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THE EFFECT OF FIXED AND LEARNER SELECTED RATES OF COMPRESSED SPEECH IN AN AUDIO-TUTORIAL LEARNING ENVIRONMENT ON THE ACHIEVEMENT OF COLLEGE LEVEL STUDENTS

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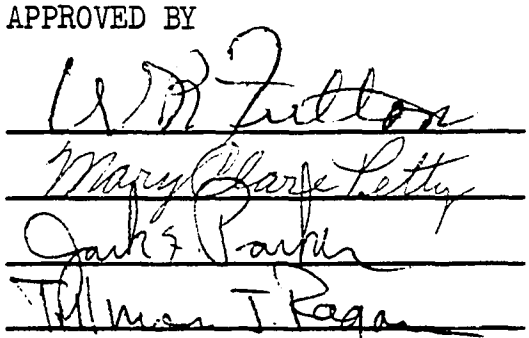
THE EFFECT OF FIXED AND LEARNER SELECTED RATES OF COMPRESSED SPEECH IN AN AUDIO-TUTORIAL LEARNING ENVIRONMENT ON THE ACHIEVEMENT OF COLLEGE LEVEL STUDENTS

APPROVED BY



DISSERTATION COMMITTEE

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

THE EFFECT OF FIXED AND LEARNER SELECTED RATES OF COMPRESSED SPEECH IN AN AUDIO-TUTORIAL LEARNING ENVIRONMENT ON THE ACHIEVEMENT OF COLLEGE LEVEL STUDENTS

CHAPTER I

INTRODUCTION

Background for the Study

The "Knowledge Explosion" about which so much has been said in the last few years has established the conditions for the educational problem which this investigation addresses. The problem has three major dimensions, each of which plays an important role in determining the learning objectives of college courses. The first dimension pertains to the difficulty in delimiting the scope of the subject area content as it relates to a given educational level, e.g. freshman, junior, or graduate level. The second dimension is that of depth in each of the components of the major subject field. The third dimension, against which the other two must be balanced, is time. The instructor is constrained by the number of lecture hours available in a given semester. The

student is constrained by the number of non-classroom hours available in which to pursue his studies in order to satisfactorily complete each course.

A recent technological development in the area of verbal information dissemination embodies a potential means for alleviating the foregoing problem to a significant degree. The development, known as accelerated or compressed speech, is the product of a technique of electronically sampling recorded speech, whereby one can listen to and comprehend audio recordings in considerably less time than was taken to deliver the original material.[1] The sampling circuits within the latest speech compression equipment reproduce a recording at an accelerated rate without distortion of pitch or tone, by shortening pauses and vowel sounds while retaining the articulation and voice identification qualities of the original recording.

It is technically possible to incorporate compression features in dial access information retrieval systems. The addition of this capability at institutions where students have access to listening carrels from which they can select recorded lectures, could result in the savings of student learning time, tape usage, and tape storage, while maximizing use of the carrels.

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[1]Emerson Foulke and Thomas G. Sticht, "Review of Research on the Intelligibility and Comprehension of Accelerated Speech," Psychological Bulletin, Vol. 72, No. 1 (1969), 50-62.

The academic application of compressed speech is not limited to student use. Presentations by authorities at seminars, conferences, and conventions, can be made available in audio form long before printed copies, particularly journal articles, are available. The timely availability of such information, compressed to the desired listening rate of the user, could provide considerable assistance in keeping professionals abreast of developments in their areas of specialized knowledge.

If it can be established that the use of compressed speech is both educationally sound and academically feasible, a significant contribution in the alleviation of the problem of assimilation of greater amounts of verbal information within a given period of time will have been made.

Fifteen years ago C. R. Carpenter said,

> Time is an indispensable factor in learning. Therefore, the rate of presentation of information in relation to the comprehension rates of students is a fundamental consideration. The presentation-comprehension rates not only interact but these rates interact with other variables. Of these other variables the demand made on the learners by the number, complexity, and subjective difficulty of the materials are most important. Therefore, the pacing or determination of the rate of presentation of a body of information is a problem which must be solved for all instructional materials and methods. This pacing is particularly difficult to estimate for those media . . . where student responses cannot regulate the predetermined or remotely determined rate of presentation. Decisions are required on what is the optimum rate of presentation for specific information to be learned by students with given characteristics.[2]

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[2]C. R. Carpenter, "Psychological Concepts and Audio-visual Instructions," AV Communication Review, Vol. 5, No. 1 (1957), 368.

Whereas considerable research has been conducted on the rate of presentation of information in visual formats such as rapid reading, films, slides, and television, very little research has been conducted in the area of audio information presentation rate in a learning environment. The entry, in 1972, of three companies into the educational equipment market with speech compression devices, underscores the immediate requirement for such research. The fact that two of these companies were formed exclusively for the production and sale of speech compression devices further substantiates the need for research upon which to base decisions about acquisition of such devices for educational purposes.

Statement of the Problem

The problem of this study was to determine 1) whether or not the use of various compression rates of recorded audio information in a college level course significantly effected achievement as measured by objective examinations, 2) the extent to which learner selection of the compression rate influences the level of comprehension/achievement as measured by the same tests, and 3) the degree of student satisfaction with learning via compressed speech, as measured by an affective questionnaire.

Limitations of the Study

The study was limited to compression rates 20%, 25%, 30%, 40%, 50% and 55%; to achievement in the cognitive area

as measured by objective, multiple choice, recognition examinations; and to college juniors and seniors. The study was also limited by the single speech compression equipment employed, as well as by the uncategorized cognitive level of the recorded subject matter.

Purpose of the Study

The purpose of this study was 1) to determine if the application of compressed speech recordings in a learning environment is a procedure which is educationally sound, 2) to assess student preference in regard to this medium, and 3) to collect data which could serve as the basis for decisions regarding the academic practicability of compressed speech as an additional tool of learning.

Questions

The following major questions regarding the use of compressed speech in a learning environment were addressed:

1. Can college junior and senior level students use compressed speech in an audio-tutorial laboratory and achieve as well as students using normal rate speech?
2. Would the option of selecting one's own rate of compression for any given audio-tutorial unit produce a different effect on achievement or attitude toward compressed speech than being assigned a fixed rate of compression for all such units?

3. Would students with low grade point averages do better with compressed speech than with normal rate speech?
4. Would students with high grade point averages do better with compressed speech than with normal rate speech?
5. Would the use of compressed speech actually result in a saving of time without negatively affecting student achievement or attitude?

Hypotheses

The following five null hypotheses were tested in this study:

1. Students who learn from compressed recordings will not score significantly different on end of course examinations than students who learn the same material from non-compressed recordings.
2. Students who can select their own rate of compressed speech for each of several audio-tutorial units will not score significantly different on end of course examination from students who are assigned one rate of compressed recordings for all units.
3. There will be no significant difference in attitude toward compressed speech between students who select their own rate of compression and

students who are assigned a fixed rate of compressed recordings.

4. There will be no significant interaction between entering grade point averages and achievement scores with different rates of compressed recordings.
5. There will be no significant interaction between the amount of time spent in audio learning activities in which different rates of compressed recordings are used, and scores achieved on end of course examinations.

Additional Research Questions

The following eleven additional questions are secondary to those cited earlier. They deal not with achievement, and the cognitive domain, but rather with student satisfaction, and consequently, the affective domain. They are listed separately, and in this order, to facilitate comparison with the results of the affective questionnaire:

1. Will students express a desire to use compressed speech in other college level courses?
2. Will the students who listen to compressed speech perceive it as impeding learning by raising their level of anxiety?
3. Will students feel that they must control the compression rate in order to maximize learning with compressed speech?

4. Will listening to compressed speech be perceived as more fatiguing than listening to normal rate speech?
5. Will the use of filmstrips in conjunction with compressed speech be perceived as detracting from the effectiveness of compressed speech?
6. Will students express a preference for a particular rate of compression?
7. Will students who exercise control over the rate of delivery of information, on the average, tend to select a common rate of compression?
8. Does the use of compressed speech involve serious administrative or equipment problems which would make its use academically impractical?
9. Will students who have completed a course which uses compressed speech feel that, with practice, a person can advance to increasingly higher rates of compressed speech?
10. Will students who have completed a course which utilizes compressed speech feel that the state of the art is sufficiently developed to be adopted as a common educational practice?
11. Will students who have completed a course which utilizes compressed speech indicate that excessive replaying of compressed speech recordings is necessary for satisfactory understanding?

Population and Sample

The population from which the sample was drawn consisted of college juniors and seniors enrolled in the Fall semester, 1972 basic audiovisual course in the College of Education, University of Oklahoma. The title of this required course is, Education 4160, "Media and Technology in Teaching." A table of random numbers was used to assign the 96 students to one of the following four groups:

Group I --Control Group, normal rate speech; WPM 120.

Group II --Exp. Gp. (E_1), 30% compression; WPM 174.

Group III--Exp. Gp. (E_2), 40% compression; WPM 200.

Group IV --Exp. Gp. (E_3), compression factor at students discretion.

After the students were assigned to the experimental groups, the mean GPA (Grade Point Average) for each group was computed to obtain a measure of homogeneity between groups. The results of that computation was:

	Group I	Group II	Group III	Group IV	Grand Mean
Mean GPA	2.74	2.88	2.70	2.83	$\bar{\bar{X}} = 2.79$

Statistical Treatment of the Data

A simple one-way Analysis of Variance (ANOVA) was computed to determine if a significant difference in achievement occurred between any of the experimental groups, or between them and the control group. A significant F-ratio was not obtained.

A two-way ANOVA was used to detect differences and interaction between compression rates for high and low achievers. A second two-way ANOVA was used to detect differences and interaction between compression rates for students with high grade point averages (GPA) and students with low GPA's. A third two-way ANOVA was used to detect differences and interaction between compression rates for students who spent the most time in the listening carrels and students who spent the least time in the listening carrels.

Organization of the Study

Chapter I provides the background for the study, statement of the problem, limitations of the study, purpose of the study, primary questions addressed by the study, hypotheses, additional research questions, population and sample, statistical treatment of the data, and organization of the study.

Chapter II is a review of pertinent selected literature which includes the theory base and relevant research, plus empirical studies of the intelligibility and comprehension of compressed speech.

Chapter III details the procedures for both the preparation and the conduct of the experiment including a description of instruments employed, and data on equipment and subjects involved, plus a description of the audio-tutorial laboratory used in the study.

Chapter IV presents the results of statistical treatments of data.

Chapter V provides the findings from both the questionnaire and from the analysis presented in Chapter IV, plus conclusions and recommendations for further study.

Bibliography.

Appendices.

CHAPTER II

A REVIEW OF SELECTED LITERATURE

The present study was designed to determine if the use of compressed speech, with its potential for the saving of time, could be employed as a satisfactory means of content presentation. The higher rates of delivery of audio information, particularly when combined with simultaneous viewing of visual information might conceivably bring about information overload conditions and thereby detract from learning. The handling capacity of the human information processing system, both in general and when subjected to different sense modalities then becomes a matter of concern. This is particularly pertinent when the feasibility of various information presentation rates are being considered.

Additionally, the process of compression itself might confound the intelligibility of the speech, thus lowering a student's comprehension, and again result in detraction from learning. Accordingly, the following studies are reviewed in order to place those factors in proper scientific perspective.

Relevant Research in Human Information Handling Capacity

The field of information theory is one which is directly related to the utilization of compressed speech as a tool of learning. The results of published research in this field, specifically in the area of human information handling capacity, is somewhat confusing. Some of the confusion is brought about by the use of the term "bit," in that sometimes the researcher is reporting the capacity of sense nerves to transmit information, while at other times he is referring to the ability of the human brain to process information. The later is reported as "bits," while the former is reported as "bits per second."

In his article dealing with "the span of absolute judgement," Miller defined a "bit" of information as, "the amount of information needed to make a decision between two equally likely alternatives."[1]

Licklider and Miller have reported the information handling capacity of the ear to be 50,000 bits per second (bits/sec.).[2] However, when one reviews the operation of the ear under various conditions, as reported by Jacobson a maximum rate of 70 bits/sec. is found for the category of

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[1]George A. Miller, "The Magical Number Seven, Plus or Minus Two: Some Limits on our Capacity for Processing Information," Psychological Review, Vol. 63, No. 2 (1956), 83.

[2]J. C. R. Licklider and G. A. Miller, "The Perception of Speech," in Handbook of Experimental Psychology, ed. by S. S. Stevens (New York: Wiley, 1951), pp. 283-290.

listening to music.[3] This could be interpreted to mean that the efficiency of the information processing function of the ear itself is little more than one tenth of 1 per cent.

Jacobson also reported the physiological information processing capacity of the human ear to be 8,000 bits per second. Since the cells in the ear which transfer information have been numbered as about 29,000, division into Jacobson's estimate gives a rate of information transfer of .28 bits/sec. In his later work, Jacobson reported the information handling capacity of the eye to be 5 bits/sec.--a considerably higher rate than he had reported for the ear.[4] Travers made this comment about Jacobson's findings.

> This comparison of the two sets of fibers may appear on the surface to account for differences in the information capacity of the two modalities, but the comparison is based on the assumption that both nerve tracts use a binary coding system whereas the auditory tract does not. . . . The data discussed here do not lead to the conclusion that a greater quantity of useful information can be supplied through the human eye than through the human ear . . . what is much more important is the fact that the brain is capable of utilizing at the highest levels less than 1 percent of the information provided by the ear and perhaps only 1 part in 250,000 for the eye.[5]

Having reestablished the operational possibility of the ear to handle compressed speech, let us examine a few

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[3]H. Jacobson, "The Information Capacity of the Human Ear," Science, Vol. 112 (1950), 143-144.

[4]H. Jacobson, "The Information Capacity of the Human Eye," Science, Vol. 113 (1951), 292-293.

[5]Robert M. W. Travers, Mans Information System (Scranton, Pa.: Chandler Publishing Co., 1970), p. 76.

more closely related investigations. Quastler and Wulff whose analysis was similar to Jacobson, arrived at an average rate of 6 to 12 bits/sec. and a maximum rate of 25 bits/sec. for continuous reception of speech.[6] In arriving at this rate, Quastler and Wulff took into account the limitations imposed by the English alphabet, the redundancy of English, and the time consumed in the actual reception of components of speech, such as vowels and pauses.

The information rate of the human audio channel was investigated by Pierce and Karlin who concluded that 43 bits/sec. was a satisfactory working approximation.[7] They arrived at this figure after manipulating the results of several subjects reading aloud as fast as they could. Pierce and Karlin were attempting to determine information capacity for audio reception based upon transmission limitations. They did not succeed in demonstrating that this was a satisfactory approach. What they did succeed in establishing was a measure of the limits of human speech transmission--prior to the advent of compressed speech.

Research on information processing capacity under various conditions such as that reported by Hartman,[8]

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[6]H. Quastler and V. J. Wulff, Human Performance in Information Transmission, University of Illinois Report No. 62 (Urbana: Control System Lab., 1955).

[7]J. R. Pierce and J. E. Karlin, "Reading Rates and the Information Rate of Human Channels," Bell Systems Technical Journal, Vol. 36 (1957), 497-516.

[8]E. B. Hartman, "The Influence of Practice and Pitch

Pollack,[9] Garner,[10] and Pollack and Fricks,[11] gives evidence of a much greater human processing capability than is in use today, even though Travers suggested that the brain is capable of processing less than one per cent of the information conveyed by the auditory mechanism.[12] Broadbent accounted for this disparity between the information handling capacity of the ear and the processing ability of the brain by interposing a filtering function in the central nervous system.[13] George A. Miller's article referenced earlier is considered by information theorists to be a classic. Miller's carefully expounded thesis was that when it comes to absolute judgements--in the psychological testing sense--the effective processing capacity of the human system averages only 7 bits, plus or minus two.[14] In a recent article, Hsia pointed out

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Distance Between Tones on the Absolute Identification of Pitch," American Journal of Psychology, Vol. 67 (1954), 1-14.

[9]I. Pollack, "The Information of Elementary Audio Displays," Journal of Acoustical Society of America, Vol. 25 (1952), 745-750.

[10]W. R. Garner, "An Information Analysis of Absolute Judgement of Loudness," Journal of Experimental Psychology, Vol. 46 (1953), 373-380.

[11]I. Pollack and L. Fricks, "Information of Elementary Multi-dimensional Auditory Displays," Journal of Acoustical Society of America, Vol. 26 (1954), 155-158.

[12]Travers, Information System, p. 81.

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

[14]Miller, Magical Number.

the central limiting factor in human information processing capacity. He said,

> The range is limited . . . but the variation within the range is partly the result of different measurements or calculations of information and in no way perfectly reflects the auditory and visual information processing capacity which is of course subject to the weakest link in the chain, i.e. the information processing capacity of the central nervous system.[15]

In the same article Hsia commented on G. A. Miller's work, and also reported a most relevant finding by Klemmer and Muller:

> Using other bases of measurement instead of the basic discriminatory capacity . . . the information processing rate is found to differ. Based on a study of the transmission of language-encoded information, G. A. Miller (1951) has reported that there are about 12.5 sounds/sec. Supposing that they are equally probable and independently selected, a speech given at average speed would convey information at a rate of 67 bits/sec. In view of the fact that vowels and consonants in English tend to alternate, the estimate becomes only 46 bits/sec. Finally, on the basis of Zipf's law, Miller further lowered the estimate to 10.6 bits/sec. As man can speak about 3 words/sec, the transmission rate can be no more than 32 bits/sec. (This, of course, is the limit imposed by normal, non-compressed speech.) Since redundancy of English is about 50 percent (Shannon & Weaver, 1949 p. 104), assuming an equally probable distribution over a vocabulary of 5,000 words spoken at a rate of 1.5 words/sec. an information rate of 16 bits/sec. is reached. . . . Klemmer and Muller (1953) who studied varying information rates pointed out that there was nearly linear increase in the transmitted information until a peak was reached, after which the transmission rate fell markedly. The decay of performance following the peak can be traced directly to information overloading.[16]

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[15]H. J. Hsia, "The Information Processing Capacity of Modality and Channel Performance," AV Communication Review, Vol. 19, No. 1 (1971), 59.

[16]Ibid., 60.

From the foregoing, it seems that the possibility exists that there are optimum rates of information handling capacities which lie below the "information overload" threshold, but yet far above the delivery rates commonly used in education today. The threshold would be expected to vary from individual to individual and in accordance with single or multiple modes of information presentation.

It has been established that the central nervous system processes information "in the form of trains of impulses (Fassard, 1961)."[17] Precisely how this processing is accomplished is not yet understood. However, it is known that as the amount of information to be processed is increased, the amount of information loss increases proportionately. Foulke et al. conducting experiments with speech compression, and using literary and technical selections, found listening compression to be only slightly affected by increasing word rate in the range 175-275 WPM (words per minute). However, from 275-375 WPM, they found an accelerating loss in listening comprehension as word rate increased.[18] One of the purposes for conducting the present research was to determine if achievement is affected in this same manner when the information presented is requisite to the satisfactory completion of an on-going college level course of instruction.

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[17] Ibid., 57.

[18] Emerson Foulke, et al. "The Comprehension of Rapid Speech by the Blind," Exceptional Children, Vol. 29 (1962), 134-141.

Foulke's study did not address this particular aspect.

Hartman, in an excellent review of single and multiple-channel communications, quoted several propositions by Cheatham, five through nine of which are applicable to this study:[19]

5. Speech (as one form of auditory stimuli) offers greater flexibility such as off-the-cuff variations in connotations, nuances, and inflection. Visual stimuli, on the other hand requires advance coding.
6. The 'selectivity' of messages in speech offers a time advantage since the pertinent information is already selected for the receiver. With visual stimuli, however, searching for information may be necessary, as in looking for information from tables, charts, maps, etc.
7. The rate of transmission of speech is limited to the speaking rate, whereas visual presentations can be faster.
8. Auditory stimuli are more 'attention-demanding'; they 'break-in' on the attention of the operator. Visual stimuli, however does not necessarily have this captive audience; the operator has to be looking toward the display in order to receive the stimulus.
9. Hearing is somewhat more resistant to fatigue than vision.[20]

The foregoing statements were not quoted for the reason that they favor auditory over visual as a means of human information input. As many examples, from an equal number of researchers in information theory, are available that favor visual input.[21] The above propositions have been

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[19]Frank R. Hartman, "Single and Multiple-Channel Communications: A Review of Research and a Proposed Model," AV Communication Review, Vol. 9, No. 6 (1961), 235-262.

[20]P. G. Cheatham, A Comparison of the Visual and Auditory Senses as Possible Channels for Communication, U.S. Air Force Technical Report 5919 (PB 110278), (Air Material Command, 1950).

[21]For example see R. H. Henneman, and E. R. Long, A Comparison of the Visual and Auditory Senses as Channels for

mentioned because they reflect some of the basic assumptions of the writer. One of the aims of this study was to assess the current validity of statements 5, 6, 8 and 9 under conditions imposed by speech compression; a technique which was little known in Cheatham's time as evidenced by his seventh proposition.

Intelligibility and Comprehension Studies

In addition to the literature reviewed previously, which forms the theory base for this experiment, comment will now be made on the reports of research studies dealing expressly with the investigation of intelligibility and comprehension of accelerated speech. Although it is not critical to the results which will be discussed, it should be noted that the equipment used in these earlier studies might be considered as first and second generation speech compression devices which did not allow for selective deletion, i.e. pause deletion and/or vowel sampling, but rather deleted both sound and silent portions indiscriminately.

As a common point of departure for the purpose of this research, the average conversational rate, as determined by Nichols and Stevens will be accepted.[22] That rate is 125 WPM (words per minute). Johnson, Darley, and Spriesterbach

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Data Presentation, U.S. Air Force Technical Report 54-363 (WADC, 1954).

[22]P. G. Nichols and L. A. Stevens, Are You Listening? (New York: McGraw Hill, 1957), p. 78.

found the median oral reading rate to be 176.5 WPM.[23] Separate studies conducted by Foulke established the mean oral reading rate as 174 WPM.[24]

Several studies have been conducted over the past twenty years which have focused on the comprehension and intelligibility of compressed speech. Diehl et al. found no change in listening comprehension with changes in word rate within the compression rate of 126-272 WPM.[25] Without reference to actual word rates, Nelson[26] and Harwood[27] found slight but insignificant loss in listening comprehension as WPM increased. A study by Harwood, conducted seven years later, resulted in similar findings. Fairbanks et al. found little difference in comprehension of listening selections at 141, 201, and 282 WPM. Thereafter, comprehension, as indicated by the percentage of test questions correctly answered, declined from 58% at 282 WPM to 26% at 470 WPM.[28]

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[23]W. Johnson, F. Darley, and D. C. Spriesterbach, Diagnostics in Speech Pathology (New York: Harper Rowe, 1963).

[24]U.S. Department of Health, Education, and Welfare, The Comprehension of Rapid Speech by the Blind, by Emerson Foulke, Project No. 2430 Part III (Washington, D.C.: Office of Education, 1967).

[25]C. F. Diehl, R. C. White, and K. Burke, "Rate and Communication," Speech Monographs, Vol. 29 (1959), 229-232.

[26]H. E. Nelson, "The Effect of Variations of Rate on the Recall of Radio Listeners of Straight Newscasts," Speech Monographs, Vol. 15 (1948), 173-180.

[27]K. A. Harwood, "Listenability and Rate of Presentation," Speech Monographs, Vol. 22 (1955), 57-59.

[28]G. Fairbanks, N. Guttman, and M. S. Miron, "Effects

This result represents a finding which is near chance.

Foulke and Sticht found a 6% loss in comprehension between 225 and 325 WPM and a 14% loss from 325 to 425 WPM.[29] They reported that they found an initial moderate linear decline in comprehension, followed by an accelerating decline. A rapid decline in listening comprehension that commenced beyond a word rate of approximately 275 WPM, regardless of the percentage of compression required to achieve that rate, was found by Fairbanks, Guttman and Miron, Foulke et al., and Goldstein.[30]

Foulke investigated the effect upon the listener's comprehension when different speakers recorded the same material. He compressed the same material read by three different readers to 275 WPM. The administration of a listening comprehension test over this material showed that significant differences were associated with the speaker variable and with the word-rate variable. However, the speaker's effect on listening comprehension did not depend upon the

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of Time Compression Upon the Comprehension of Connected Speech," Journal of Speech and Hearing Disorders, Vol. 22 (1957), 10-19.

[29]Emerson Foulke and Thomas Sticht, "The Intelligibility and Comprehension of Accelerated Speech," in Proceedings of the Louisville Conference on Time Compressed Speech (Louisville, Kentucky, 1967).

[30]Fairbanks, Guttman, and Miron, Connected Speech; Foulke et al., Rapid Speech; H. Goldstein, "Reading and Listening Comprehension of Various Controlled Rates," Teachers College Contributions to Education, No. 821 (1940).

word rate at which the selection was presented.[31]

A positive relationship between intelligence and the ability to comprehend accelerated speech was found by Fairbanks et al., Goldstein and Nelson.[32] A significant positive correlation between reading rate and the ability to comprehend accelerated speech was reported by Goldstein, and Orr, Friedman and Williams. They also found that practice in listening to compressed speech resulted in improvement of reading rate.[33] Goldstein and, Jester and Travers found simultaneous reading and listening at 350 WPM resulted in better comprehension than either mode alone.[34] Thames and Rossiter reported significant gains in reading rate with the use of compressed speech as a pacing device.[35]

Watts, in an experiment whereby he presented recorded

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[31]U.S. Department of Health, Education, and Welfare," The Comprehension of Rapid Speech by the Blind, by Emerson Foulke, Project No. 1370 Part II (Washington, D.C.: Office of Education, 1964).

[32]Fairbanks, Guttman, and Miron, Connected Speech; Goldstein, Reading and Listening; Nelson, Recall of Radio Listeners.

[33]Goldstein, Reading and Listening; A. B. Orr, H. L. Friedman, and J. C. C. Williams, "Trainability of Listening Comprehension of Speeded Discourse," Journal of Educational Psychology, Vol. 56 (1965), 148-156.

[34]Goldstein, Reading and Listening; R. Jesters and R. M. W. Travers, "Comprehension as a Function of Rate and Modality of Presentation" (paper presented at the meeting of the American Psychological Association, Chicago, 1965).

[35]Kenneth H. Thames and Chas. M. Rossiter Jr., "The Effects of Reading Practice with Compressed Speech on Reading Rate and Listening Comprehension," AV Communication Review, Vol. 20, No. 1 (1972).

lectures compressed approximately 37% to senior U.S. Air Force Officers attending an instructor course, found that the students listening to compressed speech achieved approximately the same as the students listening to live lectures. He also stated in his abstract that "portions of the experiments indicated significant advantage for compressed materials." The word rate reported by Watts for his experiment was approximately 250 WPM. His conclusion was that ". . . the observed achievement for subjects as well as their attitudes toward experimental materials seem to offer strong encouragement for the increased use of compressed speech materials for adult student populations." (p. 18) Watts restricted the generalization of compressed speech to "adults," since he defined his sample as military adults, virtually all of whom were college educated.[36]

Short found no significant differences in post tests scores of college students in a nutrition class using speech compressed to 20%, 30% and 40% when compared with scores of students in the same class who listened to normal rate recordings. She also reported that students spent 40% to 50% more time in the carrel area when listening to compressed tapes--over the original recording time--whereas students listening to non-compressed tapes spent about 100% more time in the carrel area than the original recording time. When

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[36]Meridith W. Watts Jr., Using Compressed Speech to Teach Instructional Techniques to Air Force Officers, Department of Instructional Technology Report (Alabama: Maxwell Air Force Base, 1969).

students were allowed to chose their compression rates, the greatest percentage (41% of the students) chose the 20% compression rate, while 28% chose the 30% compression rate. (Six per cent chose 40% compression while the rest of the students preferred normal rate recordings.)[37]

Summary

The preceeding review of selected research in the field of information theory demonstrates the existence of limitations in human information handling capacity, attributable to both physiological and psychological causes. It is also evident from this research that the human information handling capacity has the potential to deal with rates of information which are much higher than those which are intuitively considered as "normal." The major limiting factor appears to be a lack of capability to cognitively process audio information which is delivered at too high a rate.

The pragmatic research has established that humans are capable of handling accelerated audio information when such acceleration does not destroy the intelligibility of the speech, or exceed the rate at which it can be processed.

These findings provide the basis from which this investigation proceeds in an attempt to find answers to the

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[37]Sarah H. Short, "The Use of Compressed Speech Tapes in a Multi-Mediated Learning Laboratory" (paper presented at the annual convention of the Association for Educational Communications and Technology, Minneapolis, 1972).

questions posed by the problem hypotheses, and the additional research questions listed in Chapter I.

CHAPTER III

METHODS AND PROCEDURES

The Environment of the Experiment

The recordings used constituted an automated, self-instructional portion of the course "Media and Technology in Teaching," and cover historical development, production techniques, and current utilization procedures for audio-visual materials. There were 16 recorded readings (units) with accompanying 35mm film strips. All recordings were made by the same instructor, whose mean reading rate was 120 WPM. That this is below the mean found by Foulke is accounted for by two factors; 1) the material of this course is consistently more technical in nature than the material used by Foulke's readers, and 2) the present reading is interspersed with accompanying film strips.[1] It should be noted that Short's study used recordings which averaged 110 WPM before compression. Short accounted for this rate for much the same reasons as given in 2 above plus the attempt to keep a more

[1] Foulke, Comprehension of Rapid Speech by the Blind, Project No. 2430.

conversational, one to one relationship built into the audio-tutorial learning environment.[2]

Individual carrels and individual headsets were not used in the Watts experiment. The implied suggestion contained in the following statement by Watts about his study, was heeded in the present design:

> It is suspected, though, that student attentiveness may have been greater if the experience had been more "Privatized" using earphones and study carrels to reduce distraction.[3]

All subjects listened to the recordings while viewing the filmstrips in individual listen/viewing carrels.

The subjects in the present experiment wore headsets and had individual control over the volume of the recording to which they were listening; however, they could not adjust the tone.

To control the variable of audio equipment performance, all tape decks in the carrels were serviced prior to the start of the experiment. This included the standardization of each position's playback heads with a Nortronics AT-100 azimuth and amplifier alignment tape.

Of the total number of subjects participating in the experiment, 74% equally and randomly distributed among the four groups, were given a hearing test on a Beltone model 10C, calibrated to 1964 ISO values. No significant hearing losses

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[2]Short, Multi-Mediated Learning Laboratory.

[3]Watts, Air Force Officers, p. 4.

were detected. The hearing test was administered to establish the subject's ability to hear the audio tone which prompted them to advance the filmstrip viewer to the next frame. This procedure was incorporated because it was felt that the student who did not keep the audio and visual information in synchronization would quickly become frustrated and thereby develop a negative attitude toward the entire audio-tutorial procedure.

Specific frequencies checked were 125, 250, 500, 1,000, 2,000, 4,000, and 8,000 Hz, over a DB range from -10 to +50. See Appendix A for a sample of the audiological assessment sheet.

The listening/viewing carrels were arranged in two rows of six and one row of nine in a standard language lab configuration. Subjects in the carrels all faced forward toward the control console. The carrels had opaque acoustical separating panels on both sides and a clear plexiglass panel at the front which allowed observation of the subjects from the master console. The carrels were located in an enclosed, quiet corner in the rear of an instructional media center. Entry to the area was from a single doorway in the rear, so that there was little distraction from people passing the area. Since the area was located on the second floor, the windows along one wall offered no distraction from passers-by. The building had central heating and air conditioning and the temperature remained, with little variation, at 77 degrees.

The audio tape recordings which the subjects were directed to use were located on separate book shelves in the rear of the carrel area, and labeled with the group numbers: I, II, III, or IV. Subjects in group IV were allowed to select tapes from the group IV shelves which had compression rates of 20%, 25%, 50% and 55%, or from the group II (30%) or group III (40%) shelves. They were directed not to use group I (no compression) tapes.

All subjects received an orientation on the operation of carrel equipment, the time sheet, and the selection and reshelving of both recordings and filmstrips. (See Appendix B for the orientation sheet given to each student.) An eight step instructional sheet, plus a sample completed time sheet was posted in each carrel. (See Appendix C for a copy of this sheet.)

The subjects also recorded the beginning and ending time of their listening activity on prepared time sheets. The time sheets were completed and turned in upon completion of each unit.

Selections of rates of compression by subjects in group IV were made a matter of record by the student, who entered this information on the time sheet.

The subjects were periodically spot checked while they were in the carrel area to insure that they selected tapes from and returned tapes to the proper shelf, that the selected unit (and for Group IV subjects the compression

rate) was being recorded correctly, and that the time entries were completed in the manner directed. All time sheets were examined at the end of each class day to ensure accuracy and completeness. Whenever errors were found, the student was asked to make the necessary corrections.

Pre-Experimental Considerations

In planning the design of this experiment, consideration was given to the fact that the subjects would be receiving information visually, through the simultaneous viewing of 35mm filmstrips. The position of Broadbent was considered, wherein he views the human processing of information from more than one source at a time as being filtered by a process analogous to a kind of flap valve which allows alternate, but not simultaneous passage of separate modes of informational input.[4] In Watts' Experiment II, one experimental group listened to compressed speech while viewing slides "designed to maintain visual interest and help guard against other visual distraction . . ." It was noted that when Watts compared this experimental group against a control group which listened to compressed speech without viewing slides he found, "the addition of visual materials in the form of slides did not increase learning in any measurable way."[5] On page 16 of this same report, Watts indicated that a

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[4]Broadbent, Perception and Communication.

[5]Watts, Air Force Officers, p. 11.

possible reason for this finding may have been because of the visuals employed. I tend to agree with this assumption. Even so, based partly on Watt's results, and on the fact that all subjects in the present research were to be exposed to the same visual information, it was concluded that the filmstrips could be treated as a common environmental condition.

In order to determine if simultaneous viewing of filmstrips does effect achievement, it would be necessary to assign a control group which would not use filmstrips. Since the vehicle for this experiment was an on-going college credit course for which a significant portion of the students' informational input had been prepared in a combined audio and visual format, to deprive some students of portions of the course content was felt to be impractical. However, statements 21 through 24 of the questionnaire were designed to obtain student reaction to learning from compressed recordings while simultaneously using visuals. See Appendix D.

Hartman made a comment relative to media researcher's use of print tests for subjects who had been presented information through auditory and/or visual channels. He said:

> With regard to the relation between the presentation of a communication and the conditions under which the effectiveness of the communication is tested, the amount of demonstrable learning from the communication increases as the similarity between testing conditions and the conditions of the original presentation increases. This conclusion may be predicted by extending the stimulus generalization concept of experimental learning theory. Another way of stating the generalization is that cues available when information is

> learned are of aid only if they are present when the information is tested.[6]

His point is well taken in those instances where the results of learning via one medium is being compared with the results of learning the same content presented via another medium. In the case of the present experiment, the use of a valid and reliable printed, objective, test is assumed to be appropriate since all students would receive the same subject matter information via the same channels. Also, what is being compared in this instance is the sum total of both audio and visual learning between groups, irrespective of the mode of transmission.

Consideration was also given to the best means of obtaining accurate measures of time that students would spend in listening to the recorded instructional units. For example, the question arises as to what conclusions about the saving of time could be reached if the subjects listening to compressed speech used up so much time in replaying portions of their tape that there would be no significant difference in the total amount of time spent on units in comparison with those subjects who listened to the non-compressed speech.

To structure the listening time for groups by allocating a set amount of time would be contrary to proper experimental procedure in this particular experiment, since actual student listening time had been designated as one of

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[6]Hartman, Single and Multiple Channel.

the dependent variables, not one of the independent variables. Accordingly, it was decided to obtain a measure of control over this variable by inserting the following statement in the student questionnaire:

26.	I think that in order to understand the information being presented by compressed speech it is necessary to continually replay parts of the recording.	SD	D	U	A	SA*

In addition, the total running time of the audio-tutorial units would be computed for each rate, and the time actually spent by the subjects in completing the units would be subtracted to determine if more time was consumed in replaying/notetaking activity by subjects using compressed speech than those listening to normal rate speech.

The decision to use a posttest--only versus a pretest-posttest design was influenced by two major factors. First, the circumstances extant at the institution: The college was in a period of transition from non-required to required courses whereby initial class periods of the course selected for the research were pre-empted for necessary explanation and orientation to the new procedures. A minimum of one class period was deemed absolutely essential to orient the students towards those procedures pertaining exclusively to the experiment. Further consumption of course time (approximately two hours) to administer an alternate form of the

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*This is how the statement appears in the questionnaire, to include the response selections SD (strongly disagree, D (disagree), U (undecided), A (agree), and SA (strongly agree). See Appendix D.

posttest, as a pretest, was considered to be not only awkward and inconvenient, but potentially damaging to student motivation and subsequently the experiment itself. Second, Campbell and Stanley's comments relative to the nonessentiality of pretests in true experimental designs where proper randomization procedures are employed.[7] Accordingly a pretest was excluded from the design.

One final consideration must be presented. This involves the rationale for assigning particular rates of compression to the first and second experimental groups. Watt's successful study reported a compression rate of approximately 37%.[8] Short reported success with speech compressed by 20%, 30%, and 40%.[9] As noted earlier, the word per minute rate of the compressed recording is dependent upon both the compression rate and the speaking or reading rate of the original recording. In the case of the present study, the compression of the original average word rate of 120 WPM by 40% resulted in a word rate of 200 WPM, while 50% compression brings the word rate up to 243 WPM. This last rate falls into the zone in which Foulke and Sticht found a 6% loss in

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[7]Donald T. Campbell and Julian C. Stanley, "Experimental and Quasi-Experimental Designs for Research on Teaching," in Handbook of Research on Teaching, ed. N. L. Gage (Chicago: Rand McNally Company, 1963), pp. 195-196.

[8]Watts, Air Force Officers.

[9]Short, Multi-Mediated Learning Laboratory.

comprehension, i.e. between 225 and 325 WPM.[10] Since the subjects in this experiment would be enrolled in a credit course, and in as much as the main purpose of this research is to determine if compressed speech affects achievement over the length of an entire semester, it was not considered ethical to jeopardize student's "normal" potential achievement by imposing "abnormal" (albeit experimental) learning conditions upon them. After considering the foregoing data, the mandatory compression rates for the first experimental group (E_1) and second experimental group (E_2) were set at 30% and 40% respectively. This having been done, the lower rates of 20% and 25% plus the higher rates of 50% and 55% were made available for selection by subjects assigned to the third experimental group, (E_3).

Choice of Experimental Design

Variables

The variables involved in this study were:

Dependent Variable --Achievement. Determined by scores obtained on posttests.

Dependent Variable --Time spent in learning. Determined by subtracting the running time of the recorded units from the time consumed by subjects, and comparing the

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[10]Foulke and Sticht, Intelligibility and Comprehension.

resultant between groups.

Independent Variable--Rate of delivery of information. Controlled by the assignment of given rates of compressed speech to selected groupings of subjects.

Assignment of subjects to groups

Working with the class roster and a random number table, the students were assigned to the following groups, 24 subjects per group. N=96.

Group I --Control group. Normal rate speech.

Group II --E_1. Compression = 30%.

Group III--E_2. Compression = 40%.

Group IV --E_3. Compression rate selected by subjects. Choice of 20%, 25%, 30%, 40%, 50%, or 55%.

Experimental design paradigm

The following experimental design paradigm was selected based upon the conclusions expressed in the earlier section of this report entitled, "Pre-experimental Considerations."

R X_1 O_1--X_1 = Normal rate speech.

R X_2 O_1--X_2 = 30% Compression.

R X_3 O_1--X_3 = 40% Compression.

R X_4 O_1--X_4 = Compression rate selected by subjects.

Statistical Design

A simple one-way analysis of variance (ANOVA) was first conducted to determine the effects of the independent variable of compression rate on achievement, using the following paradigm:

	COMPRESSION RATE			
	I	II	III	IV
ACHIEVEMENT				

The GPA (grade point average) for each student was obtained, and a two-way ANOVA was used to determine if there was significant differences in achievement over various compression rates, and if interaction occurred between GPA and the independent variable of compression rate. The following paradigm was used:

		COMPRESSION RATE			
		I	II	III	IV
GPA	HI				
	LO				

Another two-way ANOVA was conducted to determine if there was significant differences in achievement, over various compression rates, between high achievers and low achievers, and if there would be interaction. The following paradigm was used:

COMPRESSION RATE

ACHIEVEMENT	I	II	III	IV
HI				
LO				

A third two-way ANOVA was used to determine if there was significant interaction between time spent in learning, over various compression rates, and the independent variable of achievement. This ANOVA used the following paradigm:

COMPRESSION RATE

TIME SPENT IN LEARNING	I	II	III	IV
MOST				
LEAST				

Instruments Used

The instruments used in this study were: 1) a 78 item multiple choice midterm examination (Appendix E), 2) a 54 item multiple choice final examination (Appendix F), and 3) a 29 item attitude questionnaire. (Appendix D)

Achievement tests

The content validity of both the midterm and final examination was established by expert judges, currently engaged in educational media and technology instructional activities, who assessed and favorably reported on both the face and sampling validity.

To assess the reliability of the midterm and final examination, a Kuder Richardson formula 20 reliability

estimate was computed. For the midterm, r=.88. For the final examination r=.73 for form A and r=.74 for form B.[11] An item analysis of both examinations revealed that the items discriminated well.

Concurrent validity of the midterm and final examinations had been established via previous administrations to students in this course with subsequent correlation of student scores on the examinations with grade point averages.

No attempt was made to determine the construct validity of the examinations. This decision should not be interpreted to infer that the tests do not in fact possess some measure of construct validity, rather that the present researcher felt that the determination of such validity for these particular tests would add nothing to the pragmatically determined content and concurrent validity. Additionally, this researcher holds with Bechtold who stated that logical precision is lacking in procedures thus far evolved for determining construct validity. There remains too many vaguely defined variables in these procedures to allow easy extrapolation to operationally identifiable concepts.[12]

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[11]James E. Wert, Charles O. Neidt, and J. Stanley Ahmann, Statistical Methods in Educational and Psychological Research (New York: Appleton Century Crofts, 1954), pp. 332-333.

[12]Harold P. Bechtoldt, "Construct Validity: A Critique," The American Psychologist, Vol. 14 (1959), 619-630.

Attitude Questionnaire

The design of the attitude questionnaire administered to each student subsequent to the midterm examination was based upon suggestions offered by Edwards.[13] The attitude scale values were first determined with the help of students enrolled in other courses in the College of Education who acted as judges. The students were asked to judge the favorableness or unfavorableness of several statements toward the psychological object--compressed speech--on a scale of 1 through 5. After judging and the resulting assignment of scale values to each statement, an item analysis was accomplished. Those statements which showed a high degree of variability were discarded and the remaining statements used in the final questionnaire. The questionnaire which the subjects completed employed a scale varying from minus two for "Strongly Disagree" to plus two for "Strongly Agree."

In addition to measuring attitude toward compressed speech, the questionnaire was designed to provide answers to some of the additional research questions addressed by this study.

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[13] A. Edwards, Techniques of Attitude Scale Construction (New York: Appleton, 1957), chaps. 7 and 9.

CHAPTER IV

RESULTS

Ninety-six junior and senior college students enrolled in the course, "Media and Technology in Teaching" were the subjects in this study. Experimental results of the study were based upon statistical analysis of student achievement on multiple choice, objective examinations. (See Appendix E and F) Descriptive results, in the affective domain, were based upon the subjects responses to a twenty-nine item questionnaire. (See Appendix D) Of the ninety-six students participating, fifty-seven per cent returned completed questionnaires.

Results of Testing the Hypotheses

Results of testing hypothesis one (1) and two (2)

Hypothesis one was stated as follows:

> Students who learn from compressed recordings will not score significantly different on end of course examinations than students who learned the same material from non-compressed recordings.

Hypothesis two was stated as follows:

> Students who can select their own rate of compressed speech for each of several audio-tutorial units will

not score significantly different on end of course examinations than students who are assigned one rate of compressed recordings for all units.

The maximum average score attainable for the combined midterm and final exam was 66. For the purpose of this experiment a raw score mean difference of five points was chosen by the investigator as the threshold indication of a practical difference.

TABLE 1.--Group means and standard deviation

Group	Compression Rate	$\bar{X}$	Standard Deviation	Grand Mean
I	0%	48.15	6.70	47.02
II	30%	47.52	6.55	
III	40%	46.06	5.27	
IV	20% - 55%	46.33	5.51	

The mean for subjects using normal rate speech (Group I) was 48.15 while subjects who listened to compressed speech achieved a mean score of 46.70, a difference of 1.45 raw grade points. Those subjects assigned to a fixed rate of compressed speech (Group II plus Group III) achieved a mean score of 46.79 while subjects who selected their own rate of compression achieved a mean score of 46.33. This latter figure represents a raw grade point difference of .46. Such small practical differences lent support to both hypothesis one and two.

To provide a statistical basis for conclusions, a

simple one-way analysis of variance was computed between the means of all groups. Alpha was set at .25 to minimize the risk of a type II error. No significant differences were found. Table 2 shows the result of that ANOVA.

TABLE 2.--One-way ANOVA between all groups

Variance	df	MS	F	Level of Significance
Between Groups	3	46.59	1.30	NSD
Within Groups	92	35.72		
Total	95			

α = .25

df 3,92 = 1.40

Null hypotheses one and two were retained.

Results of testing hypothesis three (3)

Hypothesis three was stated as follows:

> There will be no significant difference in attitude between students who select their own rate of compression and students who are assigned fixed rates of compressed speech.

Attitude toward compressed speech as a tool of learning was assessed through tabulation of subjects' responses to those items of the questionnaire which addressed hypothesis three. Since there was a choice of negative or positive responses to each item, the total value for an individual subject could range from -46 to +46. Table 3 shows the

resulting measure of attitude obtained from the questionnaire. The numerical value was derived by totaling the responses of all subjects within a group to the pertinent questionnaire items. SD (strongly disagree), D (disagree), U (undecided), A (agree), and SA (strongly agree), were scored -2, -1, 0, +1, and +2 respectively.

TABLE 3.--Attitude toward compressed speech

Group	Compression Rate	Value	Number of Respondents	Mean Value	Nr. of Neg. Responses	
I	0%	+202	16	+12.62	2	Individual Range
II	30%	+289	14	+20.64	0	
III	40%	+217	12	+18.08	1	-46 to
IV	20% - 55%	+263	13	+21.23	2	+46
$\bar{X}$ =		+242.75	13.75	+17.89	2.5	

Of the subjects responding to these specific items on the questionnaire, 91% expressed a favorable attitude toward compressed speech as a primary mode for learning subject matter. Those subjects who selected their own rates of compressed speech (Group IV) averaged .87 of a point higher on the attitude questionnaire than subjects who were assigned to fixed rates of compressed speech (Groups II and III). Because of this low obtained value, and because the actual difference in mean value between subjects assigned to 30% and

subjects assigned to 40% compression rates was itself 2.56, no statistical test was employed to test hypothesis three. Null hypothesis three was retained.

Results of testing hypothesis four (4)

Hypothesis four was stated as follows:

> There will be no significant interaction between entering grade point averages and achievement with different rates of compressed recordings.

Testing of the fourth hypothesis was accomplished by a two-way analysis of variance using rate of compression and GPA (grade point average) as main effects. For this analysis, normal rate speech was considered as having a compression rate of zero. Subjects in each of the four groups were ranked according to their GPA and the top one third was designated HI (GPA) and the bottom one third was designated LO (GPA). The achievement means of these divisions, for the control group and each of the experimental groups is displayed in Table 4. Figure 1 shows an interaction plot of the mean scores of the LO and HI GPA students over the various compression rates.

TABLE 4.--Means of HI GPA and LO GPA over various rates of compressed speech

		I	II	III	IV	Mean
GPA	HI	51.00	50.81	50.69	50.56	50.77
	LO	42.00	43.69	42.31	44.31	43.08
	$\bar{X}$	46.50	47.25	46.50	47.44	46.93

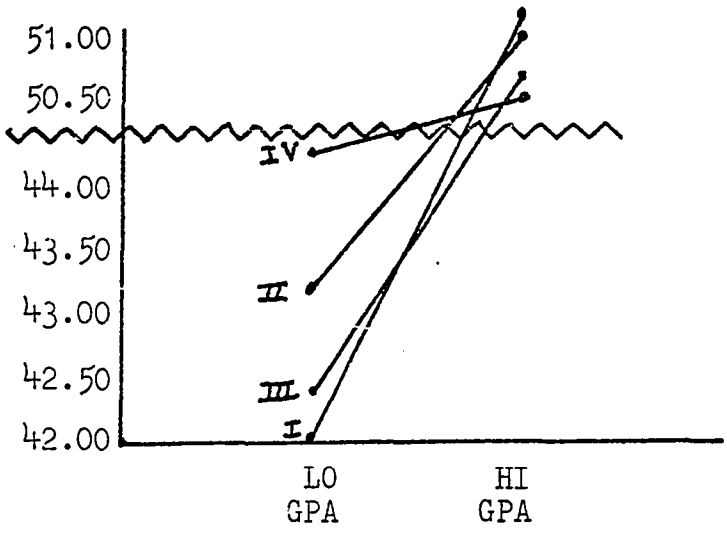


Fig. 1.--Interaction plot of HI GPA and LO GPA achievement means.

Although Figure 1 does show interaction to be present, the results of a two-way ANOVA, with compression rate and as main effects, and achievement as the dependent variable, indicates such interaction is not significant. (See Table 5.)

TABLE 5.--Two-way ANOVA comparing achievement over various compression rates with GPA

Source of Variance	SS	df	MS	F	Level of Significance
Between Columns (Rate)	11.67	3	3.89	.13	NSD
Between Rows (GPA)	945.56	1	954.56	32.36	.05
Columns by Rows (interaction)	9.29	3	3.10	.11	NSD
Between Groups	975.54	7	139.36		
Within Groups	1,652.07	56	29.50		
Total	2,627.61	63			

$\alpha = .05$ df 3,56 = 2.78

Null hypothesis four was retained.

Results of testing hypothesis five (5)

Hypothesis five was stated as follows:

> There will be no significant interaction between the amount of time spent in audio-tutorial learning activities in which different rates of compressed recordings are used and scores achieved on end of course examinations.

In addressing the fifth hypotheses, three questions were asked: 1) Did those subjects who achieved the highest scores for a given rate of compression spend consistently more time in learning activities than subjects who achieved the lowest scores with that same rate? 2) did subjects who spent more time with a given compression rate achieve significantly higher scores than subjects who spend less time with that same rate? and 3) was there interaction between achievement and time spent, with different compression rates?

To answer the first question, subjects in each group were ranked according to the average of their combined scores on the midterm and final examination. The top one third in each group was designated as HI achievers and the bottom one third was designated as LO achievers. Table 6 shows a comparison of the time spent by each group in listening, with the corresponding scores obtained.

It is apparent from inspection of Table 6 that the HI achievers in the control group (I) and in each of the experimental groups did spend consistently more time with the

audio-tutorial units than did the LO achievers. Accordingly, the answer to the first question was yes.

TABLE 6.--Time versus achievement of HI and LO achievers

Group	HI ACH Mean Time	Score	LO ACH Mean Time	Score	d(hr)
I	8:37	54.94	7:43	40.06	:54
II	8:18	54.88	6:35	40.31	1:43
III	6:26	51.93	5:14	40.69	1:12
IV	8:22	52.38	6:22	40.19	2:00
$\bar{X}$	7:56	53.53	6:29	40.31	1.27

To answer the second question, subjects in the control group and in the experimental groups were ranked from the most time spent to the least time spent. The top one third was designated as MOST time spenders, and the subjects in the bottom one third were designated as LEAST time spenders. The achievement means of these divisions, for the control group and the experimental groups is displayed in Table 7.

TABLE 7.--Means of MOST and LEAST time spenders over various rates of compressed speech

	I	II	III	IV	Mean
MOST	48.69	48.31	46.81	47.81	47.91
LEAST	47.25	46.69	44.81	43.31	45.52
$\bar{X}$	47.97	47.50	45.81	45.56	46.71

Although Table 7, like Table 6, shows that subjects who spent more time did obtain higher scores, the results of a two-way ANOVA using compression rate and time spent as main effects, and achievement as the dependent variable, revealed that the differences in the scores was not significant. (See Table 8.) Thus, the answer to the second question was negative.

TABLE 8.--Two-way ANOVA comparing achievement over various compression rates between MOST and LEAST time spenders

Source of Variance	SS	df	MS	F	Level of Significance
Between Columns (Rate)	36.12	3	12.04	.30	NSD
Between Rows (Time)	53.07	1	53.07	1.31	NSD
Columns by Rows (interaction)	93.83	3	31.28	.77	NSD
Between Groups	183.20	7	26.17		
Within Groups	2,274.29	56	40.61		
Total	2,457.31	63			

$\alpha = .05$ df $3,56 = 2.78$

To answer the third question a two-way ANOVA was computed with the achievement means of the HI achievers and LO achievers listed in Table 6. The results of this ANOVA, using Rate, and HI and LO achievers as main effects, is displayed in Table 9. No significant difference was apparent

between the various compression rates, and no interaction effect was detected. Accordingly, the answer to the third question was negative.

TABLE 9.--Two-way ANOVA comparing achievement over various compression rates between HI and LO achievers

Source of Variance	SS	df	MS	F	Level of Significance
Between Columns (Rate)	25.73	3	8.58	.35	NSD
Between Rows (HI vs LO ACH)	2,802.38	1	2,802.38	114.57	.01
Columns by Rows (interaction)	37.58	3	12.53	.51	NSD
Between Groups	2,865.69	7	409.38		
Within Groups	1,369.59	56	24.46		
Total	4,235.28	63			

$\alpha = .05$ df 3,56 = 2.78

Null hypothesis five was retained.

Additional results of analysis

A comparison of the subjects' listening time with the actual running time of the normal rate and compressed audio-tutorial units was made to answer the question, "Would subjects who listened to compressed speech negate the time saving potential by 'excessive' replaying?"

The total uninterrupted running time of the units for

each rate, as shown in Appendix G, was subtracted from the mean total time recorded by subjects in the control group and in the first two experimental groups. The results of that comparison are shown in Table 10.

TABLE 10.--Time comparisons of normal rate and compressed speech

Group	Compression Rate	$\bar{X}$ Listening Time	Running Time	Replay/ Note-taking Time	Listening Time Saved	$\bar{X}$ ACH
I	0%	8:32	5:42	2:50	0	48.15
II	30%	7:06	3:55	3:11	1:26	47.52
III	40%	5:51	3:21	2:30	2:41	46.06

Subjects listening to 30% compression spent an average of 21 minutes more in replaying/notetaking activities than subjects listening to normal rate speech, while subjects listening to 40% compression spent an average of 20 minutes less in replaying/notetaking activities than subjects listening to normal rate speech. It is apparent that replaying time does not negate the time saving potential of compressed speech since subjects in the 30% group spent one hour and 26 minutes less time in completing all units than the normal rate group, while subjects in the 40% group spent two hours and 41 minutes less time in completing all units than the normal rate group. Accordingly, the subjects who listened to units compressed by 30% realized an average time

saving of 17% while subjects listening to units compressed by 40% realized an average time saving of 31%.

Results of the Questionnaire

The following results of analysis of the attitude questionnaire is keyed sequentially to the additional research questions stated in Chapter I. To avoid the effect completion of the final examination might have on attitude, the questionnaires were completed by the students in the time period between the mid-term examination and the end of the course. In order to increase the reliability and validity of the responses through anonimity, subjects wrote only the Roman numeral for the group to which they were assigned, on the completed questionnaire. The questionnaire contained 29 items. (See Appendix D.) Of the 96 subjects participating in this experiment, 57% returned completed questionnaires.

Results relevant to additional research question one (1)

Additional research question one was stated as follows:

> Will students express a desire to use compressed speech in other college level courses?

The tabulation of response values from questionnaire items related to additional research question number one is shown in Tables 11 and 12.

Of the subjects responding, 94% expressed a desire

to take other college courses utilizing compressed speech; and 100% said they would use compressed speech for reviewing subject matter.

TABLE 11.--Would enroll in other courses using compressed speech

Group	Rate	Value	Nr. of Neg. Responses	Nr. of Respondents	
I	0%	29	1	13	Individual Range
II	30%	40	0	14	
III	40%	28	1	11	-6 to
IV	20% - 55%	31	1	13	+6
Total		128	3	51	

TABLE 12.--Would use compressed speech for review

Group	Rate	Value	Nr. of Neg. Responses	Nr. of Respondents	
I	0%	43	0	16	Individual Range
II	30%	39	0	13	
III	40%	39	0	12	-4 to
IV	20% - 55%	29	0	12	+4
Total		150		53	

Results relevant to additional research question two (2)

Additional research question two was stated as follows:

Will students who listen to compressed speech perceive it as impeding learning by raising their level of anxiety?

The tabulation of response values from the questionnaire item related to additional research question number two is shown in Table 13.

TABLE 13.--Compresses speech raises anxiety level

Group	Rate	Value	Nr. of Neg. Responses	Nr. of Respondents	
I	0%	+ 1	4	9	Individual Range
II	30%	+10	1	10	
III	40%	+ 8	1	8	-2 to
IV	20% to 55%	+11	0	9	+2
Total		+30	6	36	

Of the subjects responding, 84% disagreed with the questionnaire item which stated, "I feel that trying to learn by listening to compressed speech keeps a student's anxiety level too high to be a good means for learning."

Results relevant to additional research question three (3)

Additional research question three was stated as follows:

Will students feel that they must control the rate of compression in order to maximize learning with compressed speech?

The tabulation of response values from questionnaire

items related to additional research question three is shown in Table 14.

Of the subjects responding, 97% felt that learner control over the rate of compression was necessary if compressed speech was to be of any value educationally.

TABLE 14.--Students must have control over compression rate

Group	Rate	Value	Nr. of Neg. Responses	Nr. of Respondents	
I	0%	45	2	16	Individual Range
II	30%	49	0	13	
III	40%	45	0	12	-8 to
IV	20% to 55%	53	0	13	+8
Total		192	2	54	

Results relevant to additional research question four (4)

Additional research question four was stated as follows:

> Will listening to compressed speech be perceived as more fatiguing than listening to normal rate speech?

The tabulation of response values from the questionnaire item related to additional research question four is shown in Table 15.

TABLE 15.--Compressed speech is more tiring

Group	Rate	Value	Nr. of Neg. Responses	Nr. of Respondents	
I	0%	3	5	11	Individual Range
II	30%	14	1	13	
III	40%	3	3	8	-2 to
IV	20% to 55%	9	2	12	+2
Total		29	11	44	

Of the subjects responding, 75% disagreed with the questionnaire item which stated, "I believe that, compared with normal rate recordings, listening to compressed speech is considerably more tiring."

Results relevant to additional research question five (5)

Additional research question five was stated as follows:

> Will the use of filmstrips in conjunction with compressed speech be perceived as detracting from the effectiveness of compressed speech?

The tabulation of response values from questionnaire items related to additional research question five is shown in Table 16.

TABLE 16.--Compressed speech with accompanying filmstrips

Group	Rate	Value	Nr. of Neg. Responses	Nr. of Respondents	
I	0%	33	3	16	Individual
II	30%	47	1	13	Range
III	40%	35	1	12	-8 to
IV	20% to 55%	41	2	13	+8
Total		156	7	54	

Of the subjects responding, 87% felt that combining filmstrips with compressed speech did not make the learning experience more difficult.

Results relevant to additional research question six (6)

Additional research question six was stated as follows:

> Will students express a preference for a particular rate of compression?

The tabulation of response values from questionnaire items related to additional research question six is shown in Table 17.

TABLE 17.--Stated preference for comfortable compression rate

	0%	20%	30%	40% or Higher	Total in Group Responding
Group I	1	4	6	5	16
Group II	2	4	4	4	14
Group III	2	1	3	6	12
Group IV	0	3	5	5	13
Total	5	12	18	20	55

Of the subjects responding, 91% indicated they preferred compressed speech to normal rate since 9% chose 0% compression; 20% chose 20% compression; 34% chose 30% compression; and 37% indicated a preference for a compression rate of 40% or higher.

Results relevant to additional research question seven (7)

Additional research question seven was stated as follows:

> Will students who exercise control over the rate of delivery of information, on the average, tend to select a common rate of compression?

Those data in Table 17 which reflect the stated preference of subjects assigned to Group IV indicate that none would choose normal rate speech, 23% would choose 20% compression, and the remaining 77% were equally divided between 30% compression and 40% or higher compression. Tabulation of the compression rate entries on the time sheets of

all students in Group IV resulted in those data displayed in Table 18. The table shows the percentage of students who, at some time during the semester, actually used the various rates.

TABLE 18.--Percentage of subjects in Group IV who used rates available

Percentage of Subjects	Compression Rate Actually Used
33 1/3%	0%
79%	20%
54%	25%
42%	30%
42%	40%
33 1/3%	50%
4%	55%

It is apparent from the foregoing data that recordings compressed at 20% were chosen most often by subjects who were allowed to select their own rate of compression. It is also apparent that one third of the subjects in Group IV--contrary to instructions--indicated that they listened to a unit at normal rate speech.

Results relevant to additional research question eight (8)

Additional research question eight was stated as follows:

Does the use of compressed speech involve serious

administrative or equipment problems which would make its use academically impractical?

During the conduct of this experiment, neither an administrative nor an equipment problem arose. In retrospect, no circumstances were observed which would lead one to suspect that such problems would occur.

Results relevant to additional research question eight (8)

Additional research question eight was stated as follows:

Does the use of compressed speech involve serious administrative or equipment problems which would make its use academically impractical?

During the conduct of this experiment, neither an administrative nor an equipment problem arose. In retrospect, no circumstances were observed which would lead one to suspect that such problems would occur.

Results relevant to additional research question nine (9)

Additional research question nine was stated as follows:

Would students who have completed a course which utilized compressed speech feel that, with practice, a person could advance to increasingly higher rates of compression?

The tabulation of response values from questionnaire item six, which addressed additional research question nine, is shown in Table 19.

TABLE 19.--Rate can be increased with practice

Group	Rate	Value	Nr. of Neg. Responses	Nr. of Respondents	
I	0%	9	1	9	Individual
II	30%	11	1	10	Range
III	40%	11	1	9	-2 to
IV	20% to 55%	15	0	12	+2
Total		46	3	40	

Of the subjects responding, 90% felt that with practice, increasingly higher rates of compression could be used.

Results relevant to additional research question ten (10)

Additional research question ten was stated as follows:

> Would students who have completed a course which utilized compress-speech feel that the state of the art is sufficiently developed to be adopted as a common educational practice?

The tabulation of response values from questionnaire item 19, which addressed additional research question ten, is shown in Table 20.

Of the subjects responding, 81% did not agree that there was need for some improvement before compressed speech could be used as a regular means of obtaining subject matter information.

TABLE 20.--Some improvements needed (minus value = disagreement)

Group	Rate	Value	Nr. of Neg. Responses	Nr. of Respondents	
I	0%	- 3	3	8	Individual Range
II	30%	- 3	3	9	
III	40%	- 7	1	9	-2 to
IV	20% to 55%	-10	0	10	+2
Total		-23	7	36	

Results relevant to additional research question eleven (11)

Additional research question eleven was stated as follows:

> Would students who have completed a course which utilized compressed speech indicate that continual replaying of compressed speech recordings is necessary for satisfactory understanding?

The tabulation of response values from questionnaire item 26, which addressed additional research question eleven, is shown in Table 21.

Of the subjects responding, 46% agreed that continual replaying of parts of a compressed speech recording was necessary for satisfactory learning to take place.

The inference that compressed speech recordings require more replaying than normal rate recordings is not supported when data on such activity, shown in Table 10, is examined. In point of fact, mean time for replaying/

notetaking activity of the 30% group plus the 40% group is exactly the same as the mean time for replaying/notetaking activity of the normal rate speech group. A more tenable conclusion in light of these data is that the subjects, in responding to questionnaire item 26, are expressing a felt need for the capability of replaying audio-tutorial recordings whether they are compressed or not. In support of this conclusion, a student comment is quoted: "I feel I can get more out of listening to the tapes and viewing the filmstrips because I have complete control of how fast or slow I want to listen to them; whereas, in a classroom situation one cannot rewind the teacher and have him repeat things as often as one would probably like to." (See Appendix H for an abstract of student's comments.)

TABLE 21.--Continual replaying necessary (minus value = agreement)

Group	Rate	Value	Nr. of Neg. Responses	Nr. of Respondents	Individual Range
I	0%	-1	5	12	
II	30%	-3	6	13	
III	40%	-4	6	12	-2 to
IV	20% to 55%	-1	5	11	+2
Total		-9	22	48	

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Summary

Purpose

The purpose of this study was 1) to determine if the application of compressed speech recordings in a learning environment is a procedure which is educationally sound, 2) to assess student preference in regard to this medium, and 3) to collect data which could serve as the basis for decisions regarding the academic practicability of compressed speech as an additional tool of learning.

Procedures

The population from which a sample of 96 subjects was drawn consisted of college Juniors and Seniors enrolled in the Fall Semester, 1972, basic audiovisual course in the College of Education, University of Oklahoma. The title of this required course is, Education 4160, "Media and Technology in Teaching." The instruments used were a midterm and a final multiple choice examination, the validity and

reliability of which had been established through administration to previous classes from the same general population, and an affective questionnaire designed for the purpose of this investigation.

The subject matter of this automated portion of the course consisted of 16 recorded readings (units) with accompanying 35mm filmstrips, covering historical development, production techniques, operating procedures and current utilization procedures for audiovisual materials and equipment. All recordings were made by the same instructor, whose mean reading rate was 120 WPM (words per minute). The resulting WPM, in accordance with compression rate is shown in Table 22. Recordings were compressed on PKM corporation's VOCOM-I Speech Compressor/Expander.

TABLE 22.--Compression rate and resulting words per minute

Compression Rate	Words per Minute
0%	120
20%	155
25%	162
30%	174
40%	200
50%	243
55%	281

The subjects were assigned to one of four groups by the use of a random number table: Group I = Control group,

utilized normal rate recordings; Group II = Experimental group 1 utilized recordings compressed by 30%; Group III = Experimental group 2, utilized recordings compressed by 40%; and Group IV = Experimental group 3, chose from a selection of recordings compressed by 20%, 25%, 30%, 40%, 50% or 55%, each time they visited the independent study lab.

The subjects listened to the recordings while viewing accompanying filmstrips, in individual listening/viewing carrels equipped with headsets. Of the 96 subjects participating in the experiment, 74%, equally and randomly distributed among the four groups, were given a hearing test on a Beltone model 10C. No significant hearing deficiencies were detected.

Subjects completed time sheets by entering the start and end time for each recorded unit. Those subjects assigned to experimental group 3 also entered the compression rate chosen for each unit, in the space provided on the time sheets.

Results

Results of statistical analysis

An analysis of variance was computed on the means of the achievement scores of the four groups. The differences were neither statistically ($P = .25$) nor practically (1.57 raw grade points) significant.

A two-way analysis of variance with achievement and GPA (Grade Point Average) as main effects showed no

significant differences between subjects with high GPA using 0%, 30% and 40% compression; no significant differences between subjects with low GPA using the same compression rates; and no interaction between GPA and achievement over the various rates, all at the (P = .05) level.

A second two-way analysis of variance with achievement and time spent as main effects showed no significant differences between subjects who spent the most time using 0%, 30% and 40% compression; no significant differences between subjects who spent the least time with the same compression rates; and no interaction between time spent and achievement over the various rates, all at the (P = .05) level.

It was apparent, from the results of the present experiment, that the nature of compressed speech did not engender "excessive" replaying time. Subjects assigned to the 30% group spent an average of 21 minutes more, while subjects assigned to the 40% group spent an average of 20 minutes less in such activity than subjects assigned to normal rate speech. Subjects in the 30% group completed the units with a savings in time of 17%, while those in the 40% group completed the listening units with a savings of 31%.

Results from the affective questionnaire

The questionnaire contained 29 items. Of the 96 subjects participating in the experiment, 57% returned

completed questionnaires. Tabulation of responses resulted in the following findings:

1. Ninety-one per cent expressed a favorable attitude toward compressed speech as a primary mode for learning subject matter.
2. Ninety-four per cent expressed a desire to take other college courses utilizing compressed speech.
3. One hundred per cent indicated they would use compressed speech for reviewing subject matter.
4. In response to what rate they felt was most comfortable, 9% chose normal rate speech; 20% chose 20% compression; 34% chose 30% compression; and 37% indicated they would chose 40% or higher rates of compression.
5. Ninety per cent felt that with practice, increasingly higher rates of compression could be used.
6. Ninety-seven per cent felt that learner control over the rate of compression was necessary or desirable for a most satisfactory learning experience.
7. Twenty-five per cent felt that learning from compressed speech recordings was more tiring than normal rate speech.
8. Sixteen per cent felt that learning from

compressed speech was more anxiety producing than normal rate speech.

9. Thirteen per cent felt that combining compressed speech and filmstrips made the learning experience more difficult.
10. Nineteen per cent felt that technical improvement in compressed speech was needed before it could be implemented as a common means of learning subject matter.
11. Forty-six per cent felt that continual replaying of parts of the compressed speech recording was necessary for satisfactory learning.

Conclusions

The following conclusions are drawn from the analysis and evaluation of those data resulting exclusively from the present investigation:

1. College Junior and Senior students can learn the type of cognitive matter presented in this course at least as well via compressed speech as by normal rate recordings.
2. Less total time is spent in audio-tutorial learning of the nature provided in this investigation when compressed speech is used in lieu of normal rate recordings.
3. Audio-tutorial units of the nature used in this investigation, presented via compressed speech, allow for more engagement with content, i.e.

replay time, than non-compressed recordings during a given period of time.

4. The nature of compressed speech per se, does not engender excessive replaying.
5. The greatest majority of students express a positive attitude toward learning cognitive material of the nature used in this investigation, via compressed speech.
6. Grade point averages are a valid predictor for success in audio-tutorial learning of the nature and level provided in this investigation.
7. Compressed speech can be considered as a satisfactory alternate mode of learning.
8. Compressed speech, used in an independent study environment, provides an additional measure of individualization regarding time.
9. No administrative or equipment problems arise solely due to the use of compressed speech in an audio-tutorial learning environment structured to provide cognitive information of the nature used in this investigation.
10. Compressed speech is an academically practical tool of learning in an audio-tutorial learning environment structured to provide cognitive information of the nature used in this investigation.

Implications

As with the preceeding conclusions, the following implications are drawn exclusively from the analysis and evaluation of those data resulting from the present investigation. Generalization to populations, learning tasks, or environments outside those reported in this study are neither stated nor implied.

1. Students who have had experience with learning cognitive material of the nature used in this investigation via compressed speech, have a significantly higher positive attitude toward this mode than students who have had only an orientation exposure to compressed speech.
2. Although no statistically significant differences exist, there is an indication that students with relatively high GPA's (Grade Point Averages) tend to do better with cognitive material of the nature used in this investigation at normal rate speech, while students with low GPA's tend to do worse with normal rate speech, better with compressed speech, and best when allowed to select their own rate of compression.
3. Even though a statistically significant gain in achievement is not detected, there is an indication that students engaged in cognitive learning at the level provided by this investigation, who

are allowed to select their own rate of compressed speech tend to have a more positive attitude toward this mode of learning than students who are assigned fixed rates.

4. Although no statistically significant differences exist, there is an indication that high achieving students, engaged in cognitive learning at the level provided in this investigation, tend to do better with normal rate speech, while low achieving students tend to do better with compressed speech.
5. The compression of audio learning units to a preselected rate, e.g. 30%, could result in a savings of audio tape used, as well as a savings of storage shelving space for such tapes.
6. Compression of audio learning units to a preselected rate for use in an independent study environment could, through the savings realized in time, maximize the use of existing facilities.

Recommendations

On the basis of those data obtained from this investigation, the following recommendations are offered:

1. That institutions involved in educational and training activities give serious consideration to the application of compressed speech in their programs.

2. That organizations possessing audio tape libraries consider processing holdings at one or more compression rates.

Recommendations for Further Study

During several stages of this study, to include planning, conduct of the experiment, and analysis of data, additional hypotheses relating to the utilization of compressed audio recordings in a learning environment continued to surface. The following recommendations for further study point up areas of needed investigation, the results of which, would assist greatly in providing an expanding, sound base upon which implementation decisions could be made. Studies should be conducted which address the following questions:

1. Does the requirement for listening for a visual advance signal, plus the psycho-motor involvement in accomplishing such tasks, detract from the potential learning achievement which might be realized through the use of compressed speech?
2. Would students with lower grade point averages achieve significantly better with compressed speech plus automated visuals, than they would with normal rate speech plus automated visuals?
3. Would students who are not considered to be "High Achievers" when learning from normal rate audio recordings plus automated visuals, exhibit significantly increased learning when using

compressed speech plus automated visuals?

4. Would providing a mini-course in listening to compressed speech, prior to beginning audio-tutorial units using compressed speech, significantly increase student achievement?
5. Is there a level of cognitive learning above which compressed speech is not a satisfactory alternative mode of learning?
6. Is compressed speech applicable to automated courses of instruction which provide for the learning of psycho-motor skills?

BIBLIOGRAPHY

Books

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

Campbell, Donald T. and Stanley, Julian C. "Experimental and Quasi-Experimental Designs for Research on Teaching." Handbook of Research on Teaching. Edited by N. L. Gage. Washington, D.C.: American Educational Research Association, 1963.

Edwards, A. Techniques of Attitude Scale Construction. New York: Appleton, 1957.

Johnson, W., Darley F., and Spriesterbach, D. C. Diagnostics in Speech Pathology. New York: Harper Rowe, 1963.

Licklider, J. C. R. and Miller, George A. "The Perception of Speech." Handbook of Experimental Psychology. Edited by S. S. Stevens. New York: Wiley, 1951.

Nichols, P. G. and Stevens, L. A. Are You Listening? New York: McGraw Hill, 1957.

Travers, Robert M. W. Man's Information System. Scranton, Pa.: Chandler Publishing Co., 1970.

Wert, James E., Neidt, Charles O., and Ahmann, Stanley J. Statistical Methods in Educational and Psychological Research. New York: Appleton Century Crofts, 1954.

Periodicals

Bechtoldt, Harold P. "Construct Validity: A Critique." The American Psychologist, XIV (1959), 619-630.

Carpenter, C. R. "Psychological Concepts and Audiovisual Instruction," AV Communication Review, V (1957), 368.

Orr, A. B., Friedman, H. L., and Williams, J. C. C. "Trainability of Listening Comprehension of Speeded Discourse." Journal of Educational Psychology, LVI (1965), 148-156.

Pierce, J. R. and Karlin, J. E. "Reading Rates and the Information Rate of Human Channels." Bell Systems Technical Journal, XXXVI (1957), 497-516.

Pollack, I. "The Information of Elementary Audio Displays." Journal of Acoustical Society of America, XXV (1952), 745-750.

Pollack, I. and Fricks, L. "Information of Elementary Multidimensional Auditory Displays." Journal of Acoustical Society of America, XXVI (1954), 155-158.

Thames, Kenneth H. and Rossiter, Chas. M. Jr. "The Effects of Reading Practice with Compressed Speech on Reading Rate and Listening Comprehension." AV Communication Review, XX (1972), 35-42.

Miscellaneous

Cheatham, P. G. A Comparison of the Visual and Auditory Senses as Possible Channels for Communication, U.S. Air Force Technical Report No. 5919 (PB 110278). Air Material Command, 1950.

Foulke, Emerson. The Comprehension of Rapid Speech by the Blind. DHEW Project No. 1370 Part II. Washington, D.C.: Office of Education, 1964.

Foulke, Emerson. The Comprehension of Rapid Speech by the Blind. DHEW Project No. 2430 Part III. Washington D.C.: Office of Education, 1967.

Foulke, Emerson, and Sticht, Thomas. "The Intelligibility and Comprehension of Accelerated Speech." Proceedings of the Louisville Conference on Time Compressed Speech. Louisville, Kentucky, 1967.

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

Jesters, R. and Travers, R. M. W. Comprehension as a Function of Rate and Modality of Presentation. Paper presented at the meeting of the American Psychological Association. Chicago, 1965.

Diehl, C. F., White, R. C., and Burke, K. "Rate and Communication." Speech Monographs, XXIX (1959), 229-232.

Fairbanks, G., Guttman, N., and Miron, M. S. "Effects of Time Compression Upon the Comprehension of Connected Speech." Journal of Speech and Hearing Disorders, XXII (1957), 10-19.

Foulke, Emerson, et al. "The Comprehension of Rapid Speech by the Blind." Exceptional Children, XXIX (1962), 134-141.

Foulke, Emerson and Stricht, Thomas. "Review of Research on the Intelligibility and Comprehension of Accelerated Speech," Psychological Bulletin, LXXII (1969), 50-62.

Garner, W. R. "An Information Analysis of Absolute Judgement of Loudness." Journal of Experimental Psychology, XLVI (1953), 373-380.

Hartman, E. B. "The Influence of Practice and Pitch Distance Between Tones on the Absolute Identification of Pitch." American Journal of Psychology, XLVII (1954), 1-14.

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

Harwood, K. A. "Listenability and Rate of Presentation." Speech Monographs, XXII (1955), 57-59.

Henneman, R. H. and Long, E. R. A Comparison of the Visual and Auditory Senses as Channels for Data Presentation. U.S. Air Force Technical Report 54-363 (WADC, 1954).

Hsia, H. J. "The Information Processing Capacity of Modality and Channel Performance." AV Communication Review, XIX (1971), 59.

Jacobson, H. "The Information Capacity of the Human Ear." Science, CXII (1950), 143-144.

Jacobson, H. "The Information Capacity of the Human Eye." Science, CXIII (1951), 292-293.

Miller, George A. "The Magical Number Seven, Plus or Minus Two: Some Limits on our Capacity for Processing Information." Psychological Review, LXIII (1956), 83.

Nelson, H. E. "The Effect of Variation of Rate on the Recall of Radio Listeners of Straight Newscasts." Speech Monographs, XV (1948), 173-180.

Quastler, H. and Wulff, V. J. Human Performance in Information Transmission, The University of Illinois Report No. 62. Urbana, Illinois: Control System Laboratory, 1955.

Short, Sarah H. The Use of Compressed Speech Tapes in a Multi-Mediated Learning Laboratory. Paper presented at the annual convention of the Association for Educational Communications and Technology. Minneapolis, 1972.

Watts, Meridith W. Jr. Using Compressed Speech to Teach Instructional Techniques to Air Force Officers. Department of Instructional Technology Report. Maxwell AFB, Alabama, 1969.

APPENDIX A

AUDIOLOGIC ASSESSMENT FORM

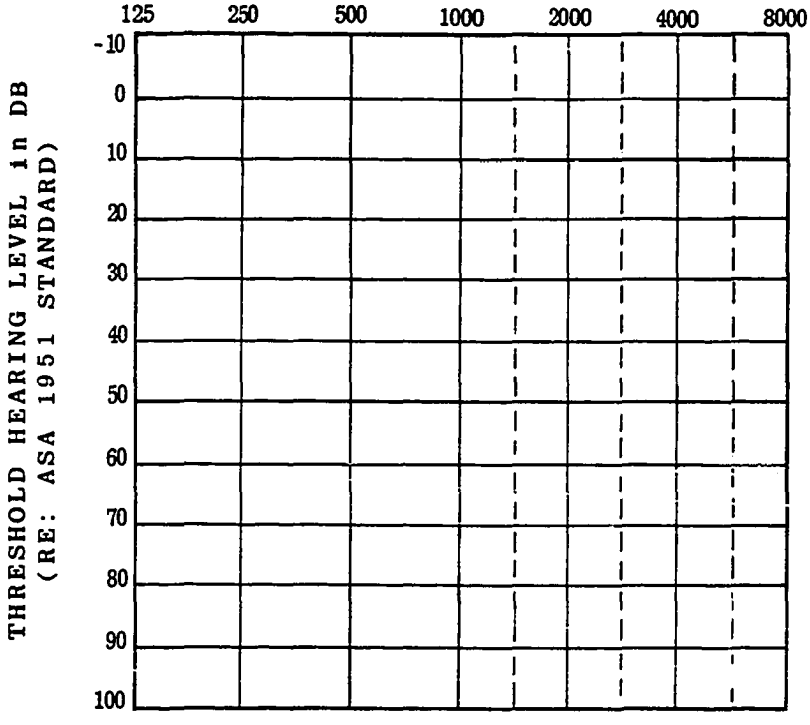
THE UNIVERSITY OF OKLAHOMA SPEECH AND HEARING CLINIC

AUDIOLOGIC ASSESSMENT

Name_____ Age_____ Sex_____ Date_____

Audiologist_____ Audiometer_____ Reliability_____

FREQUENCY IN Hz



EAR	PTA*	SRT	PB	SL
RIGHT				
LEFT				

*Pure Tone Average

STENGER TEST RESULTS

SPEECH:

PURE TONE:

AMA PERCENTAGE OF
BINAURAL HEARING IMPAIRMENT:

EFFECTIVE MASKING

MASKED EAR	R	L	R	L	R	L	R	L	R	L
AC										
BC										

ELECTRODERMAL (GSR) THRESHOLDS

	250	500	1000	2000	4000
RIGHT					
LEFT					

SYMBOLS

Ear	AC	BC
RT.	O	[
LT.	X	]

↓ = No Response

COMMENTS:

APPENDIX B

SAMPLE

STUDENT ORIENTATION HANDOUT

ORIENTATION INFORMATION

This class will participate in an investigation of a possible new tool of learning. The investigation will provide information about this possible new technique so as to allow administrative and curricular design decisions to be based upon pragmatic research. As a participant in this research, you will be assisting in advancing knowledge of learning--an area in which you have chosen to become involved as a teacher or administrator.

The investigation deals with the use of "Compressed Speech," which you may know is the result of an electronic method of reducing the listening time of recorded speech by reducing pauses and sampling vowel sounds without getting the "Donald Duck" or "Chipmunk" sound which is normally associated with accelerated playbacks.

As you may also know, a portion of your effort in this course will be devoted to individual listening/viewing of pre-recorded audio information with accompanying 35mm filmstrips. This has been a procedure for this course for the last several semesters. For the purpose of this investigation, some of you will be listening to recordings compressed at various rates. A compression rate given in per cent, means the amount of time by which the original recording has been reduced, e.g. a recording which took 30 minutes to record, when compressed by 40%, can be heard in 18 minutes.

Conduct of the Investigation

Each student will be assigned to a group; either I, II, III, or IV. You will be asked to take a hearing test prior to starting the individual listening/viewing program. You will be given a separate orientation on the operation of the equipment in the listening/viewing carrels. This will include tape recorders and filmstrip viewers. There will be individual time sheets for you to complete each time you are in the carrel. The time sheets will be available in the carrel area. You must choose the tape which you are going to listen to, from the shelf marked with your GROUP number, thread the tape into the recorder, set up the filmstrip viewer, THEN enter the time on your time sheet. When you have finished listening to the recording, enter the time again, THEN put the tape and filmstrip away. These procedures, plus a sample time sheet is posted in each of the carrels.

There will be someone in the carrel area to help you with any equipment problem that might develop. If the equipment is not working correctly, call one of the instructors immediately. As you have deduced by now, time is important in this experiment.

After the midterm examination, you will be asked to fill out a questionnaire. This will provide feedback on how things are going, and allow you to make comments which you feel will be helpful. Accordingly, when you have finished

UNIT 6, PART 2, REEL 1, please complete the questionnaire.

Remember, the information which is presented by the recordings and filmstrips is part of the course and therefore will appear in either the midterm or final examination.

The project will be conducted by Jim Challis, a Doctoral Student, under the direction of Dr. William Fulton and Dr. Tillman Ragan. Please feel free to direct any questions you may have to any one of these people.

Your participation is appreciated. Good learning!

APPENDIX C

SAMPLE

TIME SHEET INSTRUCTIONS

TIME SHEET INSTRUCTIONS

Step 1. Select the tape unit and the accompanying filmstrip from the shelves, pick up a time sheet, then go to an empty carrel.

Step 2. Turn the power switch of the tape deck to "on"; thread tape into take-up reel, turn viewer on and position filmstrip to the title frame.

Step 3. If you plan to take notes, get your notebook and pen ready.

Step 4. Fill out requested information on the top half of the time sheet. NOTE: Group IV students please enter compression rate of tape you have selected, on the top line immediately after "IV" (see sample below).

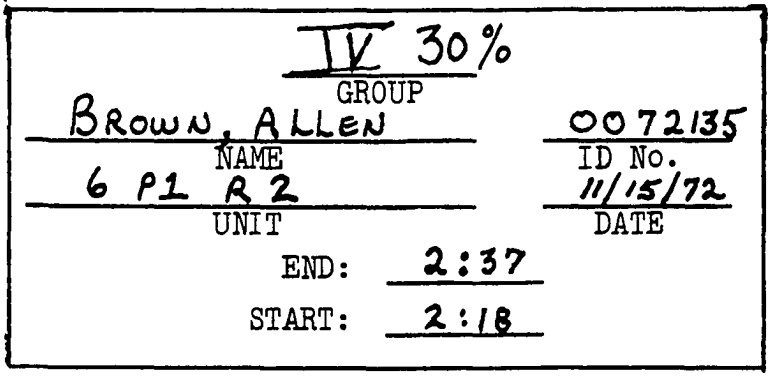
Step 5. Put on your headphones, enter the time from the wall clock, on the "Start" line of the time sheet and start the recorder.

Step 6. When the end of the unit is reached, or when you have completed your listening to that unit, switch the tape recorder to the "Stop" position and enter the time from the wall clock on the "end" line of the time sheet. Remove headphones.

Step 7. Turn in the completed time sheet to the lab instructor.

Step 8. Turn off viewer, rewind tape and filmstrip, turn power off on tape deck, and return tape and filmstrip to appropriate shelves.

SAMPLE TIME SHEET



APPENDIX D

SAMPLE QUESTIONNAIRE

COMPRESSED SPEECH QUESTIONNAIRE

This questionnaire has been designed to provide feedback to the instructor as to how you feel about this method of obtaining information in your learning process.

If you are in Group I, or in Group IV, and have not listened to all of the compression rates available, please listen to the "Compressed Speech Sampler" tape before completing this questionnaire. These sampler tapes are in a box, so marked, on the shelf alongside the box containing the time sheets.

You are asked to respond to the statements by circling one of the five choices opposite each statement. The letters mean:

SD--Strongly Disagree

D--Disagree

U--Undecided

A--Agree

SA--Strongly Agree

In the space provided on the last page, and on the back of the last page, please add any comments you wish to make about the use of compressed speech, the way the material or facility was organized, or about the course in general. Please enter your group number below.

GROUP _____

1. If given the opportunity, I feel that students will select compressed rate speech over normal rate speech recordings as a primary means of acquiring subject information. SD D U A SA

2. I believe most students would use compressed speech for reviewing material previously learned. SD D U A SA

3. I think compressed speech holds much promise for learning and that subject matter information in this mode should be made available to students now. SD D U A SA

4. I believe that all lecture type presentations recorded on audio tape should be available to students for use in the compressed speech mode. SD D U A SA

5. I believe that most students would use compressed speech as a primary means for acquiring subject matter information, if they could select the compression rate. SD D U A SA

6. I think that after listening to compressed speech for a while, a person can advance to increasingly higher compression rates. SD D U A SA

7. I would like to take other courses which use compressed speech. SD D U A SA

8. I think that compressed speech holds great promise for learning. SD D U A SA

9. I believe that most students, with a little practice, would feel comfortable learning from tapes compressed by 40%, or higher. SD D U A SA

10. I would say that most students would feel comfortable learning from tapes compressed by 30%. SD D U A SA

11. I think most students would feel comfortable learning from tapes compressed by 20%. SD D U A SA

12. I think many students who would not use compressed speech as a primary source of subject information would use it as a means of review. SD D U A SA

13. I believe that, compared with normal rate recordings, listening to compressed speech is considerably more tiring. SD D U A SA

14. I feel that trying to learn by listening to compressed speech keeps a student's anxiety level too high to be a good means for learning. SD D U A SA

15. I might take another course where compressed speech was used, but it depends on the subject matter. SD D U A SA

16. I hope I never have to take another course which uses compressed speech. SD D U A SA

17. I don't think compressed speech adds anything positive to the learning situation. SD D U A SA

18. I believe most students would prefer normal rate recordings over compressed speech. SD D U A SA

19. I believe compressed speech holds much promise for learning but that there needs to be some improvements made before it can be used as a regular means for students to obtain subject matter information. SD D U A SA

20. I think only a few students would use compressed speech as a primary means for acquiring subject matter information, even if they could select the compression rate while listening. SD D U A SA

21. I believe using compressed speech in place of normal rate speech recordings in conjunction with filmstrips makes the acquiring of information more difficult. SD D U A SA

22. I think that the use of compressed speech, by itself, is useful--but it shouldn't be used along with filmstrips. SD D U A SA

23. I don't think the use of filmstrips along with compressed speech makes it any more difficult to learn the information presented by audio recordings. SD D U A SA

24. I feel that student control over both the filmstrip and the compression rate makes for a very satisfying learning experience. SD D U A SA

25. I think that for compressed speech lectures to be of any value educationally, the student must have control over selection of the compression rate. SD D U A SA

26. I think that in order to understand the information being presented by compressed speech it is necessary to continually replay parts of the recording. SD D U A SA

27. I don't care much for this course, even if compressed speech wasn't involved, and I would rather not be taking it. SD D U A SA

28. I really like this course, even without compressed speech, and I'm glad I'm taking it. SD D U A SA

29. Oh, this course is okay, with or without compressed speech. I could take it or leave it. SD D U A SA

COMMENTS:

APPENDIX E AND F

MIDTERM EXAM

FINAL EXAM

MIDTERM

1. Which company was primarily responsible for the development of the filmstrip as an educational tool?
   a. Bell and Howell
   b. Kodak
   c. Herman DeVry
   d. Society for Visual Education

2. Which historical event was most responsible for creating an interest in research and development of instructional aids?
   a. World War I
   b. World War II
   c. The 1929 depression
   d. Modular scheduling

3. The historical event primarily responsible for the establishment of the National Defense Education Act in 1958 was:
   a. The Korean War
   b. The cold war
   c. placement of Sputnik in orbit
   d. nuclear testing

4. A post-war technological development that originated from military instructional practices was:
   a. the diorama
   b. sound filmstrips
   c. electronic language laboratories
   d. models

5. A modern instructional device greatly improved since World War II is the:
   a. model
   b. mock-up
   c. graph
   d. overhead projector

6. Memorization and drill is most characteristic of which of the following learning theories?
   a. mental discipline
   b. associationistic
   c. experimental
   d. Gestalt

7. Which practice implies a scientific approach to instruction?
   a. exploration
   b. identification
   c. problem solving
   d. all of the above

8. Which part of the communication model is most closely associated with encoding messages?
   a. sender
   b. channel
   c. receiver
   d. none of these

9. When the receiver gives the sender an indication of the success of the communication, this response is called:
   a. symbols
   b. channels
   c. reinforcement
   d. feedback

10. If the word "seahorse" causes a child to visualize a horse, he is experiencing:
    a. day-dreaming
    b. feedback
    c. referent confusion
    d. imperception

11. Which of Piaget's learning stages is characterized by individuals who are able to visualize highly abstract concepts?
    a. pre-operational
    b. post-operational
    c. formal operational
    d. concrete operational

12. Which communication channel is more appropriate for an instructional task that requires an intermittent return to material previously covered.
    a. oral (face to face)
    b. oral (audio-tape)
    c. print
    d. visual-verbal (slide-tape)

13. Multi-channel presentations are most effectively used when:
    a. the channels are properly integrated
    b. the concept to be learned is highly abstract
    c. the level of maturity of the learner is low
    d. all of the above

14. Lenses should always be cleaned with:
    a. soft cloth
    b. carbon tetrachloride
    c. lint-free lens paper
    d. lint-free chamois

15. Which of the following affects the synchronization between the sound and picture on a sound motion picture?
    a. exciter lamp
    b. tone control
    c. lower loop
    d. sound drum

16. Which motion picture film size is most commonly used in education?
    a. 8mm
    b. 16mm
    c. 35mm
    d. 70mm

17. At what speed are silent 16mm films projected?
    a. 8 frames per second
    b. 16 frames per second
    c. 24 frames per second
    d. 32 frames per second

18. Tape-recorders erase automatically when?
    a. rewinding
    b. recording
    c. playing
    d. in fast forward

19. The most suitable method for erasing tape quickly, is by:
    a. an alcohol solution
    b. running through the recorder on fast forward
    c. an electro-magnet
    d. all of these

20. Which of the following is the most suitable instrument for removing hard deposits from the pressure plate of a projector?
    a. a pocket knife
    b. a wire brush
    c. a wooden toothpick
    d. a straightened paperclip

21. According to research note-taking during films is likely to be:
    a. detrimental
    b. beneficial
    c. of no consequence either way
    d. none of these

22. Which of these is an advantage of super 8mm over 16mm?
    a. better color film
    b. larger picture area
    c. quieter operation
    d. more economical

23. Which of these motion picture techniques makes action which occurs too slowly for observation more easily observed?
    a. time-lapse
    b. flash-back
    c. slow motion
    d. animation

24. Which of these motion picture techniques is used to represent a return to an earlier time?
    a. a time-lapse
    b. flash-back
    c. slow motion
    d. animation

25. Which of the following is not a good practice in the utilization of instructional films?
    a. showing only part of a film
    b. using a film as an introduction to other activities
    c. leaving the lights on to facilitate note-taking
    d. all of the above

26. Which item represents the historical event that had the greatest effect on the use of motion picture films as an instructional tool?
    a. National Secondary School Act of 1965
    b. National Defense Education Act of 1958
    c. World War II
    d. Sputnik

27. The inventor of the flexible film base was?
    a. Thomas Edison
    b. Varney Arnspiger
    c. Oleg Kodak
    d. George Eastman

28. Which is the most appropriate question a teacher should consider in determining whether or not a motion picture film is the correct medium to use for teaching a particular concept?
    a. is the film available
    b. is the film interesting
    c. does the concept require motion
    d. is the film expensive

29. A major advantage of rear screen projection is:
    a. the wide viewing angle
    b. it is condusive to note-taking
    c. it reduces the need for room darkening
    d. the use of mirrors

30. Which of these may be used to clinch a film presentation?
    a. class discussion of the film
    b. an oral quiz
    c. written reports from other sources on the film's subject
    d. all of the above

31. A teacher must be knowledgeable in several areas to effectively utilize audiovisual materials. Which item best represents an area in which the teacher should have a basic understanding?
    a. a variety of instructional methods
    b. availability of educational media
    c. the concepts being taught
    d. all of the above

32. Which item best represents a valid criterion for selecting still-projected media to present a concept?
    a. materials are easier to find
    b. projection techniques are simple
    c. motion is not essential to the concept
    d. the concept is a visual one

33. Although all are transparencies in the broad sense, which of these sizes is most often referred to as a transparency?
    a. 2 x 2
    b. 2 1/4 x 2 1/4
    c. 3 1/4 x 4
    d. 10 x 10

34. A 10 x 10 inch transparency is often referred to as:
    a. a super slide
    b. a hand-made transparency
    c. an overhead transparency
    d. a lantern slide

35. Which of these allows group viewing of microscope slides?
    a. a microfiche
    b. micro-cards
    c. micro-film
    d. micro-projection

36. Which piece of equipment is most often used to project single frame (or "half-frame") transparent images?
    a. carousel projector
    b. overhead projector
    c. film-strip projector
    d. micro-projector

37. Transparent material which uses hinges to allow for progressive presentation is commonly called:
    a. progressive disclosure
    b. a hinged transparency
    c. an overlay transparency
    d. a multi-media transparency

38. Which item represents an advantage of 2 x 2 slides?
    a. they have larger format than filmstrips
    b. they are more easily stored than filmstrips
    c. they are less expensive than filmstrips
    d. they are easily produced by teachers

39. Which item represents the best medium for sequential rearrangement?
    a. filmstrips
    b. 2 x 2 slides
    c. motion pictures
    d. sound filmstrips

40. A disadvantage of 35mm filmstrips is:
    a. they are too expensive
    b. they are easily lost
    c. they are easily damaged
    d. all of the above

41. Small film formats which contain large amounts of information are generally called:
    a. microforms
    b. microscope slides
    c. microplates
    d. condensed slides

42. A practice commonly associated with the scientific approach to instruction is:
    a. one-way communication
    b. teacher centered
    c. verbal communication
    d. reinforcement

43. Which part of the communication model is most closely associated with decoding messages?
    a. sender
    b. channel
    c. receiver
    d. none of these

44. The sender can then give approval, corrections, or additional information. This is called:
    a. symbols
    b. channels
    c. reinforcement
    d. feedback

45. Which psychological barrier is caused by the learner using a faulty frame of reference?
    a. physical discomfort
    b. excessive verbalism
    c. daydreaming
    d. referent confusion

46. Which of these barriers to communication is often a product of the others listed?
    a. physical discomfort
    b. excessive verbalism
    c. daydreaming
    d. none of these

47. Which of Piaget's learning stages is characterized by individuals who can understand observed processes yet lack the ability to understand the same processes when related through more abstract symbols?
    a. pre-operational
    b. concrete operational
    c. formal operational
    d. pre-formal operational

48. Which communication channel is more appropriate for an instructional task that requires overt reinforcement and feedback to clarify understanding?
    a. verbal (audio-tape)
    b. visual verbal (instructional television)
    c. verbal (programmed instruction)
    d. verbal (face to face)

49. Which of the following functions primarily as a shock absorber on a motion picture projector?
    a. feed sprocket
    b. upper loop
    c. pressure plate
    d. lower loop

50. When referring to motion picture film, 16mm refers to the:
    a. speed
    b. width
    c. length of the film
    d. thickness of the film

51. At what speed are sound 16mm films projected?
    a. 8 frames per second
    b. 16 frames per second
    c. 24 frames per second
    d. 32 frames per second

52. Which tape recording speed is more suited for recording music?
    a. 1 7/8 ips
    b. 3 3/4 ips
    c. 7 1/2 ips
    d. no difference

53. Which of the following is the most suitable instrument for cleaning dust and lint from the aperture?
    a. a wooden toothpick
    b. pipe cleaner
    c. pocket knife
    d. tweezers

54. Which would you not check if a projector fails to produce a picture?
    a. projection lamp
    b. exciter lamp
    c. power cord
    d. classroom circuit breaker

55. According to research the use of color in films:
    a. is necessary to most concepts
    b. aids social understanding
    c. is more beneficial
    d. none of these

56. Which of these factors cause super 8 films to be a significant improvement over regular 8mm?
    a. better color film
    b. larger picture area
    c. quieter operation
    d. more economical

57. Which of these motion picture techniques make action that occurs too quickly for observation more easily observed?
    a. time-lapse
    b. flash-back
    c. slow motion
    d. animation

58. Which of these motion picture techniques can be used to visualize an invisible process?
    a. time-lapse
    b. slow motion
    c. flash-back
    d. animation

59. Which of these techniques is used to make extremely small objects more visible?
    a. animation
    b. tele-photo photography
    c. micro-photography
    d. slow motion

60. The man who invented the kineoscope was:
    a. George Eastman
    b. Thomas Edison
    c. Varney Arnspiger
    d. none of the above

61. The first feature length sound motion picture was:
    a. The Great Train Robbery
    b. Toll of the Sea
    c. The Al Jolson Story
    d. The Jazz Singer

62. Which item represents the type of motion picture film commonly used in single-concept loop cartridges?
    a. 8mm
    b. 16mm
    c. super 8mm
    d. A & C

63. Which of these has proven especially beneficial in how-to-do-it films?
    a. close-up photography
    b. micro-photography
    c. time-lapse action
    d. stop-action

64. A teacher must be knowledgeable in several areas to effectively utilize audiovisual materials, which item best represents an area in which teacher should have a basic understanding?
    a. standardized tests
    b. I Q scores
    c. learning theory
    d. individual differences

65. Which item is not an example of good motion picture projection techniques?
    a. fading the volume when the film ends
    b. gradually increasing the volume when the picture begins
    c. darkening the room before starting the projector
    d. rewinding the film immediately after showing it.

66. Which item represents the best utilization technique for still projected media?
    a. follow-up activities
    b. a knowledge of composition
    c. skill in running audiovisual equipment
    d. flexible pacing

67. For a small child to correctly point out to his parents all the coffee tables in a furniture store, saying "Here's another coffee table, Dad," is an example of what type of learning according to Gagne:
    a. signal learning
    b. concept learning
    c. rule learning
    d. problem solving

68. Which of these is used primarily to facilitate information storage?
    a. micro-film
    b. micro-projection
    c. film-strips
    d. 2 x 2 slides

69. Which slide size is sometimes referred to as a lantern slide?
    a. 35mm
    b. 126
    c. 3 1/4 x 4
    d. 127

70. Material which reflects rather than allowing light to pass through it is called?
    a. refraction material
    b. translucent material
    c. mirror image material
    d. opaque material

71. Which piece of equipment does not use film?
    a. carousel projector
    b. filmstrip projector
    c. micro-projector
    d. micro-fiche viewer

72. A major advantage of 2 x 2 slides is?
    a. they are less expensive than filmstrips
    b. they have a smaller format than filmstrips
    c. the sequence of pictures can be more readily changed than filmstrips
    d. they are easier stored than filmstrips

73. Which of the following is not an appropriate use for filmstrips?
    a. to provide a basis for understanding symbols
    b. to help teach skills
    c. to show motion
    d. to focus group attention

74. Filmstrips which are accompanied by records are called:
    a. slide-tapes
    b. visual recordings
    c. sound filmstrips
    d. viewgraphs

75. Slides which require specially designed glasses in order to view them are called:
    a. bi-optical slides
    b. stereo albums
    c. stereoviewers
    d. stereo slides

FINAL

1. The text material on an overhead transparency master which will be used to make a transparency that will be mounted on a standard overhead projection mount should not exceed:
    a. 10 x 10 inches
    b. 7 x 9 1/2 inches
    c. 8 1/2 x 11 inches
    d. 11 x 14 inches

2. Which process requires masters (or originals) that contain a high carbon content?
    a. thermal
    b. Diazo
    c. dry photo-copy
    d. color-lift

3. Which of these usually will not reproduce on a thermal transparency?
   a. India ink
   b. ball point pen
   c. soft lead pencil
   d. electrographic pencil

4. Which item represents an advantage of thermal transparencies?
   a. They can be produced from inks with a high carbon content
   b. Multiple copies are easily produced
   c. Masters can be made from colored pencils
   d. They look more professional than transparencies made by other methods

5. Which item represents a type of drawing material that is appropriate for producing handmade transparencies?
   a. grease pencils
   b. felt tip pens
   c. acetograph pens
   d. all of the above

6. Which of the following are criteria for selecting flat pictures for educational purposes?
   a. clarity
   b. truthfulness
   c. suitability to the teaching concept
   d. all of the above

7. Which of these is usually preferable when using flat pictures for instructional purposes?
   a. rapid inspection of many prints
   b. thoughtful study of a few prints
   c. they are equally sound practices
   d. neither is a sound practice

8. A suitable material for displaying photographic prints without damaging the print is:
   a. straight pin
   b. thumb tacks
   c. glue
   d. an easel

9. Which of these materials is not used in dry mounting?
   a. rubber cement
   b. poster board
   c. dry-mount tissue
   d. butcher paper

10. Which material is used in dry mounting a flat picture?
    a. laminating film
    b. dry-mount tissue
    c. dry-mount glue
    d. contact paper

11. Which item represents the correct temperature setting of the heat press for laminating a visual when lamination is done in a dry-mount press?
    a. 150
    b. 225
    c. 270
    d. 350

12. A type of graph that is useful for plotting trends is the:
    a. bar graph
    b. line graph
    c. circle graph
    d. pie graph

13. Which of these represents a function of bulletin boards?
    a. they facilitate study of single copy materials
    b. they stimulate student interest
    c. they create an atmosphere conducive to learning
    d. all of the above

14. Captions used to draw the reader closer in order to present additional information is a characteristic of which of the following:
    a. posters
    b. bulletin boards
    c. magnetic boards
    d. clingboards

15. Hook and loop boards are particularly advantageous for use with:
    a. flannel cut-outs
    b. magnetic materials
    c. heavier objects
    d. none of these

16. Which item represents an advantage of clingboards?
    a. inexpensive
    b. highly visual
    c. sequential development
    d. all of the above

17. A disadvantage of globe usage for instructional use is:
    a. accuracy
    b. simplicity
    c. color
    d. bulkiness

18. What do we call three dimensional representations of real things which do not necessarily look like the object being represented?
    a. copies
    b. models
    c. mock-ups
    d. specimen

19. Which of these items represents the most realistic instructional materials?
    a. globes
    b. dioramas
    c. models
    d. mock-ups

20. A major advantage of disc recordings as compared to audio-tape recordings is:
    a. they are non-erasable
    b. they use capstan drive
    c. they are more easily operated
    d. they are commercially produced

21. Most broadcast educational television stations receive some programs from:
    a. NBC
    b. FCC
    c. NET
    d. NRA

22. A device which allows visual images to be recorded and played back at future times is the:
    a. multiplexer
    b. vidicon camera
    c. synchronizer
    d. videotape recorder

23. Which item represents a function of the teacher who utilizes programmed instruction?
    a. motivation
    b. guidance
    c. coordination
    d. all of the above

24. The person generally credited with initiating the development of the branching approach to programming is:
    a. Crowder
    b. Pressey
    c. Skinner
    d. Green

25. Which type size is preferable for use on transparencies intended for general classroom use?
    a. pica
    b. elite
    c. primary
    d. all are equally acceptable

26. A translucent master is necessary for producing which type of transparency?
    a. Diazo
    b. thermal
    c. color-lift
    d. dry-photo-copy

27. Transparencies produced by the dry photo-copy method are developed by?
    a. heat
    b. ammonia fumes
    c. photographic chemicals
    d. light

28. Many 3M "Secretary" capeirs have a color coded dial for setting exposure. Which color setting is appropriate for producing thermal transparencies?
    a. red
    b. white
    c. green
    d. buff

29. Which of these practices result in a savings in transparency film over a period of time?
    a. the use of test strips
    b. running the machine faster than usual
    c. running the machine more slowly than usual
    d. making duplicate transparencies for file

30. Which item represents an advantage of handmade transparencies?
    a. they can be produced quickly
    b. they are informal
    c. they are less likely to be ruined in storage
    d. multiple copies can be made quickly

31. Which item represents an advantage of the color-lift method of transparency production?
    a. color transparencies can be made from pictures in certain magazines
    b. they do not require the use of transparent film
    c. they require little time to produce
    d. they have a professional appearance

32. Which of these is not a principle for the effective use of flat pictures?
    a. use few rather than many pictures
    b. integrate pictures with the lesson
    c. use color rather than black and white pictures
    d. use pictures for specific purposes

33. Which of these is most easily available to classroom teachers?
    a. filmstrips
    b. mock-ups
    c. flat pictures
    d. motion picture films

34. Which of these processes is the least messy?
    a. wet-mounting
    b. dry-mounting
    c. rubber cement-mounting
    d. they are equally messy

35. Before laminating, flimsy materials should be:
    a. soaked in hardening solution
    b. washed with vinegar
    c. dry-mounted
    d. sprinkled with talcum powder

36. Which item represents the correct temperature setting, in degrees f, for the dry-mounting process?
    a. 250
    b. 270
    c. 225
    d. 265

37. Good instructional cartoons have three characteristics. Which item more nearly represents one of these characteristics?
    a. they must use highly abstract symbols
    b. they must be funny
    c. they must be appropriate for the experience level of the student
    d. they must be satirical in nature

38. Dramatic simplicity is a characteristic of which of the following:
    a. clingboards
    b. chalkboards
    c. bulletin boards
    d. posters

39. Which of these is <u>not</u> characteristic of a good poster?
    a. simplicity
    b. attractiveness
    c. multi-purpose
    d. a brief text

40. Which item represents an advantage of clingboards?
    a. content is easily manipulated
    b. students prefer three dimensional materials
    c. students enjoy making the instructional material
    d. A and B

41. The most important factor that enables students to distinguish features on globes is:
    a. latitude lines
    b. lettering
    c. color
    d. embossed surfaces

42. Which item represents a type of audio material commonly used in conduction with accompanying visual material?
    a. radio
    b. optical sound recordings
    c. disc recordings
    d. magnetic tape recordings

43. Which item represents a major advantage of audio-tape recordings as compared to disc recordings?
    a. they are more easily stored
    b. they are less expensive
    c. they are more available
    d. they are more easily produced by teachers.

44. Most broadcast TV programs are transmitted over which frequency range?
    a. UHF
    b. AM-FM
    c. FCC
    d. VHF

45. A device which allows 2 x 2 inch slides, filmstrips, and motion picture film to be projected into a TV camera is a:
    a. video-tape recorder
    b. image-orthocon viewer
    c. vidicon viewer
    d. multiplexer

46. Under FCC regulations, which size vidiotape must be used for television programs broadcasting?
    a. one inch
    b. two inch
    c. one-half inch
    d. all of the above

47. A major advantage of programmed instruction is that it can be used to:
    a. teach foreign languages
    b. disseminate information
    c. motivate students
    d. solve complex problems

48. Branching programs usually utilize:
    a. a constructed response
    b. a multiple choice response
    c. a true-false response
    d. a written response

49. "Multi-Media" means:
    a. use of more than one medium at a time
    b. being snappy and up-to-date in one's classroom presentations
    c. selection of media and design of instruction involves consideration of many possible media for the teaching job at hand
    d. a & c

50. With considerable justification, "Education as a field of study and the methodology of teaching practice have both been criticised for lack of <u>theoretical</u> emphasis. Which of the following may help supply a needed theory base for instructional design and practice?
    a. communication theories
    b. systems and information theory
    c. learning theories
    d. all of the above

51. Verbal association (Gagne, Type 4 learning) is, basically a particular form of what other type of learning?
    a. signal
    b. S - R
    c. chaining
    d. concept learning

52. When a child can correctly identify something he has never seen before, like a desk lamp, as being a member of a class of things (in a furniture store, "Gee dad, tha's a desk lamp isn't it?"), he is probably demonstrating:
    a. how smart he is
    b. attainment of stimulus-response learning
    c. readiness to read
    d. attainment of concept learning

53. "Rule learning," according to Gagne, is a type of learning which:
    a. is primarily restricted to the higher grades, where application in civics and other classes may be made in which rules can be related to the personal lives of students
    b. occurs most frequently in the lower grades where much of the day's work in school is taken up in teaching rules for good and orderly behavior
    c. involves relationships between concepts, and are the same sort of things that are often expressed in the form of principles
    d. is the highest form of learning

54. In this course, we have concluded with consideration of the problem of media selection and use from which of the following standpoints:
    a. that a teacher should find ways to use as much media as possible
    b. that media should be considered systematically in the institutional design process with an eye toward providing <u>optimal</u> instruction, irrespective of amount of media use
    c. that the economics of education require that we use as little as possible of the expensive media
    d. that films and slides are wonderful

APPENDIX G

RUNNING TIME OF INSTRUCTIONAL UNITS IN ACCORDANCE WITH COMPRESSION RATE

TIME IN MINUTES PER COMPRESSION RATE

UNIT	0%	20%	25%	30%	40%	50%	55%
I	17:30	14:00	13:08	12:15	10:30	8:45	7:53
II	31:50	24:15	22:41	21:05	18:15	15:55	14:11
III	17:15	13:14	12:56	12:05	10:15	8:38	7:48
IV	26:45	21:30	20:04	18:38	16:00	13:23	12:02
V	12:45	10:15	9:34	9:02	7:45	6:23	5:39
VI 1-1	20:00	16:00	15:00	14:00	12:00	10:00	9:00
VI 1-2	26:30	21:21	19:48	16:06	13:45	13:15	11:56
VI 2-1	24:30	19:45	18:22	17:09	15:00	12:15	11:00
VI 2-2	20:00	16:00	14:30	14:00	12:00	10:00	9:00
VII	23:00	18:30	17:15	16:06	13:45	11:30	10:21
VIII	29:00	23:15	21:45	20:18	17:30	14:30	13:03
IX	19:30	15:36	14:42	13:39	12:00	9:45	8:47
X	7:00	5:35	5:15	5:54	4:15	3:30	3:09
XI	24:30	19:36	18:23	17:09	15:00	12:15	11:04
XII	25:45	20:45	19:19	17:20	15:30	12:53	11:35
XIII	15:15	12:15	11:26	10:41	9:00	7:38	6:53
Words per Minute	120	155	162	174	200	243	281
Total Running Time in Hours	5:41	4:32	4:14	3:55	3:23	2:50	2:33

APPENDIX H

ABSTRACT OF

STUDENT'S COMMENTS

GROUP I

"Comment on question 14--depending on the compression rate, it doesn't have to produce anxiety. All will force students to pay closer attention--which is probably a pretty good idea."

"I really do wish all students had choice of compression rate, because of the time conservation it would afford. I found it not difficult to distinguish between comprehension at most levels. I really enjoyed the higher compression rates."

"Question 14 (concerning anxiety level) is the most important. I think compressed speech is a great theoretical idea, but will never be widely used because it makes most people uncomfortable."

"I enjoy acquiring subject matter through tapes and filmstrips, but think that a person should be able to control the rate of compression."

"Group I 'Normal Rate' seems too slow--it is hard to tell what is important and what is not."

"The idea of compressed speech is great! The higher compressions (40% and above) are hard to understand and need improvement; however, the 20 and 30% are relatively easy to understand."

GROUP II

"I feel that each student needs an opportunity to listen to the different compression rates and by that find which one that (sic) would be suitable for the individual. I really thought listening to the tapes helped alot (sic) and by no means should the use of the filmstrips be done away with. These gave me an opportunity to see what I was being taught, and gave me a better understanding of the material. I really like how the class is made up. It's different from the same ole' thing and really interesting and helpful."

"As for compressed--I don't mind being in group II. It keeps me on my toes to keep up with taking notes."

"I feel I can get more out of listening to the tapes and viewing the filmstrips because I have complete control of how fast or slow I want to listen to them; whereas, in a classroom situation, one cannot rewind the teacher and have him repeat things as often as one would probably like to."

"Question 26 hits the mark--it's the <u>replaying</u> that is the most benefit to listener--you can't get all the information from just listening--there is a need for visual aid either filmstrips that outline tape <u>or</u> outline on paper that visualizes material."

"I would like to review W/50 on 55% compression."

GROUP III

"I also feel the compression rate would be most advantageous if the student could choose the rate he considers most desirable for himself. The problems I had with a high compression rate were that I could not take notes as fast as I was listening and had to stop the tape; and also the only time I had trouble understanding the tape was when new words were presented which were not on the filmstrip. I feel the compressed rates are great for reviewing material."

"Once I got used to them (compressed tapes) I wouldn't have trouble with them. Great advantage to saving time."

"I really liked the idea of tapes and filmstrips."

"Testing more frequently would encourage more frequent listening to tapes. The best method for me is to listen to the tapes shortly before the exam."

"Compressed speech good, subject matter uninteresting -."

"My main gripe is that we had no choice as to compression rate. I feel that the individual can better pick his own compression rate."

"I like the tapes and filmstrips, but I hope that next semester, people can choose which compression rate they would like to use, like Group IV does now. I feel that I would have done better on the mid-term if I had not had to listen to Group III tapes."

"After having that first test and not doing as well

as I thought I should, I realized that I might not have been really 'LISTENING.' Since I have completed this second half--I feel that my listening ability has increased."

GROUP IV

"I feel that this is an outstanding method of presenting material. Too much of this type instruction and the student would get bored. This would be a great way to instruct exceptional children, both the bright and retarded."

"I have enjoyed this lab better than any other labs I've taken. It's good to listen to the pertinent material at your own pace."

"The compressed speech units are useful when the compression rate is not too high. For note taking 30% is about fast enough. At 50% Compression note taking is almost impossible if one keeps up with the filmstrip. For learning new material I found I could not retain as much at say a 50% compression but for review 50% is excellent."

"I am enjoying using the compressed speech--I have found 20% the best for myself. At first I thought 20% was too fast, but after listening to a normal tape I found it too slow. I think I have learned more from the tapes and slides than I would have from straight lecture. I would like to see other courses done this way."