EFFECT OF RATE OF COMPRESSION AND MODE OF PRESENTATION ON THE COMPREHENSION OF A RECORDED COMMUNICATION TO JUNIOR COLLEGE STUDENTS OF VARYING APTITUDES

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EFFECT OF RATE OF COMPRESSION AND MODE OF PRESENTATION ON THE COMPREHENSION OF A RECORDED COMMUNICATION TO JUNIOR COLLEGE STUDENTS OF VARYING APTITUDES

DISSERTATION

Presented to the Graduate Council of the North Texas State University in Partial Fulfillment of the Requirements

For the Degree of DOCTOR OF EDUCATION

By

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Denton, Texas
June, 1970
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A problem common to most educational institutions is to identify effectual techniques for sending information across media with speed and reliability. The problem has been aggravated by an information explosion unparalleled in the history of human existence. Scientific experimentation and technological innovation has created a body of knowledge almost impossible to perceive and fully impossible to master.

The programmed learning center has earned credibility as a possible solution to some of the problems associated with the information explosion. Its effectiveness as an instructional media is dependent on the quality of the recorded communications within its repertory, and students' willingness to utilize the media. It is tenable to assume that willingness to utilize the media might be increased if time required for use were diminished.

It has been discovered that it is possible to shorten the time required for presentation of recorded messages without significantly affecting comprehension or seriously distorting pitch or quality. The technique is known as "speech compression."
Statement of the Problem

The problem of this study was to assess the desirability and practicality of utilizing compressed speech as an instructional technique within a junior college setting. More specifically, the problem was to determine the rate of compression and mode of presentation having the most favorable impact on the comprehension of a recorded communication to junior college students of varying aptitudes.

Three subproblems were also investigated. The first was to determine to what degree rate of compression could be increased without significant loss in comprehension. The second subproblem was to determine to what degree rate of comprehension could be increased with the simultaneous presentation of compressed speech and the printed page. Finally, an attempt was made to determine the effects of rate of compression and mode of presentation to students representing all levels of aptitude, low levels of aptitude, and high levels of aptitude.

Definition of Terms

1. Compressed speech was used to denote oral, tape recorded communications in which brief segments of the messages had been deleted without significant distortion in vocal pitch or quality, resulting in a reduction of the time required for presentation of aural messages by increasing the number of words delivered per minute.
2. Zero compression was used to indicate normal speaking rate, which is about 175 words per minute.

3. One-third compression was compressed speech requiring two-thirds of the original time for presentation, or about 262 words per minute.

4. One-half compression was used to denote compressed speech requiring half of the original time for presentation, or about 350 words per minute.

5. Audio-ocular denoted the addition of the printed page to match an aural message in order to add the factor of sight to a factual presentation and increase the number of communication channels from which a subject could receive information.

6. Test of comprehension was the number of correct number of responses to the comprehension test within the 1960 edition of the Nelson-Denny Reading Test, Form B.

7. Test of aptitude denoted the number of correct responses to the "Verbal Comprehension" section of the long form of the Guilford-Zimmerman Aptitude Survey.

8. All-levels group included all students involved in experiment minus those taken from study in order to provide constant mean aptitude within each of the experimental situations, minus those who indicated that they were unable to hear all of the selections, minus those who were absent from either the test of aptitude or test of comprehension.
9. **High-level group** included those students who, within their particular experimental condition, scored at or above the 67th percentile on the test of aptitude.

10. **Low-level group** was inclusive of those students who, within their particular experimental condition, scored at or below the 33rd percentile on the test of aptitude.

**Hypotheses**

The six hypotheses, stated below in the null form, were complemented with subhypotheses which were to have been tested in the event of rejection of respective hypotheses. The .05 level of significance was used as a basis for rejection of all hypotheses, and the .01 level was used as a basis for rejection of all subhypotheses.

**Hypothesis One**

There will be no significant difference between the test scores of all-level groups which heard and saw audio-ocular messages at each rate of presentation and the test scores of those all-level groups which only heard aural messages.

Subhypothesis 1a.--There will be no significant difference between the test scores of the all-levels, zero compression group which heard and saw audio-ocular messages and the test scores of the all-levels, zero compression group which only heard aural messages.
Subhypothesis 1b.--There will be no significant difference between the test scores of the all-levels, one-third compression group which heard and saw audio-ocular messages and the test scores of the all-levels, one-third compression group which only heard aural messages.

Subhypothesis 1c.--There will be no significant difference between the test scores of the all-levels, one-half compression group which heard and saw audio-ocular messages and the test scores of the all-levels, one-half compression group which only heard aural messages.

Hypothesis Two

There will be no significant difference between the test scores of high-level groups which heard and saw audio-ocular messages at each rate of presentation and the test scores of those high-level groups which only heard aural messages.

Subhypothesis 2a.--There will be no significant difference between the test scores of the high-level, zero compression group which heard and saw audio-ocular messages and the test scores of the high-level, zero compression group which only heard aural messages.

Subhypothesis 2b.--There will be no significant difference between the test scores of the high-level, one-third
compression group which heard and saw audio-ocular messages and the test scores of the high-level, one-third compression group which only heard aural messages.

**Subhypothesis 2c.**—There will be no significant difference between the test scores of the high-level, one-half compression group which heard and saw audio-ocular messages and the test scores of the high-level, one-half compression group which only heard aural messages.

**Hypothesis Three**

There will be no significant difference between the test scores of low-level group which heard and saw audio-ocular messages at each rate of presentation and the test scores of those low-level groups which only heard aural messages.

**Subhypothesis 3a.**—There will be no significant difference between the test scores of the low-level, zero compression group which heard and saw audio-ocular messages and the test scores of the low-level, zero compression group which only heard aural messages.

**Subhypothesis 3b.**—There will be no significant difference between the test scores of the low-level, one-third compression group which heard and saw audio-ocular messages
and the test scores of the low-level, one-third compression group which only heard aural messages.

Subhypothesis 3c.—There will be no significant difference between the test scores of the low-level, one-half compression group which heard and saw audio-ocular messages and the test scores of the low-level, one-half compression group which only heard aural messages.

Hypothesis Four

There will be no significant difference between the test scores of all-level groups which heard, or heard and saw uncompressed messages and the test scores of those groups which heard, or heard and saw compressed messages.

Subhypothesis 4a.—There will be no significant difference between the test scores of the all-levels, zero compression group which only heard aural messages and the all-levels, one-third compression group which only heard aural messages.

Subhypothesis 4b.—There will be no significant difference between the test scores of the all-levels, one-third compression group which only heard aural messages and the all-levels, one-half compression group which only heard aural messages.
Hypothesis Five

There will be no significant difference between the test scores of high-level groups which heard, or heard and saw uncompressed messages and the test scores of those groups which heard, or heard and saw compressed messages.

Subhypothesis 5a.—There will be no significant difference between the test scores of the high-level, zero compression group which only heard aural messages and the high-level, one-third compression group which only heard aural messages.

Subhypothesis 5b.—There will be no significant difference between the test scores of the high-level, one-third compression group which only heard aural messages and the high-level, one-half compression group which only heard aural messages.

Hypothesis Six

There will be no significant difference between the test scores of low-level groups which heard, or heard and saw compressed messages and the test scores of those groups which heard, or heard and saw uncompressed messages.

Subhypothesis 6a.—There will be no significant difference between the test scores of the low-level, zero
compression group which only heard aural messages and the low-level, one-third compression group which only heard aural messages.

**Subhypothesis 6b.**—There will be no significant difference between the test scores of the low-level, one-third compression group which only heard aural messages and the low-level, one-half compression group which only heard aural messages.

**Significance of the Study**

Junior college students in general possess an academic deficiency. In her assessment of the academic character of the junior college student, Cross (1) concluded that

... the mean score for students in four-year colleges exceeds that of students in two-year colleges, and that... the research demonstrating these facts is national in scope, unanimous in findings, and it is based upon a staggering array of traditional measures of academic aptitude (1, p. 11).

Jackson (3) found that students enrolled on the junior college campus where the present study was conducted were, on the average, some fifteen points below the national average on the Nelson-Denny Reading Test, Form A. Speegle (6) noted that those students were below the national average on the American College Test.

LeCroy (4) asserted that the deficiency reflected in traditional measures of academic aptitude does not necessarily reflect an inherent deficiency in academic ability. LeCroy (4)
contended that this deficiency might be overcome if students were instructed with more discretely selected media, and that compressed speech might have the potential for instructional effectiveness within the junior college setting.

Byrnes (2) stated that if...

... a student's experience and factual information bank is small, his potential for acquiring new concepts and information is small ... If through a faster, more efficient method, this factual information can be increased, the student's learning and success potential is increased (2, p. 1).

It was plausible to assume that compressed speech might have the potential to increase a student's chances for academic success.

Butz (5) reported that most educational experiences are predicated on the student's ability to read. If the student is unable to read,

... he cannot receive benefits from the educational experience that is provided, and the judgment is frequently made that those factors underlying his reading deficiency also militate his general success in the educational enterprise. However, there is a growing body of evidence to suggest that many ... who are poor readers are good listeners. This finding requires us to consider the possibility that such children might have made satisfactory progress in their education if their communication requirements had been given proper consideration. They have been doomed to failure because the "system" compelled them to use a poorly functioning channel of communication when a satisfactory channel was available (5, p. 3).

The findings of this study may have identified or suggested an effective instructional objective for junior colleges.
Delimitation of the Study

1. This study was limited to measuring comprehension of aural and audio-ocular stimulus materials by use of the test of comprehension previously defined.

2. A visual-only stimulus mode was not included in the experimental design.

3. Test subjects were limited to junior college students enrolled in freshman English composition classes during the initial semester of the 1969-1970 academic year.

Summary

The introductory chapter was to have established a succinct statement of the problem, and was to have defined important terms and concepts to be used in the study. Other purposes included an enumeration of hypotheses and subhypotheses, an explanation of the significance of the study, and the establishment of a frame of credibility for the affirmation or denial of hypotheses and subhypotheses.

The following chapters were designed for a number of purposes. Chapter two surveyed literature related to the historical perspective of compressed speech and research applicable to the present study. Chapter three was to have described the sample, measurement instruments, chronology of data collection, and statistical methods. Chapter four was designed to present, analyze, and discuss results, while the final chapter was to have summarized the study.
CHAPTER BIBLIOGRAPHY


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CHAPTER II

SURVEY OF THE LITERATURE

Introduction

Numerous attempts have been made during the past thirty years to reduce the time required for listening to recorded communications. It is only during the past few years, however, that intensive focus has been given to compressed speech, a technique (previously defined on p. 2) for mechanically shortening the time required for presentation of recorded communications without significant distortion in pitch or quality.

The relatively slow initial impetus of the concept of compressed speech (more thoroughly defined on pp. 15-16) requires that a historical perspective be synthesized prior to an examination of research more closely related to the present study.

Historical Perspective

Introduction

The initial segment of this chapter, the historical perspective, was developed through a three-phase organizational structure as follows: (1) research prior to
1951, (2) research from 1951 to 1960, (3) research from 1961 to the present.

**Research Prior to 1951**

**1940.**—Goldstein (21) reported that comprehension was significantly reduced when messages were presented at increased rates. He noted (21, p. 56) that the decline was progressive, particularly at the fastest rates, and that the lowest scores were obtained when a combination of difficult material and rapid rate were utilized.

**1948.**—Nelson (30) used five newscasters to record five different messages at five different rates. The slowest recording was at 125 words per minute, and the fastest at 225 words per minute. Nelson discovered (30, pp. 178-179) that rate was not a significant factor in recall, and that the level of difficulty was a significant factor.

**1950.**—Miller and Licklider (29) found that only portions of the speech signal were necessary for understanding. Utilizing a switching arrangement that permitted sporadic interruption of speech signals, Miller and Licklider discovered that intelligibility did not drop below ninety per-cent until half of the speech signal had been eliminated.
Research from 1951 to 1960

1953.—Recognizing the shortcomings of available methods of speech acceleration, Garvey (19,20) 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.

1954.—Kodman (26) 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 (?) published a description of an apparatus 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 (14), in describing the Fairbanks' apparatus, 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 noted (14) 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 rerecorded 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 (14, p. 2).

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 while the preceding head is just making contact with the tape, the segment of tape that is wrapped around the cylinder between these two heads never makes contact with a reproducing head and is therefore not reproduced. The segment of tape eliminated is always the same length, one quarter of the circumference of the cylinder (14, p. 2).

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.

1957.—Calearo and Lazzaroni (4) sought a definition of the relationship between speed of delivery and intensity
necessary for intelligibility. Calsero and Lazzaroni con-
cluded 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"
(4, p. 418).

1958.—Enc (6) reported the effect of two listening
rates on blind school children tested for learning and compre-
hension. He found (6) that practice increased listening
efficiency, and that the level of comprehension was accept-
able at either speed.

Research from 1961 to Present

1961.—With the advent of the 1960's, there was a
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 (14).
(see p. 16)
Utilizing the speed-changing method, Klump and Webster (25) made the following observations: These studies suggest that it is not the brain of the listener that is overloaded by the speech speedup. The limit is apparently set by the ability of the ear to decode the frequency shifted patterns and not by the speedup, per se. Even with the frequency shift plus speedup, a listener can be pushed 50% faster than normal in comprehending messages with but a relatively small sacrifice of intelligibility (25, 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 (17) 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 tape or record speed" (17, p. 4). Studies which utilized the speed-changing method were those by Fletcher (9), Foulke (10), Garvey (20), McLain (28), and Klump and Webster (25).

1965.—Still another method of compression was reported by Scott (36). Using a computer, he was able to discard certain segments of speech transduced to electrical form.

1966 to present.—Compressed speech, by the end of the 1960's, had become so significant that two national conferences had been held at the Center for Rate Controlled Recordings on the campus of the University of Louisville.
The Center, under the direction of Emerson Foulke, offered its services to groups and individuals wishing to have materials compressed or expanded. Too, the American Educational Research Association, in its 1969 conference in Los Angeles, devoted an entire section to the area of compressed speech.

**Recapitulation**

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 immediately following pages were designed to focus on literature more closely related, and to complement the first part of this chapter with the addition of other significant developments.

**Applicable Research**

This section of the review of the literature was organized into five areas, four representing separate dimensions of research and the other general related literature. The five areas selected were as follows: (1) research related to comprehension, (2) research related to rate of presentation, (3) research related to multi-media presentations, (4) research related to influence of aptitude, and (5) general related literature.
Research Related to 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 (8):

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 wpm, 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%, and to a sixth test-only condition in which no message was used (8, p. 18).

The curve of comprehension as a function of message time was characteristically sigmoid. Response was approximately 50% of maximum when message time was 40% (60% compression, 353 wpm). When message time was 50% (282 wpm), the response was slightly less than 90% and efficiency, response per time, was maximal. Analysis of variance indicated that time compression, listener aptitude and message effectiveness all affect factual comprehension significantly, and afforded evidence that interaction of time compression and message effectiveness in the expected direction is significant (8, p. 18).

Thus, Fairbanks, Guttman, and Miron (8) 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 (5) presented a taped recording to
matched groups, and found listening comprehension to be unaffected within the range of 125 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 a simple-recall type completion questions based on the lecture content, and a rating scale in which the delivery of the lecture was judged (5, p. 232).

Effect of method of compression.—The sampling method of compressing speech was previously differentiated from the speed changing method (see p. 17). McLain (28) 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 5 per-cent level of significance.

Foulke (10) 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 (11) 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 (12) 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 (12) 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" (12, p. 24).

Effect of practice.—A number of studies have sought to define the role of practice in the comprehension of compressed speech. Voor and Miller (42) 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 per cent level of confidence" (42, p. 454). Comprehension scores reached optimum level after a few minutes of exposure to compressed selections, indicating that practice increased subjects' ability to comprehend accelerated speech.

Orr and Friedman (33) tested the potential of compressed speech when presented under conditions of massed practice. Subjects practiced material seven hours each day for five consecutive days, and were tested each day for comprehension. Comprehension improved from a mean of about two-fifths of normal rate comprehension the first day to about seventy percent of normal rate comprehension on the final day (33, p. 6). Orr and Friedman commented, saying that "while effective, the
massed-practice procedure produced no better performance in a total of 35 hours of practice than previous experiments using spaced practice of 1-2 hr. per day produced in a total of 12-15 hr. of practice" (33, p. 6).

Previously, Orr, Friedman, and Williams (34) had divided thirty-six 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 (34) concluded that:

First, although controls may have been a slightly more able group, experimental 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 (34, p. 151).

Although there appeared to be a tendency for controls to be superior initially, there was no significant difference between experimental and controls at either the 175 wpm level or at the initial 475 wpm level. No significant difference existed between experimental and control groups at 325 wpm or 375 wpm. However, a sharply significant difference appeared at 425 wpm 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 (34, p. 151).

Thus, practice may produce an advantage when high levels of compression are used, while at the lower levels of compression there may not be as much advantage to be gained through the introduction of practice procedures.
Foulke (11) performed two experiments to evaluate training methods.

In one experiment, subjects were trained by listening to uninterrupted speech. One group listened at a constant high word rate while the other group 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 effectiveness of training was evaluated by comparing pre-training listening test scores with post-training test scores from equivalent test forms (11, p. 15).

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" (11, p. 15).

Effect on handicapped.—Foulke and others (15) tested the ability of blind students in understanding compressed speech. One literary and one scientific selection was compressed to create five speaking rates from 175 to 375 words per minute. Comprehension was measured through multiple-choice tests, and variation computed for the two-factor experiment. It was discovered that types of material and modes of presentation yielded significant variation and interaction. Braille readers experienced no significant loss in comprehension of material up through 225 words per minute, provided the literary selections were used. When scientific selections were used, there was no significant loss in comprehension through 275 words per minute (15, p. 141).
Effect of level of complexity.—Reid (35) presented compressed materials that differed in levels of grammatical complexity. Using the Nelson-Denny Reading Test, "Test of Comprehension," Reid rewrote the test to make two levels of difficulty. Reid (35) discovered a significant difference in comprehension scores in favor of the simplified version.

Recapitulation.—The review of the literature related to the concept of comprehension revealed three important concepts. First, while there was a loss in comprehension of compressed speech, the loss appeared insignificant up to about 280 words per minute. Secondly, naive subjects comprehended compressed speech without previous exposure, and best results were achieved when subjects were allowed to practice. Particularly was this manifested at the higher speeds. Finally, the type of material and level of complexity were variables having a significant influence on comprehensibility.

Research Related to Rate of Compression

Introduction.—Although the previous section was devoted primarily to the concept of comprehension, it included some ideas associated with rate of presentation as well. This section was designed to present studies especially concerned with rate of presentation.
Effect of rate.—One of the most intensive studies concerned with the effect of rate of presentation was reported by Foulke (13).

Twelve comparable groups of subjects heard a listening selection that differed, from group to group, with respect to word rate. Word rate was varied, in increments of 25 wpm, from 125 to 400 wpm, by means of the sampling method for compressing or expanding recorded speech. After listening to the selection, subjects were tested for comprehension by a multiple factor test. Comprehension was not seriously affected by increasing word rate from 125 to 250 wpm, 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 (13, p. 198).

Foulke’s results (13), because of the large number of word rates and subjects used for the study, provided a solid frame of reference to be used to determine the conditions necessary to promote rapid aural communication through compressed speech.

Foulke’s finding (13) that comprehension decreased rapidly beyond 250 words per minute was in conflict with previous findings. Fairbanks, Guttman, and Miron (8) found no decline in comprehension up to 275 words per minute. Previously, Foulke (15) had made a similar finding. In each of these two instances, however, there were fewer subjects and fewer rates of presentation.

Rate preference.—In order to determine the preferred listening rate of college students, Foulke and Sticht (16)
tested students 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" (16, p. 400).

Recapitulation.—An investigation of literature related to rate of presentation (8, 13, 15, 16) revealed that comprehension is acceptable up to around 250-275 words per minute. Thereafter, there is a rapid decline in comprehensibility. Moreover, the preferred listening rate may have been underestimated.

Research Related to Multi-media Presentations

Introduction.—A limited amount of research has been reported on the impact of a multi-media presentation on the comprehension of compressed speech. Nonetheless, information related to the single-channel concept, to simultaneous reading and listening, to simultaneous presentation of aural messages and pictorial embellishments, and to the formulation of a general concept of multi-media presentations was considered pertinent to this section of the review of the literature.

Single-channel concept.—The Broadbent (3) model implied that the perceptual system operates on a single channel when
it becomes overloaded. Furthermore, Broadbent (3) 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 characteristic 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 (3, p. 205).

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

Jester (23) used the Davis Reading Tests, presenting materials 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. Jester concluded that his results offered support for the concept that overloading the perceptual system would result in individuals selecting the one channel which seemed to be the more efficient.

Simultaneous reading and listening.—Kling and Reiland (24) 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, subjects listened to compressed speech while simultaneously reading the passages, 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.

Reporting exploratory research in multi-media presentation of highly speeded connected discourse, Orr (31) revealed that its use as a pacing procedure while reading produced a significant increase in reading speed without loss in comprehension. According to Orr, "these tentative findings, when confirmed by current work, may support the notion that the rate of processing of connected discourse is normally habituated but is trainable" (31, p. 874).

Simultaneous listening and pictorial embellishments—Loper (27) 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 three levels of compression. One hundred twenty-one students in seven groups were given a retest two weeks later.

Loper (27) 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 (27, p. 89) also concluded 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 (27) concluded that "visual augmentation of messages aids in the retention of information when the messages were originally presented at high rates of compression" (27, p. 89).

Boyle (2) designed a study 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, he discovered that these variations did not produce significant differences in listening recall. Boyle (2) 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 (1) 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. Anderton (1) 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 (1, p. 2).

Anderton (1) concluded that pictorial embellishments were not worth the time and expense of preparation, and that "considering the amount learned and time involved, the repetition of messages at 300 words per minute did not appear to be beneficial" (1, p. 3).

**General concept of multi-media presentations.**—Travers (41), after observing students receiving information through hearing alone, through vision alone, and through both vision and hearing, 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 began 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 (41, p. 376).

Travers (41) 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" (41, p. 376). The time required for switching seems to be "time out from learning" (41, p. 376).

Recapitulation.—The immediately preceding literature (1, 2, 3, 23, 24, 27, 31, 41) related to the presentation of multimedia presentations revealed that while only a limited amount of research is available, multi-media presentations caused subjects to select one channel for input of high speed presentations, and caused subjects to block the other input channel. The concept emerged that practice may have the potential to train individuals to receive information through more than one channel.

Research Related to Influence of Aptitude

While the immediately preceding material dealt primarily with multi-media presentation, this section was designed to report only those studies revealing the influence of subjects' aptitude on comprehension of compressed speech. Two studies emerged which had specific implications, for their central dimension was aptitude.

Sticht (38) test Army inductees who had been trichotomized into three mental aptitude categories: (1) low, (2) high, and (3) medium. Each of these categories was split into three groups to create nine experimental conditions
representative of three levels of aptitude and three rates of presentation. Sticht (38) found that increasing the rate of compression had a greater disrupting effect on those with high mental aptitude than those of low mental aptitude. However, the low aptitude subjects performed more poorly than higher aptitude subjects when listening to normal and compressed speech. Sticht (38) concluded that since "the low aptitude men also perform poorly on the reading test, it seems likely that some general language deficiency may account, at least in part, for their performance" (38, p. 253).

Friedman and Johnson (18) studied correlates of ability to listen to compressed speech. They found that the "Space Relations" subtest of the Differential Aptitude Test Battery and the "Phonetic Script" section of the Modern Language Aptitude Test to be less reliable than the Best Trend Name Test in predicting subjects' ability to comprehend compressed speech (18, p. 207).

General Related Literature

The average college student, according to Smith and DeChant (37), reads at 280 words per minute and is capable of reading at about three times this rate. A large number of devices have been marketed which will supposedly improve speed of reading, most of them based on attempts to train eye movements. The trade names of some of these devices are "Controlled Reader," "Reading Accelerator," "Reading
"Rate Controller," "Rate Reader," "Reading Board," and "Harvard Reading Films." All, according to Tinker (40, p. 607), are successful in increasing the reading speed of many pupils. Most of these techniques, according to Stolarz (39), train the eye to make fewer pauses per reading line. No aural or audio-ocular devices to improve reading, other than instructional recordings, were found.

While these devices may be successful in increasing reading speed of many pupils, Harris (22) contends that:

The relationship of rate to comprehension has been a subject of research interest for several decades. It has become evident that correlations between the two vary according to the group tested, the kinds of reading matter used, the measuring instruments, and the purpose for reading; most correlations have been positive but quite low. Although flexibility in reading has been stated as a desirable objective for many years, research shows that most people are relatively inflexible in their ways of reading . . . . Conventional programs which aim at improving rate generally produce moderate gains in rate with no significant changes in comprehension (22, p. 259).

Smith (37), summarizing his review of literature related to reading rate and comprehension, concluded that mechanical devices are highly effective as motivating techniques, and that a valid appraisal of increase in "reading rate must be based upon increase in amount comprehended" (37, p. 236).

Summary

The preceding survey of literature was synthesized through a two-phase organizational structure. After a
chronologically structured historical perspective, applicable research was presented as it applied to comprehension, rate, multi-media presentations, aptitude, and general related literature. The following chapter, Chapter III, was designed to describe the methods and procedures for collecting and treating the data.

Orr (32), in summarizing the significance of compressed speech, stated:

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 processing provides a degree of control over a dimension of human 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. Each individual student likewise has a greater need for appropriate education to take a useful place in an increasingly complex and technical society (32, p. 291).
CHAPTER BIBLIOGRAPHY


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CHAPTER III

PROCEDURES FOR GATHERING AND TREATING THE DATA

Introduction

While the initial two chapters were designed to introduce the study and relevant literature, Chapter III was designed to explain the procedures for gathering and treating the data. In order to achieve this goal, a five-point organizational sequence was established as follows: (1) a description of the sample, (2) an explanation of the test of aptitude, (3) explanation of the test of comprehension, (4) chronology of data collection, and (5) report on the statistical treatment of the data.

Description of the Sample

Origin of Subjects

Subjects were taken from English composition classes on a junior college campus within a large urban area. After the elimination of the night sections due to wide differences in students' ages, experiences, and educational background, twenty-two classes ranging in size from twenty-three to thirty-two were available.

Since the original plan called for the utilization of eighteen sections, it was necessary to eliminate four of
the twenty-two sections. Meredith's (3) "Table of Random Numbers" was utilized to effect this elimination requirement.

After the eighteen sections had been selected, the same table was again utilized, this time to determine treatment condition. Three sections were assigned to each of six different treatment conditions as follows: (1) aural-only, zero compression, (2) aural-only, one-third compression, (3) aural-only, one-half compression, (4) audio-ocular, zero compression, (5) audio-ocular, one-third compression, and (6) audio-ocular, one-half compression.

None of the students had been encouraged to sign for a particular English section. No factors, other than those previously stated, predicated subject selection or treatment condition.

Elimination of Subjects

The eighteen sections varied in size from twenty-three to thirty-two students, creating a total of 509 students. All of these students were of freshman standing, and enrolled in a required undergraduate class in English composition during the fall semester of the 1969-1970 academic year.

Certain subjects were eliminated from each treatment condition for one or a combination of reasons. Table I was structured to reveal reasons for elimination of these subjects, and structured to reveal numbers eliminated from each type of treatment condition.
TABLE I

SUBJECTS ELIMINATED FROM POPULATION SAMPLE BECAUSE OF ABSENTEEISM OR INABILITY TO HEAR ALL OF STIMULUS MESSAGES, CLASSIFIED ACCORDING TO TREATMENT CONDITION AND CLASS SECTION

<table>
<thead>
<tr>
<th>Treatment Condition</th>
<th>Class Section</th>
<th>Initial Class Enrollment</th>
<th>Number Absent From Test of Aptitude</th>
<th>Number Absent From Test of Comprehension</th>
<th>Number of Subjects Who Could Not Hear</th>
<th>Remaining Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aural-only, Zero Compression</td>
<td>1</td>
<td>28</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>23</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>29</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>Aural-only, 1/3 Compression</td>
<td>1</td>
<td>24</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>26</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>32</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>23</td>
</tr>
<tr>
<td>Aural-only, 1/2 Compression</td>
<td>1</td>
<td>31</td>
<td>0</td>
<td>5</td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>32</td>
<td>2</td>
<td>7</td>
<td>2</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>30</td>
<td>0</td>
<td>1</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>Audio-ocular, Zero Compression</td>
<td>1</td>
<td>30</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>30</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>Audio-ocular, 1/3 Compression</td>
<td>1</td>
<td>29</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>28</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>24</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>22</td>
</tr>
<tr>
<td>Audio-ocular, 1/2 Compression</td>
<td>1</td>
<td>30</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>25</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>30</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td>..</td>
<td>509</td>
<td>11</td>
<td>39</td>
<td>30</td>
<td>429</td>
</tr>
</tbody>
</table>
As indicated in the previous table, eleven of the 509 students were absent during the test of aptitude, and thirty-nine were absent during the test of comprehension. Moreover, thirty students stated that they were unable to hear all of the recordings during the test of comprehension. All of these students were eliminated from the sample, thus creating a final total of 429 participating students.

Description of Refined Population Sample

The refined population sample consisted of six treatment conditions, each composed of members of both sexes. Table II was structured to reveal the number of subjects within each treatment condition and to give distribution of sexes within each treatment condition.

TABLE II

NUMBER OF SUBJECTS WITHIN REFINED POPULATION SAMPLE, CLASSIFIED ACCORDING TO SEX AND TREATMENT CONDITION

<table>
<thead>
<tr>
<th>Treatment Condition</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aural-only, Zero Compression</td>
<td>40</td>
<td>36</td>
<td>76</td>
</tr>
<tr>
<td>Aural-only, One-third Compression</td>
<td>43</td>
<td>25</td>
<td>68</td>
</tr>
<tr>
<td>Aural-only, One-half Compression</td>
<td>40</td>
<td>23</td>
<td>63</td>
</tr>
<tr>
<td>Audio-ocular, Zero Compression</td>
<td>46</td>
<td>34</td>
<td>80</td>
</tr>
<tr>
<td>Audio-ocular, One-third Compression</td>
<td>47</td>
<td>26</td>
<td>73</td>
</tr>
<tr>
<td>Audio-ocular, One-half Compression</td>
<td>49</td>
<td>20</td>
<td>69</td>
</tr>
<tr>
<td>Totals</td>
<td>265</td>
<td>164</td>
<td>429</td>
</tr>
</tbody>
</table>
As indicated in Table II, there were 164 female and 265 male students within the refined population sample. Treatment groups ranged in size from 63 to 80, with a mean number of 71.5 per group.

The mean age of these 429 students was 20.5 years, with a median age of 19.0 and mode of 19.0. The ages ranged from a low of 17 to a high of 44. Two-digit numbers representing subjects' ages to their nearest birthday were the raw scores used to compute these results.

Most subjects confirmed their possession of a high school diploma. Only 18 of the subjects indicated that they were attending college by virtue of a high school equivalency certificate.

Test of Aptitude

Description of Guilford-Zimmerman Aptitude Survey

The Guilford-Zimmerman Aptitude Survey, a seven-part test for grades nine through sixteen and adults, was structured in seven parts. According to Buros (1), the seven factors included: (1) mechanical knowledge, (2) spatial visualization, (3) spatial orientation, (4) perceptual speed, (5) numerical operations, (6) general reasoning, and (7) verbal comprehension.
According to Guilford (2), each of these tests was designed to measure a different aptitude factor or primary mental ability. Guilford (2) stated that

The preference for a differential aptitude battery that is based upon the rational approach of factor theory and on empirically established factors is attributable to several considerations. The factor concepts are meaningful and dependable, as well as being broadly applicable. Factor tests provide a broad coverage of human traits in a very economical manner. They provide both for highly valid, weighted combinations of scores for predicting success in particular activities and for the basis for differential prediction (2, p. 219).

Affirming the factor of verbal comprehension as dominant in all tests of verbal intelligence, Guilford (2) asserted that this factor was best measured by a recognition-vocabulary test.

Description of "Verbal Comprehension" Section

The "Verbal Comprehension" portion of the Guilford-Zimmerman Aptitude Survey is a seventy-two item, multiple-choice vocabulary test with five alternative answers. "Answers are of the same level of commonness as the stem word, as indicated by the Thorndike-Lorge list. A wide range of difficulty is presented among the items" (2, p. 220). The test required approximately five minutes instructional time, and twenty-five minutes working time.

The "Verbal Comprehension" section of the Guilford-Zimmerman Aptitude Survey, selected for its ability to differentiate between subjects of high and low aptitude,
possessed an odd-even reliability estimate of .96. The approximate factorial-validity, according to Guilford and Zimmerman (3), was .80.

Vernon (8) stated that the test of aptitude seemed suitable for experimental use, and that the sections used to measure verbal comprehension and general reasoning were likely the most useful sections in the battery.

Moreover, the test of aptitude conformed to the time limits imposed. The publisher was willing to give permission for use of the test.

Finally, the test of aptitude had the advantage of factorially pure scores. Guilford and Zimmerman (3) stated:

Factors are known by the tests that have them in common. Tests measuring verbal comprehension have in common the number factor, a facility in using numbers. When each of these factors is measured by a test that is unique for that factor, we know rather definitely what the score means. On the other hand, if a single test measures two factors, e.g., both verbal and number abilities, each to a moderate degree, when an individual makes a better-than-average score in the test, we do not know whether he is possibly very high in either verbal or numerical ability and is below the average in the other, or whether he is possibly equally good and better than the average in both. For the clearest interpretations of test results, univocal or factorially pure scores are most important (3, p. 1).

Test of Comprehension

Introduction

To explain the test of comprehension, a three-fold organizational structure was created as follows:
(1) general description, (2) description of "Comprehension" section in particular, and (3) synthesis of recorded form.

General Description

The Nelson-Denny Reading Test, available in equivalent forms, was used in recorded form as the test of comprehension. A two-part test yielding scores for vocabulary, comprehension, and rate, the Nelson-Denny Reading Test was designated as being suitable for grades nine through sixteen and adults. Included in the test was a 100-item vocabulary section and a 36-item reading comprehension section, both of the traditional multiple-choice type with five alternative answers.

Since some students within the population sample were later to be tested by "Form A" of the Nelson-Denny, "Form B" was selected for use in the experiment. Only the "Reading Comprehension" section, in recorded form, was utilized for the experiment.

Description of Comprehension Subtest

A number of factors were responsible for the selection of the "Reading Comprehension" subtest of the Nelson-Denny. First was the absence of any test specifically designed to test listening alone, or both listening and reading. The experimental requirements called for a test which was not available from any known source.

The "Reading Comprehension" subtest of the Nelson-Denny was found suitable for recording and ultimately for the
experimental requirements. It was suitable to the imposed
time limits, and was available in an equivalent form that
would provide increased flexibility for future research.

According to Orr (6),

The test shows evidence of careful construction . . . .
in spite of certain defects, this test is one of the
better of its kind and represents a useful improvement
of an already useful test . . . . In general, the test
may be expected to provide useful information at a
reasonable cost and will doubtlessly continue to find a
place in the test user's repertoire (7, p. 1078).

The revision of the comprehension subtest, according to the
test authors, permits "an increase in range of difficulty,
a closer equating of the two forms, an improvement in validity,
and a lessening of difficulty" (5, p. 25).

As a final and important point, the publisher was willing
to permit the test to be used in compressed form. One of the
restrictions was that the research be completed prior to
December 31, 1970, and that each tape should carry a spoken
reference to the fact that the material was reproduced through
permission of the copyright owner, Houghton Mifflin Company,
Boston. It was also agreed that the material would be used
exclusively for research, and that no person participating in
the research project would be charged any fee for any purpose.

The combination of the above factors influenced the
selection of the Nelson-Denny "Comprehension" subtest as the
test of comprehension. It was then necessary to make certain
modifications of the test in order to make it suitable to the
experiment. Note that the content was never modified.
Synthesis of Modified Form

Introduction.—Synthesis of the test of comprehension was in five parts: (1) preparation of aural stimulus messages for both modes of presentation, (2) preparation of instructional messages, (3) integration of stimulus messages with instructional messages, (4) evaluation of integrated messages, and (5) preparation of visual materials.

Preparation of stimulus messages.—The preparation of materials for both modes of presentation began with the compression of the seven separate messages within the Nelson-Denny "Reading Comprehension" subtest. The passages were recorded in the studios of the Center for Rate Controlled Recordings at the University of Louisville by a professional reader at fifteen inches-per-second on a seven-inch reel. The normal rate recording was free from errors in content, diction, and pronunciation, and no significant distortion or external noise was detectable.

In addition, another normal rate recording was created for use as an introductory message. The initial recording was four-minutes in length to accommodate the requirement for three introductory messages, each two minutes in length. With this capacity, the four-minute recording was suitable for use at all levels of compression.

The paper used for the stimulus message was a graduate research paper entitled "The Effect of Television on Politics,"
and contained an introduction followed by documented supporting material explaining the effects of television on the political candidate, party machinery, and the citizenry. While only the initial section concerning the effects on the political candidate was necessary for the experimental requirements at one-half compression, the entire section was compressed at one-third and later was edited for use at one-third compression.

The completed recording was free from significant distortion or external noise. It is also important to note that the completed recording was generally free from errors in content, diction, or pronunciation.

The seven passages and the introductory messages were then compressed at the Center for Rate Controlled Recordings at the University of Louisville on a compressor of the Fairbanks' type. Compression was at one-third and one-half, and was supervised by a technician experienced in compression technique. The process resulted in a final product of four 1800 foot, seven-inch reels on Realistic professional recording tape, type 150-16. The tapes were mylar and 1.0 mil. One of the tapes contained the introductory message at zero, one-third, and one-half compression. The other three tapes each contained the Nelson-Denny comprehension readings at each level of compression.
Preparation of instructional messages.—The next step in the preparation of aural materials was the synaersis of instructional messages. Since the subjects were to be wearing headphones during the presentation of the stimulus materials, verbal instructions by a reader during testing was rejected in favor of recorded instructions to be programmed into the taped stimulus materials. Too, this approach offered additional control of variables that would have otherwise been introduced through the presentation of like instructions in a number of different testing periods.

Since the audio-ocular mode of presentation (simultaneous presentation of aural message and written manuscript) required different instructions, two sets of instructional information were prepared. The first set prepared was for the aural-only treatment conditions.

The aural-only instructions began with an admonition for the subjects to raise their hands to confirm that they could hear through their headphones. Subjects were then told to adjust the volume knob in front of them for the best hearing conditions. Afterwards, it was explained that the study would in no way affect their class grade, and they were told to listen carefully and to follow instructions.

After being informed of the forthcoming introductory message and the presentation of the two-minute communication, subjects were informed that additional similar messages would
be presented. Instructions were then given on the procedures for aligning and marking the answer sheet. Students were asked to guess on answers if necessary, and to sit quietly should they finish answering questions before other messages began.

Subjects were then instructed to turn to page five and to align their answer sheet. After the presentation of the first message, subjects were told to answer the questions to part one. Each of the remaining parts was characterized by instructional statements designed to prepare them for each passage and admonish them to answer the questions following each passage.

The final part of the instructions requested students' filling out of a brief questionnaire on the side of the answer sheet and confirming that some answer had been given to all questions. Too, a reference was made, at the appropriate place, to the fact that students had used all the time allowed for the test, and that they should fill out the questionnaire and leave all test papers and other materials on their carrel. Students were thanked for their participation.

The instructional set for the audio-ocular groups was, in almost all respects, similar to the instructional set for the aural-only groups. In addition, students were informed prior to the presentation of the introductory message that they would find a loose copy of the first test message just
inside their booklet. They were asked to try to read the passage from the printed page as they heard it over the headphones. Subjects were told to continue the practice of reading what they were hearing as each message was presented.

Beginning with the presentation of part four of the test of comprehension, students were asked only to proceed as before. Beginning with the presentation of part five, the audio-ocular instructions were identical to the aural-only instructions. Hence, the instructions recorded for the audio-ocular were reproduced from the same tape used for the aural-only groups, beginning with the presentation of segment five.

Instructions were recorded by a different reader than the one used for the stimulus messages in order to provide a clear contrast in voice. The instructions were taped on an Ampex 440 console recorder in a professional studio. Several tapes were made, and the one aural-only and the one audio-ocular instructional set which matched best in terms of timing and voice inflection was selected for use in the experiment.

Integration of stimulus messages and instructions.— The final combination of the aural stimulus materials was effected through the use of two Ampex 600 professional recorders and one Ampex 440 console recorder. Using the
console to make the final stimulus tapes, a professional technician synthesized the materials.

The instructional tape, introductory message, and test of comprehension were dubbed to create the master tapes. Each of the six master tapes resulting represented two modes of presentation and three levels of compression.

Each of the tapes contained ten pause periods. The first was a five second pause to give time to the test examiner so that he could confirm each subject's ability to hear. The second pause was a sixteen second pause to give subjects time to turn to the appropriate page and align their answer sheet at the beginning of the stimulus messages. The following pauses were after each stimulus message to give subjects time to answer the test questions.

The first message contained eight questions while the remaining messages each had four questions for a total of thirty-six questions. Fifteen seconds was allowed to answer each question, providing a requirement for an initial pause of two minutes and seven subsequent pauses of one minute each in duration. All pause times were verified by stopwatch.

The level of compression as well as the mode of presentation influenced the length of each of the treatment conditions. As compression increased, time decreased, and audio-ocular messages required more time than did aural-only messages as indicated in Table III which follows.
TABLE III
LENGTH OF AURAL-ONLY AND AUDIO-OCULAR RECORDINGS, CLASSIFIED ACCORDING TO LEVEL OF COMPRESSION

<table>
<thead>
<tr>
<th>Level of Compression</th>
<th>Aural-only</th>
<th>Audio-ocular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero</td>
<td>26 Minutes</td>
<td>26 Minutes, 30 Seconds</td>
</tr>
<tr>
<td>One-third</td>
<td>22 Minutes</td>
<td>22 Minutes, 30 Seconds</td>
</tr>
<tr>
<td>One-half</td>
<td>20 Minutes</td>
<td>20 Minutes, 30 Seconds</td>
</tr>
</tbody>
</table>

As indicated in the table above, the messages varied from twenty minutes to twenty-six minutes and thirty seconds. Each audio-ocular message was exactly thirty seconds longer than aural-only messages at the same level of compression.

Evaluation of integrated stimulus/instructional tapes.—Each of the master tapes was evaluated by a skilled observer and a professional technician. Although some chatter had been created by the compression process and slight distortion created during switching, it was believed that each of the tapes was comparable to the others and that all were of reasonably high quality. There did not appear to be a significant loss in quality due to the dubbing process itself.

Preparation of visual materials.—After preparation of the aural stimulus materials, it was necessary to prepare the
visual materials. This process involved the preparation of the introductory message manuscript, the answer sheets, and the test booklets.

The introductory message manuscript was typed on a portable Smith-Corona Coronet Electric typewriter with pica type, using eight and one-half by eleven inch white paper. Copies were made through a lithographing process, and the final copy was two pages in length, single spaced. The pages were stapled together in the upper left-hand corner, and were checked for quality and uniformity of print.

The answer sheet used for the test of comprehension was IBM form 1100 B 6005-2. It was modified somewhat by first cutting one inch from the left-hand side, creating a seven and one-half by eleven answer sheet and providing for an eight and one-half by eleven inch opaque white backing with exposed questionnaire.

The backing sheet was used to provide the desired questionnaire, and to prevent confusion between the comprehension and vocabulary test, the latter of which was not used. The final product was an answer sheet blank on one side with questionnaire and answer spaces on the eight and one-half by eleven inch facing. The questionnaire called for name, sex, college class, date of birth, and the answer to the question, "Were you able to hear all of the recordings?"
Also included was an admonition not to write in the section until completion of the test answers. These modifications neither antagonized nor omitted arrows on the answer sheet used for alignment with questions in the test booklet.

The Nelson-Denny test booklet was also modified to meet the requirements of the experiment. First, directions for the comprehension test were covered with eight and one-half by eleven inch lithographed paper giving directions for the subjects. The directions were printed on the right half of the cover page, and told the students not to turn a page until directed to do so. Next, they were to place the headphones in front of them in proper position. Finally, there was a statement telling them to listen for the test to begin and another asking them to make no marks in the test booklet.

Modifications inside the test booklet included the placement of white mail labels over directions not to stop, labels that included directions for the subject to stop and not turn the page until directed to do so. A blank label was used in each booklet to cover a specification of a twenty-minute time limit on page five and other directions not applicable at the bottom of page nine.

The Nelson-Denny test of comprehension was inclusive of reading materials on the left half of each page and questions on the right half of each page. The left half was severed by a paper cutter for use in the aural-only stimulus mode.
The test was left in original form for use with the audio-ocular stimulus mode. With the completion of the test booklet modifications, both aural and visual materials were ready for the experiment.

Recapitulation

To explain the test of comprehension, a three-fold organizational structure was followed. After a general description of the Nelson-Denny, the "Reading Comprehension" subtest and its synthesis in modified form was explained.

Chronology of Data Collection

Introduction

There were three steps in the chronology of data collection: (1) initial preparations, (2) administration of test of aptitude, (3) administration of test of comprehension.

Initial Preparations

During the summer of 1969, permission was secured from appropriate college officials, including the Chairman of the Department of English, to secure data from freshman composition classes during the fall term of the 1969-1970 academic year. One restriction was that the research would take no more than two class periods and that it would be completed during the first week of classes.

During the fall staff orientation period one week prior to registration, English teachers were given a thorough
explanation of the proposed study. The explanation included information concerning the purpose of the study, procedures for administering the tests, and the possible implications the study might ultimately have for their students.

Each staff member teaching freshman composition agreed to permit use of his class or classes for testing purposes. The eighteen sections used were taught by eight different teachers, including one part-time teacher. Four of the sections were taught by the same teacher, and two of the sections were taught by teachers teaching only one sampled section.

Staff members were instructed to say nothing about the test other than to announce the time and place where testing was to be performed. Testing was begun on the morning of September 17th and was completed the morning of September 23rd, the former date being the third day of classes and the latter date the seventh day of classes.

Monday-Wednesday-Friday sections required two class periods for testing, while those sections which met on a Tuesday-Thursday schedule were given the tests of aptitude and comprehension during a single class period.

Administration of the Test of Aptitude

To administer the test of aptitude, a college graduate with testing experience was selected. The tests were then administered in the classrooms where the subjects regularly
met their class in composition. Each of the six rooms was similar in construction and size. Construction was such that most external noises were sufficiently attenuated to prevent interruption of thought because of outside noise during the testing period.

Efforts were made to keep the testing procedures as constant as possible from group to group. Answer sheets and pencils were on the desks when the students arrived. At five minutes after class was to begin, test booklets were distributed and no others were admitted.

The test of aptitude was almost self-administering. Subjects were told to read the instructions for themselves, and were given a subsequent opportunity to ask questions concerning the directions. In some instances, further clarification was necessary.

Explanations were limited to a discussion of the instructions. Instructional time varied from three to five minutes, while working time remained constant at twenty-five minutes for each of the aptitude test periods.

Subjects were requested to respond to a questionnaire calling for their name, sex, and date of birth, together with an indication as to whether the subject held a high school diploma or certificate of equivalency. The answer sheet used was IBM form 100 A 1493.
Administration of Test of Comprehension

Personnel.—To administer the test of comprehension, a team of three was used. One was responsible for all verbal interaction with subjects. A technician was primarily responsible for periodic equipment checks. A student distributed and gathered materials, and stayed just outside the door during testing to make certain there were no interruptions during the test of comprehension.

Test site.—All tests of comprehension were administered in the Language Laboratory within the Programmed Learning Center of the junior college where the subjects were enrolled. The room was sufficient in size to accommodate thirty carrels forty-eight inches high by thirty inches wide by thirty inches deep, and arranged in two rows of eight carrels and two rows of seven. Also in the center was an instructor's console unit and two twenty-one inch screen television monitors. The center, which had one entrance at the rear, was carpeted.

Student carrels.—Each of the student positions was of all metal framework with acoustical partitions and a desk top covered with formica type laminate. Each acoustical panel was equipped with an acoustical core of two fiberglass bats separated by a solid fiberboard center. At least one-fourth of the paneled area was perforated. Desk tops were
twenty-eight and one-half inches wide by twenty and one-fourth inches deep by three-fourths inches thick. The front panel of each carrel was constructed of laminated safety glass, and had a decal indicating the carrel number.

Each booth was equipped with headphones, channel selector, and volume control. The earphones were a headphone and microphone combination consisting of a headset with a dynamic microphone mounted on a single headband. The headphone contained low-impedance elements, and was capable of producing a maximum of twenty-five decibels noise attenuation by virtue of its filled vinyl covered ear cushions (7).

The channel selector provided for multiple selection of input, but was of no use to subjects since the selection of any channel from any carrel would connect with the stimulus message. The volume control was adjustable between a sixty-five to eighty-five decibel level.

Instructor's console.—The instructor's console panel was equipped with one contact function switch for each student, arranged, numbered and patterned to correspond to the student seating layout of the center. The panel contained a three-inch color calibrated volume unit meter, key-operated master switch and pilot light, and was flush mounted in the center section of the instructor's console desk.

The panel had the capability of instructor control for all lesson sources to individuals or rows of students. It
also provided the capability for the instructor to distribute any one lesson source to the entire class by means of one switch, regardless of the lesson selection of the student's carrel unit (8).

Included in the instructor's console were two tape record-playback program sources consisting of a tape transport and amplifier, both of the Instructomatic brand. The tape transport was half-track and three-speed, complete with a four digit push button resettable counter, tape runout safety switch, pause control, and three motors. It was equipped with a record interlock to prevent inadvertant erasure. The amplifier was fully transistorized with a playback distortion of less than one per-cent at zero level (8, p. 7).

**Procedures antecedent to test of comprehension.**—Administering the test of comprehension required a constant set of procedures prior to, during, and after the tests. Antecedent to the testing of each respective section was an equipment check and a materials check.

The equipment check commenced with an examination of the stimulus tape, first to confirm the selection of the appropriate stimulus message and afterwards to determine if controls were properly set for transmission. Each tape was sampled at various points and volume readings taken and volume level adjusted to insure that there would be as little difference
as possible between groups because of output level. While
the tape was being transmitted, each receiver was set at a
common volume setting and was checked to confirm audio
reception. Headsets were then placed on hooks, each in
similar positions, and the tape was cued for the forth-
coming test of comprehension.

Concurrent with the equipment check was a materials
check. Each carrel was to have been supplied with two
marking pencils, test questions, and answer sheet. In
addition to these items, printed messages to match the aural
messages were supplied for the audio-ocular groups. The
materials check confirmed the existence of these materials
at each station and the absence of any marks in test
booklets previously used.

Procedures concurrent with test of comprehension.--
Students entered the Language Laboratory in a group, and were
free to select any one of the available booths. As soon as
all students had entered, they were informed by the examiner
to read the directions on the top sheet of their materials.
After two minutes, the examiner activated the aural stimulus
materials and remained seated at the console throughout the
test of comprehension.

During the sixteen-second pause used for subjects to
confirm their ability to hear, the examiner noted that all
students in all sections indicated that ability by a raised
hand. The examiner did not manipulate any of the console controls during the examining periods. The examiner noted only four subjects attempting to record answers after time for the test had elapsed, but did not permit them to do so.

**Procedures after test of comprehension.**—After having completed the test of comprehension, students exited without removing any materials from their student positions. Answer sheets were gathered and then placed in an envelop identifying class section and treatment condition. When the final test of comprehension was completed, data collection was also complete.

**Recapitulation**

To give the chronology of data collection three segments were utilized in the organizational sequence: (1) initial preparations, (2) administration of the test of aptitude, and (3) administration of test of comprehension. The following section was structured to give the statistical treatment of the data.

**Statistical Treatment of the Data**

**Introduction**

The examination and treatment of the data involved a three-phase structure: (1) manual tasks performed to prepare data for computer processing, (2) computer tasks performed
to permit testing of hypotheses, and (3) computer tasks performed to gather supplementary data.

**Manual Tasks**

Manual tasks included the scoring of answer sheets, and the transferring of data to keypunch worksheets. All answer sheets were hand-scored and double-checked for accuracy, with the score being representative of the correct number of responses to the respective tests. No correction was made for guessing.

The subjects within each respective treatment condition were divided into thirds, each third representing either high, medium, or low aptitude subjects. In some instances, this procedure did not result in an even split, and subjects were categorized into aptitude levels with unequal numbers but with a range of only one point.

Data were then transferred to keypunch worksheets which provided for the recording of scores on the tests of aptitude and comprehension, plus an indication of aptitude level, treatment condition, age, sex, subject number, and whether the subject was a high school graduate or holder of a certificate of equivalency. Entries were twice reviewed.

The worksheets were delivered to a computer center where data processing was to punch data on IBM program cards. Punched cards were verified through use of the center's verification equipment and personnel.
Computer Tasks

In order to test null hypotheses one through six which predicted no significant variation due to rate of compression or mode of presentation, data were processed on an IBM 1620 computer programmed for a two-way analysis of variance for unequal cells. The process yielded three F-ratios for each of the three aptitude groups, ratios representative of variation due to rate of compression, variation due to mode of presentation, and the interaction effect. The levels of significance for the F-ratios were obtained from the tables of Williams (9, p. 171).

A Fisher t test for testing hypotheses about differences between means was used to test all subhypotheses, null subhypotheses which predicted no significant differences between specific treatment groups of certain aptitude levels. In contrast to the .05 level of significance used to test the hypotheses, the .01 level was used to test all subhypotheses.

Since the hypotheses included all-level, high-level, and low-level aptitude groups and omitted the medium-level aptitude group, it was decided that the same data would be gathered for the medium-level aptitude group in order to supplement and complement the results. A decision was also made to assess the value of the test of aptitude in predicting scores on the test of comprehension. Pearson's Product Moment Correlation formula was utilized to achieve this end, and correlations were processed for each of the six
treatment conditions. The .05 level of significance was used to assess the correlations.

Other supplementary data collected and assessed was concerned with determining the significance of differences in certain means as follows: (1) comparison of audio-ocular, zero compression mean with audio-ocular, one-third compression mean, (2) comparison of audio-ocular, one-third compression mean with audio-ocular, one-half compression mean. Fisher $t$ tests were run for all aptitude levels, including the all-level, high-level, medium-level, and low-level groups. This procedure resulted in eight additional $t$ scores as a part of the supplementary data.

Recapitulation

With the completion of manual and computer tasks, the processing of the data was complete. Results were ready for analysis and interpretation.

Summary

The purpose of this chapter was to detail the procedures for gathering and treating the research data. First, the subjects and their selection were described. This description was followed by an explanation of the measurement instruments (the test of comprehension and the test of aptitude,) the chronology for data collection, and a report on the examination and treatment of the data.
The following chapter, Chapter IV, is designed to present, analyze, and discuss the results of the compressed speech experiment. The final chapter is structured primarily to give the findings, conclusions, and recommendations.
CHAPTER BIBLIOGRAPHY


7. Tarrant County Junior College District, "Specifications for Programmed Learning Center," undated, Fort Worth, Texas.


CHAPTER IV

PRESENTATION, ANALYSIS, AND DISCUSSION OF RESULTS

Introduction

The chief portent of this chapter involved an analysis of the data gathered and treated as described in previous chapters. Such an examination of data should provide a basis upon which a determination might be made with respect to the desirability and practicality of utilizing compressed speech as an instructional technique within a junior college setting. More specifically, the analysis allows a determination of the rate of compression and mode of presentation having the most favorable impact on the comprehension of a recorded communication to junior college students of varying aptitudes.

Subanalyses included efforts to (1) determine to what degree rate of compression could be increased without significant loss in comprehension, (2) determine to what degree rate of comprehension could be increased with the simultaneous presentation of compressed speech and the printed page, and (3) determine the effects of rate of compression and mode of presentation on students representing various levels of aptitude.
To accomplish these objectives, the present chapter is divided into three parts: (1) a presentation of the findings associated with the statistical tests of the hypotheses, (2) a presentation of the findings associated with the supplementary data, and (3) a discussion of these findings.

Statistical Tests of the Hypotheses

Introduction

The statistical tests of the hypotheses transpired in the following order: (1) tests of hypotheses for all-levels aptitude group, (2) tests of hypotheses for high-level aptitude group, and (3) tests of hypotheses for low-level aptitude group. The present chapter is designed to present the tests of the hypotheses in this sequence.

Tests of Hypotheses for All-levels Group

Hypotheses one and four.--Hypothesis one (see p. 4) stated that there would be "no significant difference between the test scores of all-level groups which heard and saw audio-ocular messages at each rate of presentation and the test scores of those all-level groups which only heard aural messages." Hypothesis four, also related to the all-levels group (see p. 7), stated that there would be no significant difference "between the test scores of all-level groups
which heard, or heard and saw uncompressed messages and the
test scores of those groups which heard, or heard and saw
compressed messages." The technique of two-way analysis of
variance, as recorded in Table IV, was used to test the
significance of these sources of variation and to test the
interaction effect.

TABLE IV
SUMMARY OF TWO-WAY ANALYSIS OF VARIANCE FOR
ALL-LEVELS OF APTITUDE, WITH F-RATIOS FOR
VARIANCE DUE TO RATE OF COMPRESSION AND
MODE OF PRESENTATION PLUS INTERACTION

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF*</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rows</td>
<td>1423.35</td>
<td>1</td>
<td>1423.35</td>
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</tr>
<tr>
<td>Columns</td>
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<td>2</td>
<td>550.71</td>
<td>21.10</td>
<td>.01</td>
</tr>
<tr>
<td>Interaction</td>
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<td>2</td>
<td>174.99</td>
<td>6.70</td>
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<tr>
<td>Error</td>
<td>11040.34</td>
<td>423</td>
<td>26.10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*DF = Degrees of Freedom

Hypotheses one and four were rejected after an exami-
nation of the data in Table IV. The F-ratio required for
significance with 1 and 423 degrees of freedom associated
with the numerator and denominator, respectively, is 6.63
at the 1 per cent level. The F-ratio of 54.73 was most
sufficient to warrant rejection of hypothesis one predicting
no significant variation due to mode of presentation within
the all-levels group.

The F-ratio required for significance with 2 and 423
degrees of freedom associated with the numerator and the
The significant level of interaction for the high-levels of aptitude group, however, indicated the presence of variation not attributable to either of the main effects of mode and rate. The presence of interaction at better than the .01 level of significance was indicative of additional effects due to the combination of mode of presentation and rate of compression, effects that were later revealed through an integration of the hypothesized and the supplementary data.

Subhypotheses 1a, 1b, 1c, 4a, and 4b.—With the rejection of hypotheses one and four and according to previous plan, it was necessary to examine differences between means related to the all-levels aptitude group. These means were examined by use of Fisher’s $t$.

Subhypothesis "1a" (see p. 4) predicted no significant difference between test scores of the all-levels, zero compression, audio-ocular group and the all-levels, zero compression, aural-only group. Subhypothesis "1b" predicted no significant difference between test scores of one-third compression, audio-ocular group and the aural-only group which heard the same level of compression. Subhypothesis "1c" predicted no difference between modes at one-half compression.
Subhypothesis "4a" (see p. 7) predicted no significant difference between test scores of the all-levels, zero compression group which only heard aural messages and the one-third compression group which only heard aural messages. Subhypothesis "4b" predicted equality for test scores of the aural-only, one-third compression group and the aural-only, one-half compression group. The mean scores, mean differences, standard deviations, degrees of freedom, t values, and levels of significance for subhypotheses for the all-levels group were recorded in Table V.

**TABLE V**

**MEAN SCORES, MEAN DIFFERENCES, STANDARD DEVIATIONS, t VALUES AND LEVELS OF SIGNIFICANCE OF MEAN DIFFERENCES BETWEEN ALL-LEVEL GROUPS**

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Score</th>
<th>Mean Difference</th>
<th>S.D.</th>
<th>t Value</th>
<th>DF</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A(N=76)</td>
<td>19.56</td>
<td>1.69</td>
<td>5.37</td>
<td>-2.07</td>
<td>154</td>
<td>.05</td>
</tr>
<tr>
<td>B(N=80)</td>
<td>21.35</td>
<td></td>
<td>5.12</td>
<td>5.69</td>
<td>4.13</td>
<td>139</td>
</tr>
<tr>
<td>C(N=68)</td>
<td>18.13</td>
<td>3.23</td>
<td>5.37</td>
<td>-3.74</td>
<td>139</td>
<td>.01</td>
</tr>
<tr>
<td>D(N=73)</td>
<td>21.36</td>
<td></td>
<td>5.37</td>
<td>5.69</td>
<td>4.13</td>
<td>130</td>
</tr>
<tr>
<td>E(N=63)</td>
<td>13.75</td>
<td>6.06</td>
<td>4.46</td>
<td>-6.81</td>
<td>130</td>
<td>.01</td>
</tr>
<tr>
<td>F(N=69)</td>
<td>19.81</td>
<td></td>
<td>5.69</td>
<td>4.13</td>
<td>130</td>
<td>.01</td>
</tr>
<tr>
<td>A(N=76)</td>
<td>19.66</td>
<td>1.53</td>
<td>5.37</td>
<td>1.79</td>
<td>142</td>
<td>.05</td>
</tr>
<tr>
<td>C(N=68)</td>
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<td>4.13</td>
<td>4.91</td>
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<td>.01</td>
</tr>
<tr>
<td>C'(N=68)</td>
<td>18.13</td>
<td>4.38</td>
<td>4.13</td>
<td>4.91</td>
<td>129</td>
<td>.01</td>
</tr>
<tr>
<td>E(N=63)</td>
<td>13.75</td>
<td></td>
<td>4.46</td>
<td>4.13</td>
<td>129</td>
<td>.01</td>
</tr>
</tbody>
</table>
As shown in Table V, there was evidence calling for the retention of two of the five subhypotheses related to the all-level aptitude groups and for the rejection of the other three. The comparison of Group A with Group B, which had reference to subhypothesis "la," yielded a t-ratio of -2.07 with 154 degrees of freedom. The t-ratio required at the .01 level of significance is 2.33, while a t-ratio required to reach significance at the .05 level is slightly less.

Although the difference between Group A and Group B was significant at the .05 level, it was not significant at the .01 level. Accordingly, subhypothesis "la" predicting no significant difference between the scores of the all-levels, zero compression group which heard and saw audio-ocular messages and the test scores of the all-levels, zero compression group which only heard aural messages was retained.

Subhypothesis "lb" predicting no significant difference between mean scores of the one-third compression, audio-ocular group and the one-third compression, aural-only group was rejected. As shown in Table V in the comparison between mean scores of Group C and Group D, a .01 level of significance was reached with a t-ratio of -3.74 and 139 degrees of freedom. A t-ratio of 2.33 is required for significance at the .01 level.

Subhypothesis "lc" predicting no significant difference between mean scores of the one-half compression, audio-ocular group and the mean scores of the one-half compression aural-only
group was also rejected. As shown in Table V in the comparison of Group D and Group E means, a .01 level of significance was reached with a \( t \)-ratio of -6.31 and 130 degrees of freedom. A \( t \)-ratio of 2.33 was required for significance.

A subhypothesis "4a" was retained, for there was no significant difference between test scores of the all-levels, zero compression group of the aural-only mode and the test scores of the all-levels, one-third compression group of the same mode.

Subhypothesis "4b" was rejected, for a comparison of the means of Group C and Group E indicated a difference that was significant at better than the .01 level. This indicated that a difference this great could have occurred by chance less than one per-cent of the time. Subhypothesis "4b" had predicted equality for the aural-only, one-third compression means and the aural-only, one-half compression means within the all-levels aptitude group. The significant difference was in favor of the one-third level of compression.

Tests of Hypotheses for High-Level Group

Hypotheses two and five.—Hypothesis two (see p. 5) stated that there would be "no significant difference between the test scores of high-level groups which heard and saw audio-ocular messages at each rate of presentation and the test scores of those high level groups which only heard aural messages."
Hypothesis five (see p. 8) predicted no significant difference between the test scores of high-level groups which heard, or heard and saw uncompressed messages and the test scores of those groups which heard, or heard and saw compressed messages. The technique of two-way analysis of variance, as recorded in Table VI, was used to test the significance of these sources of variation and to test the interaction effect.

**TABLE VI**

**SUMMARY OF TWO-WAY ANALYSIS OF VARIANCE FOR HIGH-LEVELS OF APTITUDE, WITH F-RATIOS FOR VARIANCE DUE TO RATE OF COMPRESSION AND MODE OF PRESENTATION PLUS INTERACTION**

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rows</td>
<td>671.79</td>
<td>1</td>
<td>671.79</td>
<td>35.16</td>
<td>.01</td>
</tr>
<tr>
<td>Columns</td>
<td>291.48</td>
<td>2</td>
<td>145.74</td>
<td>7.63</td>
<td>.01</td>
</tr>
<tr>
<td>Interaction</td>
<td>253.63</td>
<td>2</td>
<td>126.81</td>
<td>6.64</td>
<td>.01</td>
</tr>
<tr>
<td>Error</td>
<td>2617.42</td>
<td>137</td>
<td>19.10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hypotheses two and five were rejected after an examination of the data in Table VI. The F-ratio required for significance with 1 and 137 degrees of freedom associated with the numerator and denominator, respectively, is 6.63 at the 1 per cent level. The F-ratio of 35.16 was sufficient to warrant rejection of hypothesis two predicting no significant variation due to mode of presentation within the high level aptitude group.

The F-ratio required for significance with 2 and 137 degrees of freedom associated with the numerator and the
denominator, respectively, is 4.61 at the 1 per cent level. Since the value obtained was 7.63, the value was sufficient to reject hypothesis five predicting no significant variation due to rate of presentation.

The presence of a significant level of interaction was found for the high-level aptitude group as was found for the all-levels aptitude group. This interaction was significant at better than the .01 level, indicating that some special combination of factors was also inherent in the statistical data.

Subhypotheses 2a, 2b, 2c, 5a, and 5b.—According to plan and with the rejection of hypotheses two and five, it became necessary to examine t-ratios for the high-level group in order to determine whether differences between means of specific treatment conditions were significant.

Subhypothesis "2a" (see p. 5) predicted no significant difference between the test scores of the high-level, zero compression group of the audio-ocular mode and the test scores of the high-level, zero compression group of the aural-only mode. Subhypothesis "2b" (see pp. 5-6) predicted equality for mean scores of one-third compression groups of both modes of presentation. Subhypothesis "2c" predicted no difference between means of the aural-only, one-half compression group and the audio-ocular, one-half compression group. All subhypotheses in this paragraph were designed to test
significant differences related to the high-level aptitude
group. The same aptitude group was involved with the
following two subhypotheses.

Subhypothesis "5a" (see p. 8) stated that "there will
be no significant difference between the test scores of the
high-level, zero compression group which only heard aural
messages and the high-level, one-third compression group
which only heard aural messages." Subhypothesis "5b" (see
p. 8) stated that "there will be no significant difference
between the test scores of the high-level, one-third
compression group which only heard aural messages and the
high-level, one-half compression group which only heard
aural messages."

Table VII was designed to give that information
necessary to retain or reject subhypotheses "2a, 2b, 2c, 5a,
and 5b." Groups A, C, and E were to have referred to aural
groups at zero, one-third, and one-half compression,
respectively, Groups B, D, and F were to have referred to
audio-ocular groups at zero, one-third, and one-half
compression, respectively, Thus, the first t-ratio was
used to test "2a," the second to test "2b," the third to
test "2c," etcetera. The mean scores, mean differences,
standard deviations, degrees of freedom, t values, and
levels of significance for subhypotheses in the high-level
aptitude groupings were recorded in Table VII.
TABLE VII

MEAN SCORES, MEAN DIFFERENCES, STANDARD DEVIATIONS, 
$ t $ VALUES AND LEVELS OF SIGNIFICANCE OF MEAN 
DIFFERENCES BETWEEN HIGH-LEVEL GROUPS

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Score</th>
<th>Mean Difference</th>
<th>S.D.</th>
<th>$ t $ Value</th>
<th>DF</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A(N=25)</td>
<td>22.88</td>
<td>1.75</td>
<td>4.58</td>
<td>-1.44</td>
<td>50</td>
<td>NS</td>
</tr>
<tr>
<td>B(N=27)</td>
<td>24.63</td>
<td>3.27</td>
<td>4.02</td>
<td>-2.56</td>
<td>45</td>
<td>.01</td>
</tr>
<tr>
<td>C(N=23)</td>
<td>20.48</td>
<td>8.02</td>
<td>4.37</td>
<td>-6.08</td>
<td>42</td>
<td>.01</td>
</tr>
<tr>
<td>D(N=24)</td>
<td>23.75</td>
<td>8.02</td>
<td>4.37</td>
<td>-6.08</td>
<td>42</td>
<td>.01</td>
</tr>
<tr>
<td>E(N=21)</td>
<td>16.24</td>
<td>4.24</td>
<td>4.02</td>
<td>1.90</td>
<td>46</td>
<td>.05</td>
</tr>
</tbody>
</table>

A $ t $-ratio of 2.33 was necessary for rejection of all subhypotheses for the high-level aptitude groups, since the .01 level was being utilized and since each category had more than thirty degrees of freedom. As indicated in the table above, three of the subhypotheses warranted rejection and the other two were retained.

Subhypothesis "2a" predicting no significant difference between modes for means at zero compression was acceptable since the $ t $-ratio was not sufficient to indicate a significant difference. For the high-levels group, the audio-ocular mode offered no advantage at normal speaking rate.
Subhypothesis "2b" predicting no significant difference in the means for aural-only subjects of high aptitude hearing messages compressed one-third and those for audio-ocular subjects of the same aptitude and level of compression was rejected. The t-ratio indicated a significant difference, and that difference was in favor of the audio-ocular mode of presentation.

Subhypothesis "2c" predicted no significant difference in comprehension test score means for aural-only subjects of high aptitude hearing messages compressed one-half and comprehension test score means for audio-ocular subjects of the same aptitude level and rate of compression. This subhypothesis was rejected when a t-ratio of -6.08 was revealed, indicating a significant difference at better than the .01 level. The difference was again in favor of the audio-ocular mode.

Subhypothesis "5a" was, as the result of information and the t-ratio presented in Table VII, retained. The one-third level of compression for the high aptitude subjects in the aural-only mode was not significantly different from the zero compression for subjects of the same aptitude and mode in terms of comprehension.

Subhypothesis "5b" was rejected, indicating a significant difference in favor of one-third compression as opposed to one-half compression. High aptitude subjects hearing
messages compressed one-half in the aural-only mode scored significantly lower than did high aptitude subjects hearing messages compressed one-third.

**Tests of Hypotheses for Low-levels Group**

Hypotheses three and six*--Hypothesis three (see p. 6) prognosticated no significant difference between test scores of low-level groups which heard and saw audio-ocular messages at each rate of presentation and the test scores of those low-level groups which only heard aural messages. Hypothesis six (see p. 8) stated that there would be no significant difference between low-level groups of both modes at zero compression and low-level groups of both modes at one-third and one-half compression. The two-way analysis of variance used to test these hypotheses and interaction was recorded in Table VIII.

**TABLE VIII**

**SUMMARY OF TWO-WAY ANALYSIS OF VARIANCE FOR LOW-LEVELS OF APTITUDE, WITH F-RATIOS FOR VARIANCE DUE TO RATE OF COMPRESSION AND MODE OF PRESENTATION PLUS INTERACTION**

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rows</td>
<td>204.43</td>
<td>1</td>
<td>204.43</td>
<td>10.31</td>
<td>.01</td>
</tr>
<tr>
<td>Columns</td>
<td>424.72</td>
<td>2</td>
<td>212.36</td>
<td>10.71</td>
<td>.01</td>
</tr>
<tr>
<td>Interaction</td>
<td>43.67</td>
<td>2</td>
<td>21.83</td>
<td>1.10</td>
<td>NS</td>
</tr>
<tr>
<td>Error</td>
<td>2716.85</td>
<td>137</td>
<td>19.83</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As the result of the data presented in Table VIII, both hypothesis three and hypothesis six were rejected. An F-ratio of 6.63 is required for significance at the 1 per cent level with 1 in the numerator and 137 in the denominator. The obtained F-ratio of 10.31 for rows called for the rejection of hypothesis three. An F-ratio of 4.61 is required for significance at the 1 per cent level with 2 in the numerator and 137 in denominator. The obtained F-ratio of 10.71 for columns called for the rejection of hypothesis six.

The absence of a significant interaction, even at the .05 level of significance, differed from the presence of a significant interaction at the .01 level for groups of all-level and high-level aptitudes. A nonsignificant interaction indicated that the difference in effects of the three levels of compression on audio-ocular subjects was the same as the difference in effects of the three levels of compression on aural-only subjects, and that the difference in effects of the two modes of presentation at each level of compression was the same as the difference in effects for uncompressed messages.

Subhypotheses 3a, 3b, 3c, 6a, and 6b.—With the rejection of hypotheses three and six, it was then necessary to investigate the t-ratios associated with the five related subhypotheses. The first of these subhypotheses, "3a," stated (see p. 6) that there would be no significant difference between the
comprehension test scores of the low-level, zero compression group which heard and saw audio-ocular messages and those groups which only heard aural messages. Subhypothesis "3b" (see pp. 6-7) predicted no significant difference between comprehension test scores of the low-level, one-third compression group which heard and saw audio-ocular messages and the test scores of the low-level, one-third compression group which only heard aural messages. Subhypothesis "3c" (see p. 7) prognosticated no significant difference between mean comprehension scores of the aural-only, one-half compression group and the audio-ocular, one-half compression group.

Two subhypotheses were related to hypothesis six: (1) subhypothesis "6a" (see pp. 8-9) predicting no significant difference between comprehension scores of the low-level, zero compression group of the aural-only mode and the comprehension scores of the low-level, one-third compression group of the aural-only mode, and (2) subhypothesis "6b" (see p. 9) predicting no significant difference between comprehension mean scores of the low-level, one-third compression group of the aural-only mode and the scores of the low-level, one-half compression group of the same mode.

As indicated in Table IX, there was basis for the rejection of some of these subhypotheses and retention of others. Table IX, like its predecessors for t-tests of
group means associated with all-level and high-level groups, was designed to indicate mean scores, mean differences, standard deviations, t values, and levels of significance.

TABLE IX

MEAN SCORES, MEAN DIFFERENCES, STANDARD DEVIATIONS, t VALUES AND LEVELS OF SIGNIFICANCE OF MEAN DIFFERENCES BETWEEN LOW-LEVEL GROUPS

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Score</th>
<th>Mean Difference</th>
<th>S.D.</th>
<th>t-Value</th>
<th>DF</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A(N=25)</td>
<td>17.20</td>
<td>.84</td>
<td>5.84</td>
<td>-0.68</td>
<td>50</td>
<td>NS</td>
</tr>
<tr>
<td>B(N=27)</td>
<td>18.04</td>
<td>4.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C(N=23)</td>
<td>15.78</td>
<td>3.30</td>
<td>3.51</td>
<td>-2.54</td>
<td>45</td>
<td>.01</td>
</tr>
<tr>
<td>D(N=24)</td>
<td>19.08</td>
<td>5.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E(N=21)</td>
<td>12.33</td>
<td>3.06</td>
<td>2.62</td>
<td>-2.27</td>
<td>42</td>
<td>.05</td>
</tr>
<tr>
<td>F(N=23)</td>
<td>15.39</td>
<td>3.96</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A(N=25)</td>
<td>17.20</td>
<td>1.42</td>
<td>5.84</td>
<td>1.10</td>
<td>46</td>
<td>NS</td>
</tr>
<tr>
<td>C(N=23)</td>
<td>15.78</td>
<td>3.51</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C(N=23)</td>
<td>15.78</td>
<td>3.45</td>
<td>3.51</td>
<td>2.57</td>
<td>42</td>
<td>.01</td>
</tr>
<tr>
<td>E(N=21)</td>
<td>12.33</td>
<td>2.62</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A t-ratio of 2.33 was necessary for rejection of all subhypotheses for the low-level groups, since the .01 level was being utilized and since each category had more than thirty degrees of freedom. As indicated in the table above, only two of the t-ratios reached an acceptable level of significance.
Accordingly, subhypothesis "3a" predicting no significant difference between aural-only and audio-ocular means at zero compression was retained. Neither mode seemed to offer an advantage at this rate of compression.

Subhypothesis "3b" was rejected, since the obtained t-ratio of -2.54 was sufficient to indicate a significant difference. The difference was in favor of the audio-ocular mode of presentation when the low-level means at one-third compression were compared.

Subhypothesis "3c" predicting no significant difference between aural-only and audio-ocular means at one-half compression was retained for the low-level groups. The obtained t-ratio of 2.27 was sufficient to indicate a significant difference at the .05 level, but was insufficient to indicate a significant difference at the selected .01 level.

Subhypothesis "6a" predicting no significant difference between the low-level, aural-only, zero compression group and the low-level, aural-only, one-third compression group was retained. There was seemingly no appreciable loss in comprehension when normal messages within the aural-only mode and low aptitude level were speeded to one-third compression.

Subhypothesis "6b" was rejected, for there was a significant difference in favor of the one-third compression level. When low-level, aural-only subjects heard one-half compression, comprehension was significantly less than at one third.
 Recapitulation

Statistical tests of the hypotheses were made in the following order: (1) tests of hypotheses for all-levels aptitude group, (2) tests of hypotheses for high-level aptitude group, and (3) tests of hypotheses for low-level aptitude group. All six of the major hypotheses were rejected with the qualification that in the all-levels and high-level aptitude groups a significant interaction existed. Subhypotheses were also tested. The next section was designed to present the supplementary data.

Supplementary Data

Introduction

In addition to the data gathered for testing the hypotheses, other information was gathered as follows: (1) supplementary t tests for all-level, high-level, and low-level aptitude groups, (2) two-way analysis of variance and t tests for medium-level aptitude group, and (3) Pearson's product moment correlation for the six treatment conditions.

Supplementary t Tests

Previously, t-ratios were presented for all-level, high-level, and low-level aptitude groups. The t-ratios made comparisons between modes at each level of compression, and between levels of compression for the aural-only mode. Conspicuously absent were t-ratios between levels of
compression for the audio-ocular mode. These t-ratios, as presented in Table X, are pertinent to the complete understanding of the study and the interaction effects.

**TABLE X**

**MEAN SCORES, MEAN DIFFERENCES, STANDARD DEVIATIONS, t VALUES, AND LEVELS OF SIGNIFICANCE OF MEAN DIFFERENCES BETWEEN SPECIFIED GROUPS**

<table>
<thead>
<tr>
<th>Group</th>
<th>A.L.*</th>
<th>Mean Score</th>
<th>M.D.</th>
<th>S.D.</th>
<th>t-Value</th>
<th>DF</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>B(N=80)</td>
<td>All</td>
<td>21.35</td>
<td>0.01</td>
<td>5.12</td>
<td>-0.01</td>
<td>151</td>
<td>NS</td>
</tr>
<tr>
<td>D(N=73)</td>
<td>All</td>
<td>21.36</td>
<td>1.55</td>
<td>5.37</td>
<td>1.80</td>
<td>140</td>
<td>NS</td>
</tr>
<tr>
<td>D(N=73)</td>
<td>All</td>
<td>19.81</td>
<td>5.69</td>
<td>5.14</td>
<td>0.71</td>
<td>49</td>
<td>NS</td>
</tr>
<tr>
<td>F(N=69)</td>
<td>All</td>
<td>24.63</td>
<td>0.88</td>
<td>3.87</td>
<td>0.71</td>
<td>49</td>
<td>NS</td>
</tr>
<tr>
<td>B(N=27)</td>
<td>High</td>
<td>23.75</td>
<td>0.51</td>
<td>3.49</td>
<td>0.40</td>
<td>45</td>
<td>NS</td>
</tr>
<tr>
<td>D(N=24)</td>
<td>High</td>
<td>24.26</td>
<td>1.04</td>
<td>4.01</td>
<td>0.84</td>
<td>49</td>
<td>NS</td>
</tr>
<tr>
<td>D(N=24)</td>
<td>Low</td>
<td>18.04</td>
<td>1.04</td>
<td>4.01</td>
<td>0.84</td>
<td>49</td>
<td>NS</td>
</tr>
<tr>
<td>F(N=23)</td>
<td>Low</td>
<td>19.08</td>
<td>5.16</td>
<td>2.84</td>
<td>45</td>
<td>.01</td>
<td></td>
</tr>
<tr>
<td>D(N=24)</td>
<td>Low</td>
<td>19.08</td>
<td>5.16</td>
<td>2.84</td>
<td>45</td>
<td>.01</td>
<td></td>
</tr>
<tr>
<td>F(N=23)</td>
<td>Low</td>
<td>15.39</td>
<td>3.69</td>
<td>3.96</td>
<td>2.84</td>
<td>45</td>
<td>.01</td>
</tr>
</tbody>
</table>

*A.L. = Aptitude Level

As indicated in the table above, in only one instance was the t-ratio large enough to indicate a significant difference between means. In that instance, the significant difference was between low-level aptitude subjects hearing and seeing audio-ocular messages at one-third compression.
and those low-level aptitude subjects hearing and seeing audio-ocular messages at one-half compression. The difference was in favor of the one-third compression level.

In all other instances, there appeared to be no significant difference between subjects' ability to comprehend at normal speaking rate and at one-third compression, and at one-third compression as compared to one-half compression—all comparisons having been made within the audio-ocular mode of presentation.

**Supplementary Tests for Medium-level Aptitudes**

It was felt that the data would be complete if the two-way analysis of variance and t-ratios were run for the medium-level aptitude groups. Table XI was designed to present the two-way analysis of variance, indicating variation due to mode, rate, and interaction.

**TABLE XI**

**SUMMARY OF TWO-WAY ANALYSIS OF VARIANCE FOR MID-LEVELS OF APTITUDE, WITH F-RATIOS FOR VARIANCE DUE TO RATE OF COMPRESSION AND MODE OF PRESENTATION PLUS INTERACTION**

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rows</td>
<td>634.43</td>
<td>1</td>
<td>634.43</td>
<td>28.24</td>
<td>.01</td>
</tr>
<tr>
<td>Columns</td>
<td>436.37</td>
<td>2</td>
<td>218.19</td>
<td>9.71</td>
<td>.01</td>
</tr>
<tr>
<td>Interaction</td>
<td>150.59</td>
<td>2</td>
<td>75.29</td>
<td>3.35</td>
<td>.05</td>
</tr>
<tr>
<td>Error</td>
<td>3077.73</td>
<td>137</td>
<td>22.46</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As indicated in Table XI, there was significant variation due to rate, mode, and interaction. While rate and mode were significant at the .01 level of significance, the interaction was significant at the .05 level.

The t-ratios, as recorded in Table XII, are also for the medium-level aptitude groups. A total of seven comparisons were made.

Table XII

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Score</th>
<th>Mean Difference</th>
<th>S.D.</th>
<th>t Value</th>
<th>DF</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A(N=26)</td>
<td>18.92</td>
<td>2.46</td>
<td>3.86</td>
<td>-1.87</td>
<td>50</td>
<td>.05</td>
</tr>
<tr>
<td>B(N=26)</td>
<td>21.38</td>
<td>5.08</td>
<td>3.37</td>
<td>-2.24</td>
<td>45</td>
<td>.05</td>
</tr>
<tr>
<td>C(N=22)</td>
<td>18.14</td>
<td>3.10</td>
<td>4.78</td>
<td>.78</td>
<td>41</td>
<td>.01</td>
</tr>
<tr>
<td>D(N=25)</td>
<td>21.24</td>
<td>4.92</td>
<td>7.11</td>
<td>-4.97</td>
<td>42</td>
<td>.01</td>
</tr>
<tr>
<td>E(N=21)</td>
<td>12.67</td>
<td>4.97</td>
<td>3.86</td>
<td>-0.57</td>
<td>44</td>
<td>NS</td>
</tr>
<tr>
<td>F(N=23)</td>
<td>19.78</td>
<td>3.37</td>
<td>3.37</td>
<td>-3.78</td>
<td>41</td>
<td>.01</td>
</tr>
<tr>
<td>A(N=26)</td>
<td>18.92</td>
<td>0.78</td>
<td>3.86</td>
<td>0.57</td>
<td>44</td>
<td>NS</td>
</tr>
<tr>
<td>A(N=26)</td>
<td>18.14</td>
<td>5.47</td>
<td>3.86</td>
<td>-3.78</td>
<td>41</td>
<td>.01</td>
</tr>
<tr>
<td>C(N=22)</td>
<td>18.14</td>
<td>5.08</td>
<td>3.37</td>
<td>-0.11</td>
<td>49</td>
<td>NS</td>
</tr>
<tr>
<td>D(N=25)</td>
<td>21.24</td>
<td>4.78</td>
<td>5.48</td>
<td>1.06</td>
<td>46</td>
<td>NS</td>
</tr>
</tbody>
</table>

Table XII MEAN SCORES, MEAN DIFFERENCES, STANDARD DEVIATIONS, t VALUES AND LEVELS OF SIGNIFICANCE OF MEAN DIFFERENCES BETWEEN MID-LEVEL GROUPS.
The t value required to indicate a significant difference for means compared in Table XII is 2.63 for the .01 level of significance and 1.64 for the .05 level of significance. When medium-level groups hearing zero compression, aural-only recordings were compared with those subjects hearing zero compression, audio-ocular recordings, there was a significant difference. There was a significant difference between modes at one-third compression, but the significance was at the .05 level. A significant difference at the .01 level did appear, however, when the one-half compression, aural-only mean comprehension scores were compared with the one-half compression, audio-ocular means. This difference was in favor of the audio-ocular mode.

The remaining comparisons given in Table XII compared medium level groups as follows: (1) aural-only, one-third compression with aural-only, zero compression, (2) aural-only, one-third compression with aural-only, one-half compression, (3) audio-ocular, one-third compression with aural-only, zero compression, and (4) audio-ocular, one-third compression with audio-ocular, one-half compression. In only one instance was there a significant difference at the .01 or .05 level. The difference (at the .01 level) was in favor of the aural-only, one-third compression group as compared to the aural-only, one-half compression group.
Correlations for Treatment Conditions

The last data to be gathered for inclusion with the supplementary data was information concerning correlations between scores on the test of aptitude and the test of comprehension. The correlations, classified according to treatment condition without regard to aptitude level, were recorded in Table XII.

### TABLE XIII

**PEARSON'S PRODUCT MOMENT CORRELATIONS FOR TESTS OF APTITUDE AND COMPREHENSION, CLASSIFIED ACCORDING TO THE TREATMENT CONDITION**

<table>
<thead>
<tr>
<th>Treatment Condition</th>
<th>Comp.* Mean</th>
<th>S.D.</th>
<th>Apt.** Mean</th>
<th>S.D.</th>
<th>r</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aural-only</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zero Com- (N=76)</td>
<td>19.66</td>
<td>5.37</td>
<td>30.54</td>
<td>10.23</td>
<td>0.53</td>
<td>.01</td>
</tr>
<tr>
<td>1/3 Com- (N=68)</td>
<td>13.13</td>
<td>4.13</td>
<td>30.10</td>
<td>8.49</td>
<td>0.53</td>
<td>.01</td>
</tr>
<tr>
<td>1/2 Com- (N=63)</td>
<td>13.75</td>
<td>4.49</td>
<td>29.63</td>
<td>7.80</td>
<td>0.62</td>
<td>.01</td>
</tr>
<tr>
<td>Audio-ocular</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zero Com- (N=80)</td>
<td>21.35</td>
<td>5.12</td>
<td>28.02</td>
<td>8.61</td>
<td>0.51</td>
<td>.01</td>
</tr>
<tr>
<td>1/3 Com- (N=73)</td>
<td>21.36</td>
<td>5.37</td>
<td>30.04</td>
<td>8.06</td>
<td>0.49</td>
<td>.01</td>
</tr>
<tr>
<td>1/2 Com- (N=69)</td>
<td>19.81</td>
<td>5.70</td>
<td>29.54</td>
<td>8.53</td>
<td>0.62</td>
<td>.01</td>
</tr>
</tbody>
</table>

*Comp. = Comprehension  **Apt. = Aptitude*
As indicated in Table XIII, all correlations reached the .01 level of significance. Hence, the probability that correlations obtained could have occurred by chance are very slim. The correlations, which ranged from .46 to .62, were not sufficiently high to indicate that the test of aptitude was tremendously successful in predicting scores on the test of comprehension.

Recapitulation

The section on supplementary data presented three types of material: (1) supplementary t tests for all-level, high-level, and low-level aptitude groups, (2) two-way analysis of variance and t tests for medium-level aptitude group, and (3) Pearson's product moment correlation for the six treatment conditions. The next general section is designed to discuss the findings.

Discussion of the Findings

Introduction

To discuss the findings, four sections as follows were developed: (1) general statements related to the overall findings, (2) discussion of the findings with respect to the main hypotheses, (3) discussion of the findings related to the subhypotheses, and finally, (4) findings not associated with either the hypotheses or subhypotheses.
General Overview

Generally, it was felt that any differences in means could be attributed to differences in mode of presentation, rate of compression, or a combination of these two main effects. At least one qualification should be made, however, particularly with respect to one of the eighteen sampled sections where nine people indicated an inability to hear all of the recordings.

The question stated on the answer sheet was, "Were you able to hear all of the recordings?" Since all students in the section in question affirmed their ability to hear at the beginning of the test session and since all equipment had been checked prior to testing and observed during experimentation, it was believed that the students were interpreting the question with respect to their ability to understand rather than to hear. Support was given to this belief in that subjects were being exposed to the fastest rate of compression at the time, and after the final stimulus message a student blurted in dismay, "I just couldn't hear them!" The student may have influenced other students to think in that manner, and thus could have been responsible for the large number of denials at the conclusion of the test period.

Moreover, other students asked the experimenter if the question meant ability to understand or ability to just hear.
Too, the highest incidence of inability to hear occurred in the one-half compression groups, while no students complained of not being able to hear normal rate recordings.

However, the absence of these subjects from the population sample may have distorted the true results to some degree, particularly in comparisons of one-half compression means of either mode with the other means. Since only twenty-five students from a population of 500 were affected, it was not believed that the results would have been influenced significantly.

Findings Associated with Hypotheses and Subhypotheses

The results from the two-way analyses of variance resulted in the rejection of all six major null hypotheses predicting no significant difference in means for various aptitude levels. The rejections were qualified ones, however, in that a significant interaction was found to exist in the all-levels, high-level, and medium-level groups. Thus, only in the low-level aptitude groups could differences be attributed to main effects alone. In the other instances, some combination of effects—perhaps associated with the forthcoming section on findings associated with the subhypotheses—were operative.

Findings Associated with Subhypotheses

In each instance, regardless of aptitude level or mode of presentation, there was no significant difference between
means representing normal rate recordings and recordings compressed one-third. Although the results may have been somewhat distorted through the Hawthorne effect, the results nonetheless indicate the ability of junior college students to understand speech compressed one-third almost as well as a normal rate recording, regardless of the mode of presentation.

In each instance, regardless of aptitude level, there was a significant decline in comprehension when aural-only messages compressed one-third were compressed to one-half of the original time. Junior college students involved in this experiment were unable to comprehend one-half compression as well as one-third compression within the aural-only mode.

In all but one instance, subjects were able to comprehend messages compressed one-half in the audio-ocular mode as well as they were able to understand messages compressed one-third in the audio-ocular mode. The exception was for the low-aptitude subjects.

In every instance, the audio-ocular mode was of no advantage for normal rate recordings. No significant differences were found for any of the aptitude levels.

The audio-ocular mode did prove advantageous for three of the four aptitude levels at one-third compression. Subjects in the medium-level aptitude group did as well in the aural-only mode at one-third compression as they did in the audio-ocular mode at the same level of compression.
The audio-ocular mode proved advantageous for three of the four aptitude levels at one-half compression. The exception in this instance was for the low-level aptitude subjects. While the other aptitude levels experienced no significant decline in comprehension when audio-ocular messages of one-third compression were compared with audio-ocular messages of one-half compression, the low aptitude group experienced a significant decline in comprehension.

The commonalities of phenomenon associated with mode, rate, and aptitude levels probably accounts for the significant levels of interaction. The interaction would seem to indicate that it is a combination of mode of presentation and rate of compression responsible for variations rather than mode or rate alone.

Summary

Chapter IV is developed through a three-fold organizational sequence as follows: (1) presentation of findings associated with statistical tests of the hypotheses, (2) a presentation of the findings associated with the supplementary data, and (3) a discussion of the findings. The final chapter presents the summary, conclusions, and the recommendations.
CHAPTER V
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction
The final chapter, Chapter V, summarizes the study and reports the findings, conclusions, and recommendations. The first section follows:

Summary
This study was designed to assess the desirability and practicality of utilizing compressed speech as a technique for instruction within a junior college setting. Assessments were made to determine to what degree rate of compression could be increased without significant loss in comprehension, to determine to what degree rate of comprehension could be increased with the simultaneous presentation of the printed page, and to determine the effects of variations in mode and rate on the comprehension of students representing all, low, and high levels of aptitude.

A two-by-three design, representing three levels of compression and two modes of presentation, was developed to test comprehension. A recorded version of the comprehension subtest within the Nelson-Denny Reading Test, the test of comprehension included eight stimulus messages followed by
one or two minute testing periods used to answer a total of thirty-six multiple choice questions:

In order to determine aptitude level, a part of the Guilford-Zimmerman Aptitude Test Battery was used to create three aptitude levels. The segment used was the "Verbal Comprehension" subtest consisting of a seventy-two item multiple choice vocabulary test. Those subjects scoring at or above the 66th percentile were assigned to the high aptitude group, while those scoring at the 33rd percentile and below were assigned to the low aptitude group. All subjects were assigned to the all-levels group according to their treatment condition.

The sample of 429 students was composed of eighteen sections of freshman English composition minus those students absent from either the test of aptitude or test of comprehension and those who indicated an inability to hear all of the recordings during the test of comprehension. The subjects represented freshmen students of both sexes, a few of whom were attending college by virtue of a certificate of equivalency.

The basic hypotheses, six of them, were supplied with subhypotheses to be tested in the event of rejection of basic hypotheses. Hypotheses one and four for all-level groups are hereafter recorded with their respective subhypotheses. Hypotheses two and three were identical to one except for aptitude level. Hypotheses five and six were identical to
four except for aptitude level. Two and five related to high-level aptitude while three and six were related to low-level aptitude. All hypotheses and subhypotheses can be reconstructed by substituting the appropriate aptitude level in the following restatement of hypotheses one and four.

Hypothesis one stated that there will be "no significant difference between the test scores of all-level groups which heard and saw audio-ocular messages at each rate of presentation and the test scores of those all-level groups which only heard aural messages." Subhypothesis "1a" stated that there will be "no significant difference between the test scores of the all-levels, zero compression group which heard and saw audio-ocular messages and the test scores of the all-levels, zero compression group which only heard aural messages." Subhypothesis "1b" stated that there will be "no significant difference between the test scores of the all-levels, one-third compression group which heard and saw audio-ocular messages and the test scores of the all-levels, one-third compression group which only heard aural messages." Subhypothesis "1c" predicted "no significant difference between the test scores of the all-levels, one-half compression group which heard and saw audio-ocular messages and the test scores of the all-levels, one-half compression group which only heard aural messages."

Hypothesis four stated that there "will be no significant difference between the test scores of all-level groups
which heard, or heard and saw uncompressed messages and the
test scores of those groups which heard, or heard and saw
compressed messages." Subhypothesis "4a" predicted "no
significant difference between the test scores of the all-
levels, zero compression group which only heard aural
messages and the all-levels, one-third compression group
which only heard aural messages." Subhypothesis "4b" stated
that "there will be no significant difference between the
test scores of the all-levels, one-third compression group
which only heard aural messages, and the all-levels, one-
half compression group which only heard aural messages.

Two-way analysis of variance was used to test basic
hypotheses while t tests were run to assess differences in
means related to subhypotheses. In addition, t tests were
run to assess differences in means of audio-ocular groups,
creating comparisons for zero with one-third compression
and one-third with one-half compression. The same type of
techniques were used to test the medium aptitude group,
differences of which had not been formally hypothesized.
Too, Pearson's Product Moment Correlation was used to
assess the ability of the test of aptitude to predict
scores on the test of comprehension within treatment groups.
In all instances except analysis of variance, the .01
level was used to test significance. The .05 level was
used for the analysis of variance.
Findings

All six major hypotheses were rejected with qualification. Although there was evidence indicating that mode of presentation and rate of compression accounted for significant variation for each of the aptitude groups, there was also a significant interaction for all aptitude groups except the low-level aptitude group. The finding of these significant interactions was indicative of the presence of variation due to a combination of factors related to mode and rate.

All subhypotheses predicting no significant difference between comprehension scores of aural-only subjects hearing normal rate recordings and recordings compressed one-third were retained, indicating that no loss in comprehension occurred when a message was presented in two-thirds of its original time. (Tables V, VII, and IX)

All subhypotheses predicting no significant difference between comprehension scores of aural-only subjects hearing one-third compression and those hearing one-half compression were rejected, indicating a significant loss in comprehension when a message was presented in one-half rather than two-thirds of its original time.

All subhypotheses predicting no significant difference between comprehension scores of aural-only subjects hearing normal rate recordings and audio-ocular subjects hearing
and seeing normal rate messages were retained. The audio-ocular mode offered no advantage for normal rate recordings.

All subhypotheses predicting no significant difference between comprehension scores of aural-only subjects hearing recordings compressed one-third and audio-ocular subjects hearing and seeing one-third compressed messages were rejected. There was a consistent difference in favor of the audio-ocular mode at one-third compression.

All subhypotheses predicting no significant difference between modes at one-half compression were rejected as well. Once again, the audio-ocular mode proved superior. One exception was the low-level aptitude group. In this instance, there was no significant difference.

Audio-ocular subjects hearing normal rate recordings, when compared with audio-ocular subjects hearing compression at one-third, were not superior in their ability to comprehend messages. When the one-third compression group was compared with the one-half compression group, there was again no significant difference in ability to comprehend except in the low-level aptitude group. In this instance, there was a significant decline in comprehension.

All correlations were significant at the .01 level, and ranged from a high of .62 for the all-levels, one-half compression, audio-ocular mode to a low of .46 for the group of the same aptitude level and compression but of the
aural-only mode of presentation. Thus, the lowest correlation was found within an aural-only treatment condition, while the highest was isolated within an audio-ocular treatment condition.

Conclusions

After an analysis of the findings, and within the limitations of this study, certain conclusions are warranted.

1. Mode of presentation and rate of compression are variables significantly affecting level of comprehension.

2. Certain combinations of mode of presentation and rate of compression affect level of comprehension, with a possible exception being for those subjects of low aptitude.

3. Utilization of the printed page in conjunction with aural messages offers little or no advantage for subjects hearing normal rate recordings.

4. The audio-ocular mode may be advantageous, however, for most aptitude groups hearing and seeing messages presented in two-thirds of their original time.

5. The audio-ocular mode is better for subjects hearing messages presented in one-half of the original time, except for those subjects of low aptitude.

6. Messages presented in two-thirds of their original time are probably comprehended as well as those presented in a normal rate, regardless of the mode of presentation or the level of aptitude.
7. Messages presented in an aural-only mode in one-half of the original time are less effective than those messages presented in two-thirds of the original time within the same mode.

8. Comprehension is maintained in the audio-ocular mode even at one-half compression, while there is a significant loss within aural-only groups. One exception may be for those with low aptitude.

9. Compressed speech may have potential as a technique of instruction within junior colleges, particularly if messages are presented in two-thirds rather than one-half of the original time.

10. The audio-ocular mode may have more promise than the aural-only mode, particularly for subjects of average and above aptitude.

Recommendations and Implications

A number of factors emerged from this study which could indicate the need for further research, particularly in the areas hereafter noted:

1. Additional research needs to be done within the junior college setting to determine the impact of longer messages on the comprehension of recorded messages. Lectures, curricula units, even literary selections might be compressed and the effectiveness of the technique assessed.
2. There is a need for more information concerning the ability of the technical-vocational students in the comprehension of compressed speech. The possibility exists that students in this area who never learned to read acceptably learned to listen. Compressed speech may be a medium that will complement their success in educational efforts.

3. Further investigation is needed to determine if the improved results obtained through the simultaneous presentation of the printed page with a compressed message are due to the processing of two concurrent channels of information or the selection of the one channel most efficient. There has been far more speculation in this area than experimentation.

4. The experiment performed in this study needs to be repeated, preferably with modifications in tests of aptitude and comprehension. The original Fairbanks' instrument could possibly be used.

Implications from the results of the preceding recommended research could substantially modify present concepts of the role of compressed speech as an instructional technique. Although not directly supported by research, the following implications emerged:

1. Junior college students may be able to utilize compressed speech for an instructional advantage. If it is possible for students to save one-third of their time in listening without significant loss in comprehension, it is
conceivable that the time saved could be used for reinforcement, repetition, discussion, or additional instruction.

2. Junior college programmed learning centers may be able to serve greater numbers of students in less time with less equipment and personnel. If the time required for utilization of learning centers may be decreased through the use of some compressed messages, present facilities could substantially increase their service potential.

3. The addition of the printed page to match aural messages, a process which may result in better comprehension, may enable most students to listen to higher degrees of compression without loss in comprehension and comparable degrees of aural-only compression with an advantage in the ability to comprehend.

4. The separation of the low aptitude subject from the higher aptitude subjects may result in paced instruction that would help the slow learner and the student that learns at a faster pace.

5. Faculty members within junior colleges should search their repertory of recordings and planned recordings, and should select those communications which may have some applicability or suitability for pilot compression projects.

6. Effort should be made to assess the influence of compressed speech on student attitudes, particularly during pilot projects.
7. Teachers within the elementary and secondary schools should investigate the plausibility of compressed speech as an instructional technique within their respective school setting.

8. Those responsible for educating the student with low verbal intelligence should consider the possibility of using compressed speech. Some students who learned to listen may have never learned to read. The low score on the test of verbal intelligence might reflect inability to read, but does not necessarily reflect low verbal intelligence. Compressed speech may offer hope for this type of student.

9. Those in industry and business should investigate the possibility of integrating compressed speech into the communications system of their firm or corporation. The technique could easily have implications for the improvement of initial and continued personnel orientation programs, and could result in a substantial savings in time and money.
APPENDIX A

INSTRUCTIONS PRESENTED TO AURAL-ONLY GROUPS

If you can hear me, please raise your right hand.
(five second pause) Feel free to adjust the volume knob in front of you for the best hearing conditions.

You are being asked to participate in a scientific study. It will in no way affect your grade, but the value of the study depends on your cooperation. You are asked to listen carefully and to follow instructions. You will now hear a sample of the type of messages you will hear under test conditions. (sample introductory message of two minutes in length)

The type of messages which you are about to hear will be similar to that you just heard. You will hear a total of eight messages. Listen carefully; When told to do so, open the booklet which you have received to page five. After you have heard the first message, begin to mark the answer sheet with the corresponding answers you feel are correct. You will find arrows on every page which are positioned in the same way as those on page five. By aligning the arrows on the page with the arrows to the left of the answer column headed "Page Five," you will avoid having to make an alignment when you turn to page
five. Make sure that each time you turn a page of the test booklet, the arrows on that page align with the arrows in the proper column on the answer sheet.

Remember to guess on answers you don't know. When you finish marking the answers for part one, sit quietly until the second message begins. Now turn to page five and align your answer sheet. (sixteen second pause, presentation of first message) Now, answer the questions to part one. (two-minute testing period)

Turn to page six, and listen for the second message. (presentation of second message) Now that you have heard the second message, mark the answers for part two. (one-minute test period)

We are now ready for the third message. (presentation of part three) Answer the questions for part three. (one-minute testing period)

Turn to page seven, align your answer sheet, and listen to part four. (presentation of part four) Answer the questions to part four. (one-minute testing period)

Listen now to part five. (presentation of part five) Answer the questions for part five. (one-minute testing period)

Turn to page eight, align your answer sheet again, and listen to part six. (presentation of part six) Answer the questions to part six. (one-minute testing period)
We are now ready for part seven. (presentation of part seven) Answer the questions for part seven. (one-minute testing period)

Turn to page nine, align your answer sheet once again, and listen to the final selection. (presentation of part eight) Answer the questions to part eight. When you have finished with part eight, fill out the brief questionnaire on the side of the answer sheet, and make certain that you have given some answer to all questions. (one-minute testing period)

You have used all the time allowed for the test. When you have filled out the questionnaire on the side of the answer sheet, you are free to go. Leave your test paper and all other materials on the carrel. Thank you once again for your assistance with this project.
APPENDIX B

INSTRUCTIONS PRESENTED TO
AUDIO-OCULAR GROUPS

If you can hear me, please raise your right hand.
(five second pause) Feel free to adjust the volume knob in front of you for the best hearing conditions.

You are being asked to participate in a scientific study. It will in no way affect your grade, but the value of the study depends on your cooperation. You are asked to listen carefully and to follow instructions. You will soon hear and see a sample of the type of messages you will be given under test conditions. Just inside your test booklet you will find a loose copy of the first message. Try to read the passage from the printed page as you hear it over your earphones. (two-minute introductory message)

The type of messages which you are about to hear will be similar to that you just heard. You will hear a total of eight messages, and will answer a few questions about each of the messages. In each instance, follow what you hear by reading the passage from the printed page.

Listen carefully. When told to do so, open the booklet which you have received to page five. After you