Test was utilized. At the conclusion of each reading test, the date and time for the listening sessions were announced. A total

of 165 students participated in the reading exercise of the study.

Two things should be noted at this point. One, the instructions for the reading test were slightly modified from the McGraw-Hill's original instructions since only one reading passage was utilized rather than two. Second, all of the reading tests were administered by the investigator of this study.

The reading tests were hand scored by the investigator of the study. The resulting data were used to determine the students' reading rate and comprehension level of factual material.

In order to classify subjects as fast or slow readers, the population was divided into three categories, upper, middle, and lower, according to their reading rate scores. Since the study was concerned with only fast and slow readers, the middle one-third of the population was not used in further data analysis. Furthermore, only those subjects in the top and bottom thirds having 70 percent or greater comprehension scores were used for the final data analysis since the investigator had previously determined that this comprehension level was viable for the study. From the resulting data, it was determined that 45 subjects met the criteria for fast readers and 42 subjects met the criteria for slow readers.

The fast and slow readers were randomly assigned to each of the three compression groups: (1) zero compression (165 w.p.m.), (2) 20 percent compression (208 w.p.m.), and (3) 40 percent compression (266 w.p.m.). Although the middle third of the population and fast and slow readers with below 70 percent comprehension scores were not used in further data analysis, these subjects were also randomly assigned to each of the three compression groups in order to provide an

opportunity for everyone to participate in the listening sessions. In addition, this served to negate the "Hawthorne Effect" in that a subject was not aware of his role in the experiment, i.e., subjects were not aware of who was classified as fast and slow readers.

On February 10, 1976, at 4:30 p.m., the three listening sessions were conducted in Case Study Rooms A, B, and C located in the Student Union at Oklahoma State University. The three compression groups were arbitrarily assigned to the three rooms as follows: (1) 20 percent compression group to Case Study Room A, (2) zero percent compression group to Case Study Room B, and (3) 40 percent compression group to Case Study Room C. The three Case Study Rooms are nearly identical in every detail, i.e., excellent acoustics, seating arrangement, number of seats, number of speakers, and type of sound system.

As the subjects arrived for the listening sessions, they were informed of the room to which they were assigned. Care was taken that each person was in the properly assigned room. As each student entered the assigned room, he/she was given a pencil and a computer answer card with his/her name on it. The computer card served as a check for proper room assignment for each individual.

A group monitor and proctor were on duty in each of the three listening sessions. The duty of each monitor was to operate the Wollensak cassette tape player. As stated before, listening instructions and test instructions along with the listening passage were pre-recorded on each of the master cassette tapes (see Appendixes A & B). The duty of the proctor was to pass out the listening comprehension test and collect materials, i.e., test, pencils, and computer cards, at the proper time. Each listening session began at exactly 4:30 p.m. The

Maxell audio cassette tapes were played on high quality cassette tape players with identical sound systems. It should be emphasized at this point that the only variable in the listening sessions was the rate of compression of the audio tapes.

At the end of the three listening sessions, the students were given a ten-item multiple choice comprehension test over the listening passage presented on the tape. At the conclusion of the testing period, the students were thanked for their participation in the study and dismissed by each group monitor.

Due to absentees on the date of the listening sessions, only 41 fast readers and 38 slow readers participated. In order to secure an equal number of subjects per listening group and thus facilitate subsequent statistical treatment, the two classification groups, fast and slow readers, were equalized at 36 subjects each. This was done by randomly eliminating five subjects from the fast group and two from the slow group. Because the 40 percent compression group was made up of only 12 subjects in each of its two cells, all cells had to be made equal to those cells. Consequently, the random elimination was done accordingly (see Table II Chapter 4).

The computer answer cards of the 36 fast and 36 slow readers were assembled and properly coded for data analysis by the Computer Center at Oklahoma State University

Methods for Data Analysis

The statistical technique used to determine the significance of the results of this study was the analysis of variance. The acceptance level was set at the .05 level of significance.

In their description of the analysis of variance technique, Runyon and Haber (1967) state:

> The analysis of variance is a technique of statistical analysis which permits us to overcome the ambiguity involved in assessing significant differences when more than comparison is made. It allows us to answer the question: Is there an overall indication that the experimental treatments are producing differences among the means of the various groups? Although the analysis of variance may be used in the two-sample case (in which event it yields precisely the same probability values as the Student t ratio), it is most commonly employed when three or more groups are involved. Indeed, it has its greatest usefulness when two or more independent variables are studied (p. 51).

Hence, the analysis of variance technique was used on the listening comprehension test scores of fast and slow readers in this study for data analysis.

This chapter has been concerned with the design and methodology of the study. The next chapter will present the statistical analysis of the results of the subjects' (fast and slow readers) scores on the reading test and listening comprehension test.

CHAPTER IV

RESULTS OF THE STUDY

Introduction

The analysis of data regarding the reading ability and listening comprehension of subjects participating in this study is presented in this chapter. The purpose of this research was to determine the effects of compressed speech upon the listening comprehension of fast and slow readers. Specifically, the study was concerned with (1) the effects of varying rates of compression upon the comprehension of audio tape material and (2) the interactive effects of rate of compression and reading ability upon the comprehension of audio tape material.

Specific hypotheses tested in this investigation are as follows:

I. There will be no significant effects of varying rates of compression upon the comprehension of audio tape material.

II. There will be no significant interactive effects of rate of compression and reading ability upon the comprehension of audio tape material.

This research was conducted with a population composed of undergraduates enrolled in the Utilization of Instructional Media course C&IED 3122 during the spring semester of the 1976 academic year at Oklahoma State University. The population consisted of a total of 165 students representing seven sections of the Utilization of Instructional Media course C&IED 3122. The course is a predominantly junior level

course required for teacher certification of all secondary and elementary education majors; it also meets the media proficiency requirement of the Oklahoma State Department of Education. The test subjects for the listening exercise of this study were limited to fast and slow readers (previously defined, page 5 & 6) enrolled in the seven sections of the Utilization of Instructional Media course C&IED 3122. Of the population consisting of 165 students, a total of 45 subjects met the criteria for fast readers and 42 subjects met the criteria for slow readers. The fast and slow readers were randomly assigned to each of three compression groups: (1) zero percent compression (165 w.p.m.), (2) 20 percent compression (208 w.p.m.), and (3) 40 percent compression (266 w.p.m.). Those subjects not meeting the criteria for fast and slow readers were also randomly assigned to each of the three compression groups in order to provide an opportunity for everyone to participate in the listening exercise of the study; however, their comprehension scores from the listening comprehension test were not used in the final data analysis. Identical material on audio tape, which varied only in the rate of compression, was presented to each of three compression groups.

Description of Data and Testing of Hypotheses

Due to absentees on the day of the listening sessions, only 41 fast readers and 38 slow readers participated. A summary of the results from the McGraw-Hill Reading Test of these subjects is shown in Table I.

TABLE I

SUMMARY OF DATA OF THE McGRAW-HILL READING TEST
(Test Subjects)

FAST READER			SLOW READER		
Subject Number	Reading Rate (Words per minute)	Comprehension Level (Percent)	Subject Number	Reading Rate (Words per minute)	Comprehension Level (Percent)
1	299	70	1	136	70
2	299	100	2	141	70
3	302	80	3	177	80
4	304	80	4	179	70
5	304	70	5	182	80
6	304	70	6	195	80
7	305	80	7	212	70
8	305	100	8	215	70
9	307	70	9	217	70
10	314	70	10	225	70
11	314	80	11	225	80
12	314	70	12	225	70
13	316	70	13	227	80
14	323	70	14	236	70
15	323	70	15	236	80
16	323	90	16	236	70
17	325	70	17	244	80
18	333	90	18	246	70
19	333	70	19	248	70
20	333	70	20	248	80
21	341	70	21	248	70
22	343	90	22	248	70
23	348	70	23	248	70
24	359	90	24	251	80
25	363	90	25	253	90

TABLE I (Continued)

26	363	90	26	253	70
27	367	90	27	253	90
28	373	80	28	253	70
29	385	90	29	255	70
30	397	70	30	257	70
31	418	70	31	257	70
32	430	100	32	257	80
33	441	80	33	257	80
34	461	100	34	257	80
35	468	70	35	259	70
36	525	70	36	259	70
37	547	70	37	259	70
38	547	80	-	-	-
39	547	70	-	-	-
40	547	80	-	-	-
41	549				

In order to secure an equal number of subjects per listening group and thus facilitate subsequent statistical treatment, the two classification groups, fast and slow readers, were equalized at 36 subjects each. This was done by randomly eliminating five subjects from the fast group and two subjects from the slow group. Because the 40 percent compression group was made up of only 12 subjects in each of its two cells, all cells had to be made equal to those cells. The random elimination is depicted in Table II.

TABLE II

DISTRIBUTION OF FAST AND SLOW READERS BY COMPRESSION GROUPS

Compression Groups By Percent and w.p.m.	Subjects Participating In Listening Sessions		Subjects Dropped		Total Subjects	
	Fast	Slow	Fast	Slow	Fast	Slow
Zero (165 w.p.m.)	15	14	3	2	12	12
Twenty (208 w.p.m.)	14	12	2	0	12	12
Forty (266 w.p.m.)	12	12	0	0	12	12

Fast = Fast Reader Slow = Slow Reader w.p.m. = words per minute

A summary of the results of scores from the listening comprehension test for fast and slow readers for each compression group is presented in Table III.

TABLE III

SUMMARY OF RESULTS OF SCORES FROM THE LISTENING COMPREHENSION TEST (Fast and Slow Readers)

	Zero Percent Compression Group		20 Percent Compression Group		40 Percent Compression Group	
	Subject	Test Score	Subject	Test Score	Subject	Test Score
Fast Readers	1	9	25	4	49	7
	2	9	26	7	50	5
	3	6	27	7	51	8
	4	9	28	5	52	4
	5	8	29	9	53	9
	6	4	30	8	54	5
	7	8	31	8	55	3
	8	9	32	5	56	6
	9	7	33	8	57	5
	10	4	34	7	58	6
	11	10	35	9	59	5
	12	8	36	9	60	5
Slow Readers	13	9	37	2	61	6
	14	7	38	8	62	6
	15	8	39	9	63	6
	16	8	40	7	64	10
	17	9	41	4	65	10
	18	8	42	6	66	5
	19	7	43	6	67	7
	20	6	44	6	68	9
	21	7	45	9	69	4
	22	8	46	6	70	7
	23	4	47	1	71	4
	24	5	48	9	72	8

Total Possible Test Score = 10

The mean score for each of the three compression groups, zero percent, 20 percent, and 40 percent, was calculated and the results are presented in Table IV.

TABLE IV

MEAN SCORES OF FAST AND SLOW READERS ACCORDING TO COMPRESSION GROUPS

	Zero Percent Compression Group Mean	20 Percent Compression Group Mean	40 Percent Compression Group Mean
Fast and Slow Readers	7.38	6.62	6.25

The analysis of variance technique was used to analyze the data relevant to the hypotheses in this investigation. This statistic allows one to determine the effects of rate of presentation of audio taped material upon the listening comprehension of fast and slow readers. All results were evaluated at the .05 level of significance.

Hypothesis I. There will be no significant effects of varying rates of compression upon the comprehension of audio tape material.

The purpose of testing Hypothesis I is to determine if varying rates of compression had an influencing effect upon listening comprehension. The analysis of variance yielded an F value of 2.00. Rejection of the null hypothesis at the .05 level of confidence with 2 and 69 degrees of freedom called for an F value of 3.15. Hence, the experimenter failed to reject the null hypothesis; groups did not differ significantly due to the varying rates of compression. A summary of the analysis of variance data is presented in Table V.

TABLE V

OVERALL ANALYSIS OF VARIANCE
(Rate of Compression)

	Sum of Squares	Degrees of Freedom	Mean Square	F Ratio	Critical F (5% Level)
Total	287.50	71	4.05	--	--
Compression Rate	15.75	2	7.88	2.00	N.S.
Error	271.75	69	3.94	--	--

Table F = 3.15 at .05 level

A summary of the results of scores from the listening comprehension test for fast readers and slow readers for each compression group was previously presented in Table III. The mean scores for fast vs. slow reading groups for each of the three compression groups was calculated and the results are presented in Table VI.

TABLE VI

MEAN SCORES OF FAST VS. SLOW READERS
ACCORDING TO COMPRESSION GROUPS

	Zero Percent Compression Group Mean	20 Percent Compression Group Mean	40 Percent Compression Group Mean
Fast Readers	7.58	7.17	5.67
Slow Readers	7.17	6.08	6.83

Hypothesis II. There will be no significant interactive effects of rate of compression and reading ability upon the comprehension of audio tape material.

The purpose of testing Hypothesis II is to determine if the interaction of compression rate and reading ability had an influencing effect upon listening comprehension. The analysis of variance for interaction effects yielded an F value of 2.07. Rejection of the null hypothesis at the .05 level of significance with 2 and 66 degrees of freedom called for an F value of 3.15. Hence, the experimenter failed to reject the null hypothesis; groups did not differ significantly due to the interactive effects of reading ability and rate of compression. A summary of the analysis of variance data is presented in Table VII.

TABLE VII

OVERALL ANALYSIS OF VARIANCE
(Compression Rate X Reading Rate)

	Sum of Squares	Degrees of Freedom	Mean Square	F Ratio	Critical F (5% Level)
Total	287.50	71	4.05	--	--
Compression Rate	15.75	2	7.88	2.03	N.S.
Reading Rate	0.22	1	0.22	0.06	N.S.
Compression Rate X Reading Rate	16.03	2	8.01	2.07	N.S.
Error	255.50	66	3.87	--	--

Table F = 3.15 at .05 level

This chapter has presented the findings of the present investigation. These results were interpreted according to the analysis of variance technique. The statistical analysis of data involving varying rates of compression and the interaction of rate of compression and reading ability upon listening comprehension showed no significant differences. Consequently, the experimenter failed to reject both hypotheses I and II.

Chapter V will present the summary, conclusions, and recommendations of the study based on these data results.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this research was to determine the effects of compressed speech upon the listening comprehension of fast and slow readers. Specifically, the study was concerned with (1) the effects of varying rates of compression upon the comprehension of audio tape material, and (2) the interactive effects of rate of compression and reading ability upon the comprehension of audio tape material. This study was conducted with a population composed of undergraduates enrolled in the Utilization of Instructional Media course C&IED 3122 during the spring semester of the 1976 academic year at Oklahoma State University. The population consisted of a total of 165 students representing seven sections of the Utilization of Instructional Media course C&IED 3122.

The test subjects of this investigation were limited to fast and slow readers enrolled in the seven sections of the Utilization of Instructional Media course C&IED 3122. Subjects were classified as fast or slow readers in the following manner. The 165 students representing seven sections of the Utilization of Instructional Media course C&IED 3122 were administered the Reading Rate and Comprehension section of the McGraw-Hill Basic Skills System Reading Test, Form A, in order to

determine their reading rates and comprehension levels. The population was divided into three categories, upper, middle, and lower, according to their reading rate scores. Since the study was concerned with only fast and slow readers, the middle one-third of the population was not used in further data analysis. Furthermore, only those subjects in the top and bottom thirds having 70 percent or greater comprehension scores were used for the final data analysis since the investigator had previously determined that this comprehension level was viable for the study.

Fast and slow readers were randomly assigned to each of three compression groups: (1) zero percent compression (165 w.p.m.), (2) 20 percent compression (208 w.p.m.), and (3) 40 percent compression (266 w.p.m.). Although the middle third of the population and fast and slow readers with below 70 percent comprehension scores were not used in further data analysis, these subjects were also randomly assigned to each of the three compression groups in order to provide an opportunity for everyone to participate in the listening sessions.

A listening passage was recorded at 165 words per minute (zero compression) and compressed by approximately 20 and 40 percent resulting in two compressed passages of 208 words per minute and 266 words per minute. The three compression groups listened to audio tape messages which differed only in the rate of presentation. A listening comprehension test was administered to each compression group.

In the final data analysis for listening comprehension, the sample for this study included a total of 72 subjects, 36 fast and 36 slow readers equally distributed in each of the compression groups.

The hypotheses which this investigation was designed to test are as follows:

I. There will be no significant effects of varying rates of compression upon the comprehension of audio tape material.

II. There will be no significant interactive effects of rate of compression and reading ability upon the comprehension of audio tape material.

The statistical treatment of the data to test the preceeding hypotheses was the analysis of variance. The analysis of variance was used to analyze the listening performance of the groups with respect to varying rates of compression and the interaction of compression rate and reading ability.

Conclusions of the Study

Generalizations from this study are limited to populations which have characteristics similar to the population of the present study. Therefore, the following conclusions seem warranted from the results of the statistical treatment of the data.

1. The hypothesis of no significant effects of varying rates of compression upon listening comprehension was accepted at the .05 level of confidence. Groups did not differ significantly due to varying rates of compression. Hence, the students were able to listen to an audio tape message compressed by as much as 40 percent (266 w.p.m.) without significant loss of comprehension. Therefore, it would appear that listening time could be saved without significant loss of comprehension.

2. The hypothesis of no significant interactive effects of compression rate and reading ability upon listening comprehension was accepted at the .05 level of confidence. Groups did not differ significantly due to the interaction of compression rate and reading ability. Hence, interaction was not sufficient to produce any significant effects upon listening comprehension.

Recommendations for Further Research

Results of the data from this study indicate that students can listen to compressed speech at high rates of compression without significant loss of comprehension. Results of the data from this study also indicate that the interaction of compression rate and reading ability is not sufficient to produce any significant effects upon listening comprehension. It is the opinion of this writer that the outcomes of this study are particularly relevant to the college instructional level.

Based upon the findings of this particular study and a review of selected literature of time-compressed speech, some implications for additional research in listening comprehension seem implicit. These additional suggested research areas are as follows:

1. A replication of this study with a larger population for testing of reading ability.
2. A comparable study including retention as a variable as well as comprehension.
3. A replication of the present study employing a different test for reading ability but the same design and methodology.

4. A study with the same design and methodology but using subjects from different academic grade levels.
5. An investigation employing an audio taped test of listening comprehension instead of a written listening comprehension test.
6. A replication of the present study testing for listening comprehension of other types of material than factual material.
7. An investigation exploring the teaching of listening skills necessary for comprehending time-compressed speech.

It would seem from the research available to date that time-compressed speech is an area that possesses high potential for both education and basic research and hopefully this study will play some small part in leading to an increased realization of that potential.

A SELECTED BIBLIOGRAPHY

Adelson, Loretta. "An Experimental Study in Comprehension by College Students of Time-Compressed Educational Materials." (Unpub. doctoral dissertation, Columbia University, 1972.)

Anderton, Ray L. "The Effect of Time-Compressed Tape-Slide Instructional Program Upon the Learner." Center for Rate Controlled Recordings Newsletter, III (December, 1970), pp. 2-3.

Barabasy, Arreed F. "A Study of Recall and Retention of Accelerated Lecture Presentation." Journal of Communication, XVIII (September, 1968), pp. 283-287.

Barnard, Douglas P. "A Study of the Effect of Differentiated Auditory Presentation on Listening Comprehension and Rate of Reading Comprehension at the Sixth Grade Level." (Unpub. doctoral dissertation, Boston University, 1970.)

Bellamy, Martha J. "An Experimental Study to Compare the Comprehension of Speeded Speech by Blind and Sighted Children." In Time-Compressed Speech: An Anthology and Bibliography in Three Volumes. Ed. Sam Duker. Vol. III. New Jersey: The Scarecrow Press, Inc., 1974, pp. 485-486.

Benz, Carlton R. "Effects of Time-Compressed Speech Upon the Comprehension of a Visually Oriented Televised Lecture." (Unpub. doctoral dissertation, Wayne State University, 1971.)

Bird, Donald E. "Have You Tried Listening?" Journal of the American Diatetic Association, XXX (March, 1954), pp. 225-230.

Black, John W. "Natural Frequency Duration and Intensity of Vowels in Reading." Journal of Speech and Hearing Disorders, XIV (September, 1949), pp. 216-221.

Boyle, Virginia A. "Effects of Variations in Visual Stimulation on Listening Comprehension." Center for Rate Controlled Recordings Newsletter, III (December, 1969), pp. 1-2.

Breiter, Lila R. "Research in Listening and its Importance to Literature." (Unpub. M. S. thesis, Brooklyn College, 1957.)

Broadbent, D. C. "A Mechanical Model for Human Attention and Immediate Memory." Psychological Review, XIV (September, 1957), pp. 205-214.

Bruland, Richard A. "Listening and Listening-Reading at Two Different Rates of Presentation by Fifth Grade Pupils." In Time-Compressed Speech: An Anthology and Bibliography in Three Volumes. Ed. Sam Duker. Vol. II. New Jersey: The Scarecrow Press, Inc., 1974, pp. 837-842.

Cain, Cheryl J. and Norman J. Lass. "Listening Rate Preferences of Adults." In Time-Compressed Speech: An Anthology and Bibliography in Three Volumes. Ed. Sam Duker. Vol. II. New Jersey: The Scarecrow Press, Inc., 1974, pp. 674-678.

Calearo, C. and A. Lazzaroni. "Speech Intelligibility in Relation to the Speed of the Message." Laryngoscope, LXVII (May, 1957), pp. 410-419.

Carroll, John B. "Problems of Measuring Speed Rate." Proceedings of the Louisville Conference on Time-Compressed Speech, October 19-21, 1966. Ed. Emerson Foulke. Louisville, Kentucky: Center for Rate Controlled Recordings /Perceptual Alternatives Laboratory/ U. of Louisville, 1966, pp. 88-94.

Chapman, W. D. "Speech Compression By Tape Loop and Computer." Proceedings of the Louisville Conference on Time-Compressed Speech, October 19-21, 1966. Ed. Emerson Foulke. Louisville, Kentucky: Center for Rate Controlled Recordings. /Perceptual Alternatives Laboratory/, U. of Louisville, 1967, pp. 98-107.

Diehl, Charles F., Richard C. White, and Kenneth W. Burk. "Rate and Communication." Speech Monographs, XXVI (August, 1959), pp. 229-232.

Enc, M. C. and L. M. Stolurow. "A Comparison of the Effects of Two Recording Speeds on Learning and Retention." The New Outlook for the Blind, LIV (February, 1960), pp. 39-48.

Ernest, Carole H. "Listening Comprehension As A Function of Type of Material and Rate of Presentation." Speech Monographs, XXXV (June, 1968), pp. 154-158.

Fairbanks, Grant, W. L. Everitt and R. P. Jaeger. Experimental Phonetics. Urbana, Illinois: U. of Illinois Press, 1954.

Fairbanks, Grant, Newman Guttman and Murry S. Miron. "Effects of Time Compression Upon the Comprehension of Connected Speech." Journal of Speech and Hearing Disorders, XXII (March, 1957), pp. 10-19.

Fergen, Geraldine K. "Listening Comprehension at Controlled Rates for Children in Grades IV, V, and VI." (Unpub. doctoral dissertation, Missouri University, 1954.)

Fletcher, Harvey. Speech and Hearing. Princeton, New Jersey: Van Nostrand, 1929.

Foulke, Emerson. Comprehension of Rapid Speech By the Blind. Louisville, Kentucky: U. of Louisville, Final Progress Report No. 1370, 1964.

Foulke, Emerson. "A Survey of the Acceptibility of Rapid Speech." New Outlook for the Blind, LX (October, 1966a), pp. 261-265.

Foulke, Emerson. "A Comparison of Comprehension of Two Forms of Compressed Speech." Exceptional Children, XXXII (November, 1966b), pp. 169-173.

Foulke, Emerson. "The Retention of Information Presented at an Accelerated Word Rate." International Journal for the Education of the Blind, XVI (October, 1966c), pp. 11-15.

Foulke, Emerson. "The Influence of a Reader's Voice and Style of Reading on Comprehension of Time-Compressed Speech." New Outlook for the Blind, LXI (March, 1967a), pp. 65-68.

Foulke, Emerson (ed). Proceedings of the Louisville Conference on Time Compressed Speech, October 19-21, 1966. Louisville, Kentucky: Center for Rate Controlled Recordings /Perceptual Alternatives Laboratory/, U. of Louisville, 1967b.

Foulke, Emerson. "Listening Comprehension as a Function of Word Rate." Journal of Communication, XVIII (September, 1968), pp. 198-206.

Foulke, Emerson. Comprehension of Rapid Speech By the Blind. Louisville, Kentucky: U. of Louisville, Final Progress Report No. 2430, 1969.

Foulke, Emerson. "The Perception of Time-Compressed Speech." In The Perception of Language. Ed. David L. Horton and James J. Jenkins. Columbus, Ohio: Charles E. Merrill, 1971, pp. 79-107.

Foulke, Emerson, Clarence H. Amster, Carson Y. Nolan, and Ray H. Bixler. "The Comprehension of Rapid Speech by the Blind." Exceptional Children, XXIX (November, 1962), pp. 134-141.

Foulke, Emerson and Thomas G. Sticht. "Listening Rate Preferences of College Students for Literary Material of Moderate Difficulty." Journal of Auditory Research, VI (1966), pp. 397-401.

Foulke, Emerson and Thomas G. Sticht. "A Review of Research on Time Compressed Speech." Proceedings of the Louisville Conference on Time Compressed Speech, October 19-21, 1966. Ed. Emerson Foulke. Louisville, Kentucky: Center for Rate Controlled Recordings /Perceptual Alternatives Laboratory/, U. of Louisville, 1967a, pp. 3-20.

Foulke, Emerson and Thomas G. Sticht. "The Intelligibility and Comprehension of Time-Compressed Speech." Proceedings of the Louisville Conference on Time-Compressed Speech, October 19-21, 1966. Ed. Emerson Foulke. Louisville, Kentucky: Center for Rate Controlled Recordings. /Perceptual Alternatives Laboratory/, U. of Louisville, 1967b, pp. 21-28.

Friedman, Herbert L., David B. Orr, O. R. Freedle, and Cynthia M. Norris. Further Research on Speeded Speech as an Education Medium. Washington, D. C.: Office of Education, Department of HEW, Progress Report No. 2, 1966.

Friedman, Herbert L. and David B. Orr. "Recent Research in the Training of Compressed Speech Comprehension." Proceedings of the Louisville Conference on Time-Compressed Speech, October 19-21, 1966. Ed. Emerson Foulke. Louisville, Kentucky: Center for Rate Controlled Recordings. /Perceptual Alternatives Laboratory/, U. of Louisville, 1967, pp. 69-76.

Garvey, William D. "The Intelligibility of Abbreviated Speech Patterns." Quarterly Journal of Speech, XXXIX (October, 1953), pp. 108-116.

Gemelli, A. "The Minimum Duration of a Phoneme Sufficient for its Perception." In L' Analisi Elellroacustica del Linguaggio. Ed. A. Gemelli and G. Pastori. Milan, Italy: Societa Editrice "Vita e Pensiero," 1934, pp. 149-162.

George, Robert G. "Difficulty of Material and Retention of Compressed Speech." In Time Compressed Speech: An Anthology and Bibliography in Three Volumes. Ed. Sam Duker. Vol. II. New Jersey: The Scarecrow Press, Inc., 1974, pp. 741-749.

Gill, Larry. "The Effects of Time Compressed Speech and an Interim Activity Upon the Listening Comprehension of Students." (Unpub. doctoral dissertation, Oklahoma State University, 1975.)

Gleason, Gerald, Rolland Calloway, and Robert Lakota. "Effects of Audio Rate Compression on Student Comprehension and Attitudes." In Time Compressed Speech: An Anthology and Bibliography in Three Volumes. Ed. Sam Duker. Vol. II. New Jersey: The Scarecrow Press, Inc., 1974, pp. 954-959.

Goldhaber, Gerald M. "Listener Comprehension of Compressed Speech When the Difficulty Level of the Content and the Sex of the Listener are Varied." Speech Monographs, XXXV (June, 1968), pp. 20-25.

Goldhaber, Gerald M. "Listener Comprehension of Compressed Speech as a Function of the Academic Grade Level of the Subjects." Journal of Communication, XX (June, 1970), pp. 167-173.

Goldhaber, Gerald M. "Effects of Speech Compression Training on Comprehension of Native Speakers of English, Spanish, and Navajo." In Time Compressed Speech: An Anthology and Bibliography in Three Volumes. Ed. Sam Duker. Vol. II. New Jersey: The Scarecrow Press, Inc., 1974, pp. 730-735.

Goldstein, Harry. Reading and Listening at Various Controlled Rates. New York: Bureau of Publications, Teachers College, Columbia University, 1940.

Hartlage, L. "Differences in Listening Comprehension Between Blind and Sighted Subjects." International Journal of Education for the Blind. XXIII (January, 1963), pp. 1-6.

Hogben, Michael D. "An Investigation of Comprehension in Compressed Speech." In Time-Compressed Speech: An Anthology and Bibliography in Three Volumes. Ed. Sam Duker. Vol. III. New Jersey: The Scarecrow Press, Inc., 1974, p. 90.

Hopkins, Fred W., Jr. "An Experimental Study of the Effects of Repetitive Compressed Speech on Listening Comprehension." In Time-Compressed Speech: An Anthology and Bibliography in Three Volumes. Ed. Sam Duker. Vol. II. New Jersey: The Scarecrow Press, Inc., 1974, pp. 802-808.

Jester, Robert E. "Comprehension of Connected Meaningful Discourse as a Function of Individual Differences and Rate and Modality of Presentation." In Time-Compressed Speech: An Anthology and Bibliography in Three Volumes. Ed. Sam Duker. Vol. II. New Jersey: The Scarecrow Press, Inc., 1974, pp. 821-832.

Jester, Robert E. and Robert M. Travers. "The Effects of Various Presentation Patterns on the Comprehension of Speeded Speech." American Educational Research Journal, IV (November, 1967), pp. 353-360.

Johnson, W., Frank Darley, and D. C. Spriesterback. Diagnostic Methods in Speech Pathology. New York: Harper and Row, 1963.

Kling, Martin and Mary Luke Reiland. "Comprehension Boosts Reading Rate." Center for Rate Controlled Recordings, II (July, 1968), pp. 3-4.

Klump, R. G. and J. E. Webster. "Intelligibility of Time-Compressed Speech." Journal of the Acoustical Society of America, XXXIII (March, 1961), pp. 265-267.

Kodman, Francis, Jr. "An Investigation of Word Intelligibility as a Function of Time Compression." (Unpub. doctoral dissertation, University of Illinois, 1954).

Langford, Robert P. "The Effect of Compressed Speech on Listening Comprehension." In Time-Compressed Speech: An Anthology and Bibliography in Three Volumes. Ed. Sam Duker. Vol. II. New Jersey: The Scarecrow Press, Inc., 1974, pp. 890-893.

Loper, James L. "An Experimental Study of Some Effects of Time Compression Upon the Comprehension and Retention of a Visually Augmented Televised Speech." In Time-Compressed Speech: An Anthology and Bibliography in Three Volumes. Ed. Sam Duker. Vol. II New Jersey: The Scarecrow Press, Inc., 1974, pp. 843-851.

McLain, Julie R. "A Comparison of Two Methods of Producing Rapid Speech." International Journal of Education of the Blind, XII (December, 1962), pp. 40-42.

Miller, George A. "Intelligibility of Speech: Effects of Distortion." In Combat Instrumentation II. Ed. G. E. Waring. Washington, D. C.: Government Printing Office, 1946, pp. 88-109.

Miller, G. A. and J. E. Licklider. "The Intelligibility of Interrupted Speech." Journal of the Acoustical Society of America, XXII (March, 1950), pp. 167-173.

Miron, Murry S. and Eric W. Brown. "Durational Variables in Speech Compression." In Time-Compressed Speech: An Anthology and Bibliography in Three Volumes. Ed. Sam Duker. Vol. I. New Jersey: The Scarecrow Press, Inc., 1974, pp. 555-556.

Moll, H. G. "The Effect of Selective Elimination of Speech Sounds on the Comprehension of Compressed Speech." (Unpub. doctoral dissertation, Indiana University, 1968).

Nelson, Harold E. "The Effect of Variations of Rate on the Recall by Radio Listeners of 'Straight Newscasts'." Speech Monographs, XV (1948), pp. 173-180.

Nichols, Ralph G. and Leonard Stevens. Are You Listening? New York: McGraw-Hill Book Co., Inc., 1957.

Nolan, Carson Y. "Listening and Reading in Learning." Proceedings of the Louisville Conference on Time-Compressed Speech, October 19-21, 1966. Ed. Emerson Foulke. Louisville, Kentucky: Center for Rate Controlled Recordings /Perceptual Alternatives Laboratory/, U. of Louisville, 1967, pp. 67-68.

Oakley, Gary D. "The Feasibility of Compressed Speech." (Unpub. doctoral dissertation, Southern Illinois University, 1970.)

Orr, David B. "Note on Thought Rate as a Function of Reading and Listening Rates." Perceptual and Motor Skills, XIX (December, 1964), pp. 874.

Orr, David B. "Time Compressed Speech - A Perspective." Journal of Communication, XVIII (September, 1968), pp. 290-291.

Orr, David B. and Herbert L. Friedman. Research on Speeded Speech as an Educational Medium. Washington, D. C.: Office of Education, Department HEW, Progress Report Grant No. 7-48-7670-203, 1964.

Orr, David B. and Herbert L. Friedman. "The Effect of Listening Aids on the Comprehension of Time-Compressed Speech." Journal of Communication, XVII (September, 1967), pp. 223-227.

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

Parker, Clement. "The Effect of Rate of Compression and Mode of Presentation on the Comprehension of a Recorded Communication to Junior College Students of Varying Aptitudes." Microfilm copy. (Unpub. doctoral dissertation, Library, North Texas State University, 1970.)

Peterson, Gordon E. "The Significance of Various Portions of the Wave Length in the Minimum Duration Necessary for the Recognition of Vowel Sounds." (Unpub. doctoral dissertation, Louisiana State University, 1939.)

Qureshi, Shadid U. "Speech Compression by Small Computer." In Time-Compressed Speech: An Anthology and Bibliography in Three Volumes. Ed. Sam Duker. Vol. II, New Jersey: The Scarecrow Press, Inc., 1974, pp. 618-623.

Rankin, Paul T. "The Measurement of the Ability to Understand Spoken Language." (Unpub. doctoral dissertation, Michigan University, 1926.)

Reddy, D. R. and P. J. Vicens. "A Procedure for the Segmentation of Connected Speech." Journal of the Audio Engineering Society, XVI (1968), pp. 404-411.

Reid, Ronald H. "Grammatical Complexity and Comprehension of Compressed Speech." Journal of Communication, XVIII (September, 1968), pp. 236-242.

Reiland, Sr., Mary L. "The Effect of Compressed Speech on Reading and Listening Abilities of Sixth-Grade Children." In Time-Compressed Speech: An Anthology and Bibliography in Three Volumes. Ed. Sam Duker. Vol. II, New Jersey: The Scarecrow Press, Inc., 1974, pp. 879-887.

Resta, Paul E. "The Effects of Training on the Intelligibility and Comprehension of Frequency Shifted Time-Compressed Speech by the Blind." Proceeding of the Second Louisville Conference on Rate and/or Frequency-Controlled Speech, October 22-24, 1969. Ed. Emerson Foulke. Louisville, Kentucky: Center for Rate Controlled Recordings /Perceptual Alternatives Laboratory/, U. of Louisville, 1971, pp. 347-362.

Robinson, Jacques H. Bimodal Education Inputs to Educable Mental Retarded Children. Silver Spring, Maryland: American Institutes for Research, Report No. AI R-E-49-9-66-FR, 1966.

Runyon, Richard P. Fundamentals of Behavioral Statistics. Reading, Mass: Addison-Wesley Publishing Co., Inc., 1967.

Sarenpa, Dennis E. "A Comparative Study of Two Presentations of Rate Controlled Audio Instruction in Relation to Certain Student Characteristics." (Unpub. doctoral dissertation, U. of Minnesota, 1971.)

Scott, Robert J. "Computers for Speech Time Compression." Proceedings of the Louisville Conference on Time-Compressed Speech, October 19-21, 1966. Ed. Emerson Foulke. Louisville, Kentucky: Center for Rate Controlled Recordings /Perceptual Alternatives Laboratory/ U. of Louisville, 1967, pp. 29-35.

Seo, Hideo. "New Approach to Speech Compression." Journal of the Acoustical Society of America, XLI (1967), pp. 1595.

Short, Sarah H. "The Use of Compressed Rate Speech Tapes in a Self-Instructional Laboratory." In Time-Compressed Speech: An Anthology and Bibliography in Three Volumes, Ed. Sam Duker. Vol. II. New Jersey: The Scarecrow Press, Inc., 1974, pp. 939-942.

Spicker, Howard H. "Listening Comprehension and Retention of Intellectually Normal and Retarded Children as Functions of Speaking Rate and Passage Difficulty." (Unpub. doctoral dissertation, George Peabody College, 1963.)

Steinberg, E. D. "Acoustics, the Sense of Hearing." In Electrical Engineer's Handbook. Ed. H. Pender and K. McIlwain. New York: Wiley, 1936a, pp. 9-32.

Steinberg, E. D. "Effects of Distortion on Speech and Music." In Electrical Engineer's Handbook. Ed. H. Pender and K. McIlwain. New York: Wiley, 1936b, pp. 932-938.

Sticht, Thomas G. "Studies on the Efficiency of Learning by Listening to Time-Compressed Speech." Proceedings of the Second Louisville Conference on Rate and/or Frequency Controlled Speech, October 22-24, 1969. Ed. Emerson Foulke. Louisville, Kentucky: Center for Rate Controlled Recordings /Perceptual Alternatives Laboratory/, U. of Louisville, 1971, pp. 80-89.

Taylor, Stanford E. Listening: What Research Says to the Teacher. Washington, D. C.: National Education Association, 1964.

Thames, Kenneth H. "The Effects of Training with Compressed Speech on Reading Rate and Listening Comprehension." In Time-Compressed Speech: An Anthology and Bibliography in Three Volumes. Ed. Sam Duker. Vol. II. New Jersey: The Scarecrow Press, Inc., 1974, pp. 887-889.

Travers, Robert M. "The Transmission of Information to Human Receivers." Audio-Visual Communication Review, XII (Winter, 1964), pp. 373-385.

Watts, Meredith W., Jr. "Differences in Educational Level and Subject Matter Difficulty in the Use of Compressed Speech with Adult Military Students." Adult Education Journal, XXI (1971), pp. 27-36.

Wilson, James. "Effects of Stimulus and Interstimulus Duration on the Immediate Recall of Time-Compressed Sequences of Different Orders of Approximation to English." (Unpub. M. S. thesis, University of Louisville, 1969.)

Wood, C. David. Comprehension of Compressed Speech by Elementary Children. Bloomington, Indiana: Indiana University Final Report on Title VII, Project No. 1300, 1965.

Woodcock, Richard W. "The Application of Rate-Controlled Recordings in the Classroom." Proceedings of the Second Louisville Conference on Rate and/or Frequency Controlled Speech, October 22-24, 1969. Ed. Emerson Foulke. Louisville, Kentucky: Center for Rate Controlled Recordings /Perceptual Alternatives Laboratory/, U. of Louisville, 1971, pp. 90-102.

Woodcock, Richard W. and Charlotte R. Clark. "Comprehension of a Narrative Passage by Elementary School Children as a Function of Listening Rate, Retention Period, and I.Q." Journal of Communication, XVIII (September, 1968a), pp. 259-271.

Woodcock, Richard W. and Charlotte R. Clark. Influence of Presentation Rate and Media on the Comprehension of Narrative Material by Adolescent Educable Mental Retardes. Nashville: George Peabody College, Institute on Mental Retardation and Intellectual Development, IMRID Reports and Papers, V (June, 1968b), pp. 1-27.

Voor, John B. and Rev. Joseph M. Miller. "The Effect of Practice Upon Comprehension of Time-Compressed Speech." Speech Monographs, XXXII (November, 1965), pp. 452-454.

Zemlin, William R., Raymond G. Daniloff and Thomas H. Shriner. "The Difficulty of Listening to Time-Compressed Speech." Journal of Speech and Hearing Research, XI (1968), pp. 875-881.

APPENDIXES

APPENDIX A

INSTRUCTIONS FOR THE READING TEST

INSTRUCTIONS FOR THE READING TEST

The class proctor will now distribute the test booklets and answer sheets. Do not open the test booklets until told to do so. Place your name in the appropriate section of your answer sheet. In just a moment you will be asked to read a passage from this test booklet. You should read the passage as fast as you can. A short comprehension test will be given over the material at the end of the reading period. Notice that the lines of print are numbered. At the end of three minutes, you will be told to record the exact number of the line you are reading in the upper right-hand section of your answer sheet in the space marked "Line Number". You will continue reading for two minutes longer. You will then have three minutes to answer the test items without referring to the reading passage.

Are there any questions?

(If so, questions were answered)

Turn to page seven in your test booklet.

Begin your reading.

(Three minute reading time)

STOP

Record on your answer sheet the exact number of the line you are reading in the space labeled "Line Number".

(15 second pause)

Does everyone have his "Line Number" recorded?

(Pause)

Now that everyone has his/her line number recorded, continue your reading.

(Two minute continued reading time)

STOP

You are now going to answer the ten questions on the material you have just read. Please answer the questions without referring to the reading passage. Please place all of your answers on the answer sheet. You will have three minutes in which to work.

Are there any questions?

(If so, questions were answered)

Turn to Page 11.

Begin your test.

(Three minute testing time)

STOP

Place your answer sheet inside your test booklet. The test booklets with the answer sheets will be picked up by the class proctor.

Thank you for your participation in the reading exercise. You are now dismissed.

APPENDIX B

LISTENING INSTRUCTIONS FOR COMPRESSION GROUPS

LISTENING INSTRUCTIONS FOR THE

ZERO PERCENT COMPRESSION GROUP

The ability to communicate effectively is what distinguishes a civilization from a so-called non-civilization or simply masses of individuals. Although modern man has developed unique ways to communicate, the most widely used way is still that of verbal speech. Even with a highly literate society such as our own, speech is still the predominant mode of communication.

A large portion of your formal education has been communicated to you by the spoken word; consequently, you have spent a considerable amount of time as a listener and an interpreter of lectures and discussions. Listening will also be a significant part of this exercise today.

In a few moments you will be listening to a taped message presented at the same word rate as I am now speaking. At the end of the taped message, you will be given a short comprehension test over the message content. It is important that you concentrate on the message content and attempt to ignore everything else. Instructions for taking the test will be given later.

(Two second pause)

Now for the message.

(Two second pause)

Ready.

(Three second pause)

(Message)

(Three second pause)

LISTENING INSTRUCTIONS FOR THE

20 PERCENT COMPRESSION GROUP

The ability to communicate effectively is what distinguishes a civilization from a so-called non-civilization or simply masses of individuals. Although modern man has developed unique ways to communicate, the most widely used way is still that of verbal speech. Even with a highly literate society such as our own, speech is still the predominant mode of communication.

A large portion of your formal education has been communicated to you by the spoken word; consequently, you have spent a considerable amount of time as a listener and an interpreter of lectures and discussions. Listening will also be a significant part of this activity today.

A problem with listening is that the spoken word is one of the slowest means of communicating information. The problem is that a speaker cannot talk as fast as you can listen. The limitation is not yours but is the speaker's since he can only talk or read to you at a rather slow rate. Recent technological developments have made it possible to deal with this limitation. It is now possible to speed up the rate of speaking with no loss of intelligibility.

In a few moments you will be listening to a taped message presented at a much faster rate than I am now speaking. It is important that you accept the fact that you can listen and comprehend at this accelerated rate. There will be no distortion and no words will have been taken out to make the message more rapid.

At the end of the taped message you will be given a short comprehension test over the message content. Instructions for taking the test will be given later.

There are two important suggestions which will help you gain the most from a message compressed to less than normal listening time.

First--concentrate on the message content and attempt to ignore everything else.

Second--do not let the speed with which the words are coming to you be a distraction. Despite the rapid pace at which the words flow, you can comprehend the message. Numerous studies have already proven that people can comprehend speech which is accelerated considerably.

As an introduction to accelerated or compressed speech, you will now hear my introductory comments accelerated by 20 percent, or stated another way, you will hear my comments in just 80 percent of the original time.

(Two second pause)

Ready.

(Three second pause)

(Instructions repeated - compressed version)

(Three second pause)

You are now ready to listen to the taped message. Remember, the taped message will be presented in 80 percent of the original time.

(Two second pause)

Ready.

(Three second pause)

(Message)

(Three second pause)

LISTENING INSTRUCTIONS FOR THE

40 PERCENT COMPRESSION GROUP

The ability to communicate effectively is what distinguishes a civilization from a so-called non-civilization or simply masses of individuals. Although modern man has developed unique ways to communicate, the most widely used way is still that of verbal speech. Even with a highly literate society such as our own, speech is still the predominant mode of communication.

A large portion of your formal education has been communicated to you by the spoken word; consequently, you have spent a considerable amount of time as a listener and an interpreter of lectures and discussions. Listening will also be a significant part of this activity today.

A problem with listening is that the spoken word is one of the slowest means of communicating information. The problem is that a speaker cannot talk as fast as you can listen. The limitation is not yours but is the speaker's since he can only talk or read to you at a rather slow rate. Recent technological developments have made it possible to deal with this limitation. It is now possible to speed up the rate of speaking with no loss of intelligibility.

In a few moments you will be listening to a taped message presented at a much faster rate than I am now speaking. It is important that you accept the fact that you can listen and comprehend at this accelerated rate. There will be no distortion and no words will have been taken out to make the message more rapid.

At the end of the taped message you will be given a short comprehension test over the message content. Instructions for taking the test will be given later.

There are two important suggestions which will help you gain the most from a message compressed to less than normal listening time.

First--concentrate on the message content and attempt to ignore everything else.

Second--do not let the speed with which the words are coming to you be a distraction. Despite the rapid pace at which the words flow, you can comprehend the message. Numerous studies have already proven that people can comprehend speech which is accelerated considerably.

As an introduction to accelerated or compressed speech, you will now hear my introductory comments accelerated by 40 percent, or stated another way, you will hear my comments in just 60 percent of the original time.

(Two second pause)

Ready.

(Three second pause)

(Instructions repeated - compressed version)

(Three second pause)

You are now ready to listen to the taped message. Remember, the taped message will be presented in 60 percent of the original time.

(Two second pause)

Ready.

(Three second pause)

(Message)

(Three second pause)

APPENDIX C

INSTRUCTIONS FOR THE LISTENING COMPREHENSION TEST

INSTRUCTIONS FOR THE LISTENING COMPREHENSION TEST

This concludes the listening exercise.

The class proctor will now pass out the test booklets. Do not begin the test until told to do so.

(Tape stopped - three minute gap)

This is a timed test. You will have five minutes in which to answer questions 1-10. Please answer all questions on the answer sheet. If you complete your test in less than the time allotted, please remain at your testing station and review your test answers. Your test booklet and answer sheet will be picked up by the class proctor at the end of five minutes.

(Three second pause)

Ready.

(Two second pause)

Begin your test.

(Five minutes - testing time)

STOP.

VITA

George Edward Nipper

Candidate for the Degree of

Doctor of Education

Thesis: THE EFFECTS OF RATE OF PRESENTATION OF AUDIO TAPES UPON THE LISTENING COMPREHENSION OF FAST AND SLOW READERS

Major Field: Curriculum and Instruction

Biographical:

Personal Data: Born on July 28, 1945, in Magnolia, Arkansas, the son of Mr. and Mrs. J. E. Nipper.

Education: Graduated from Magnolia High School, Magnolia, Arkansas, in 1963; received the Bachelor of Science in Education degree from Southern State College, Magnolia, Arkansas, with a major in biology in August, 1967; received the Master of Science degree from Louisiana Tech University, Ruston, Louisiana, with a major in science education in 1971; completed requirements for the Doctor of Education Degree at the Oklahoma State University in May, 1976.

Professional Experience: Teacher of biology, chemistry, and general science at Vivian High School, Vivian, Louisiana, 1967-1969; biology teacher at Magnolia High School, Magnolia, Arkansas, 1969-1971; Assistant Professor of Education at Louisiana Tech University, Ruston, Louisiana, 1971-1976 (1974-1976 on leave); research graduate assistant, Oklahoma State University, Stillwater, Oklahoma, 1974-1975; teaching assistant in Curriculum and Instruction, College of Education, Oklahoma State University, Stillwater, Oklahoma, 1975-1976.