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ABSTRACT

Experiments measured the effectiveness and efficiency of audio tape recordings using "time-compressed speech" compared to those using normal recording rates in an audio-tutorial system. The experimental tapes were compressed to 60 percent of the original rate of delivery. Results showed that the rate of speech made no difference in the students' achievement. The time-compressed recording group had a 12.3 percent saving of time as compared to the control group, but this saving is not statistically significant. Little relationship was found between achievement and the personality characteristics of creativity and sociability as measured by the Remote Associations Test and the Thorndike Dimensions of Temperament test. No advantage or disadvantage accrues from using time-compressed recordings in an audio-tutorial system. Results indicate that high rates of speech, up to 210 words a minute, should work well on tapes assuming the speaker is intelligible. (JK)

A COMPARATIVE STUDY OF TWO PRESENTATIONS OF RATE CONTROLLED AUDIO INSTRUCTION IN RELATION TO CERTAIN STUDENT CHARACTERISTICS

A THESIS
SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF THE UNIVERSITY OF MINNESOTA

By

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CHAPTER I

INTRODUCTION AND PURPOSE OF THE STUDY

This study is a report of a field experiment concerned with collegiate level independent learning with audio tape recordings as the main vehicle of instruction. The study investigates the effect of tape recordings at two different word rates upon achievement. Word rate was manipulated by means of time-compression equipment which gives the effect of a higher word rate. The study assesses the efficiency of time-compressed recordings in relation to normal speed recordings. The study further investigates the degree of relationship between certain personality characteristics and independent learning via audio tape recordings.

Need for the Study

In 1961, a method of independent, self-paced tape recorded instruction was introduced to augment a collegiate freshman botany course at Purdue University. (I, 7, p. iii) This method, developed by Dr. S. N. Postlethwait, appropriately titled "Audio-Tutorial" has grown in acceptance as evident by its widespread

adoption throughout the nation. While the bulk of applications of audio-tutorial methodology has been in the teaching of plant sciences, the methods employed have also been applied to a number of other subject fields and at different levels. The audio-tutorial method places reliance upon such conventional technological teaching devices as tape recorders, 2x2 slide projectors and 8mm motion picture projectors. This application of technology to the instructional process is significant because of its apparent success and wide acceptance. An outspoken critic of educational technology, Anthony Oettinger, has stated:

> The keystone is Postlethwait and his enthusiastic crew. Where comparable talents can be mustered, comparable results may be expected. Where not, the results might well be inferior to those obtainable through conscientious teacher proofing. In this respect, therefore, higher education, like military or industrial training programs, provides a better laboratory for educational technology than lower schools. (I, 6, p. 155)

Achieving success in using audio-tutorial methodology requires a significant commitment of instructional planning and a sustained financial commitment to ensure an effective program. Failure to secure either commitment is almost surely to result in failure. (III, 14, p. 82; I, 7, p. 139)

The audio-tutorial instructional concept, although widely heralded, is not without its critics. Most of the criticism attacks elements in the methodology which places the individual student in direct

contact with real objects with the instruction given by a tape recorded teacher. In his book, Postlethwait and his colleagues (I, 7, p. 139) have outlined common problems in applying audio-tutorial methods for the first time. He suggests three problem areas: (1) the structuring of audio-tutorial method to the subject, (2) psychological issues involving learning theory, and (3) technical deficiencies. These issues raise numerous questions relating to the application of the audio-tutorial methodology. The present study will focus attention upon certain aspects of the latter two problem areas.

Postlethwait warns against the temptation for teachers to base instructional tape recordings made for independent instruction upon prior lecture notes. He said that lectures are seldom planned to incorporate simultaneous direct experiences with study materials by students during recorded instruction. He also warns that extended didactic presentation is often boring when live, and when on audio tape, the lecture can have a narcotic effect. (I, 7, p. 139)

Others have been critical of the length of the lessons presented by tape recordings. A study of the application of the audio-tutorial method in a foods and nutrition class in a college level home economics course reports that a frequent criticism was the length of time students must spend in the laboratory.

(III, 14, p. 65) Sherman, reporting the application of the audio-tutorial method college level teaching of history, states that there was frequent student criticism in regard to the length of the tape recordings. (III, 12, p. 5) Likewise, Bell reports a negative relationship existing between the length of taped lessons and student evaluations. (III, 2, p. 65) Bell states that the shorter tapes, less than twenty minutes, will usually exhibit higher evaluations than longer tapes. None of the studies reported specific reasons for the discontent with longer tapes.

With regard to these findings a legitimate area for investigation would be the discovery of the most efficient rate of delivery and its relationship to the optimum length of an instructional tape used in audio-tutorial instruction. These two variables, tape length and rate of delivery, may be important when reports of discontent with tape length are considered. Nichols (II, 22, p. 301) suggests that the rate of delivery by a speaker may be an important factor in listening comprehension. Comprehension is of utmost importance in audio-tutorial instruction for the tape is the teacher and permits little opportunity for immediate feedback. One of the purposes of the present study is to assess the effect of different rates of delivery upon comprehension.

The audio-tutorial method is often referred to in the literature on individualized instruction. It permits adaptation to individual differences through provision for student manipulation of the tape recorder, but it is not individualized instruction through varying objectives and techniques of instruction to meet individual student needs. The fact that the student learns by himself, without aid or distraction of other students raises the question as to the effect of independent study upon the social needs of the student. In a study of the personality characteristic of sociability as a predictor of achievement in lecture and small group teaching methods, Beach (II, 3) reports that students with high social need achieved significantly more than students with low social need in the small group situation. The reverse was reported true in the large group lectures. A review of the literature does not reveal the sociability variable as a predictor of achievement in audio-tutorial or other independent instruction via audio tape recordings.

In his section, "Student Characteristics Related to Effective Teaching," McKeachie cites numerous studies which have indicated the need to find out more information concerning teaching method variables and the dimensions of individual differences.

> Most teachers are aware that differences between students are not taken into account sufficiently by our usual teaching methods. . . . One reason for the host of experimental comparisons resulting in non-significant differences may be simply that methods optimal for some students are detrimental to the achievement of others. When mean scores are compared, one method thus seems to be no different in its effect from any other. (II, 19, p. 1157)

Tape recorded independent instruction, such as that of audio-tutorial methodology, may, because of little provision for spontaneous student interaction and the structure and pacing of the recording, influence the achievement of the student. This is especially true for a student who needs student-teacher or student-student interaction. One purpose of the present study is to assess the effect of social need upon achievement in independent tape recorded instruction.

A personality characteristic often linked to instructional method and its effects is that of student creativity. In a discussion of Oettinger's Run, Computer, Run, Glaser stresses the importance of providing education which will provide society with people capable of doing new things, rather than repeating what other generations have done. Fitzgerald (II, 7), in an article highly critical of programed instruction, points to the stifling effect of highly structured instruction which he suggests does not encourage thought or foster student creativity. The personality characteristic of creativity may have some effect upon

achievement if the creative person is stifled by structured instructional materials. Perhaps the more creative student is at a disadvantage in an instructional program where he feels he is unable to have free expression. Another purpose of the present study is to assess the effect of creativity upon achievement in independent instruction taught by means of audio tape recordings.

The student learning from audio tape recordings differs in one major respect from the student who is learning by reading. The difference is that the student who learns by reading is able to vary his rate of input. The student may leisurely read or read at a higher rate of speed contingent upon his reading skills and his perceived needs. The student who learns from audio tape recordings, however, is restricted to the speaking rate on the tape recording to which he is listening. Nichols states:

> On the average in America we talk at about 125 words per minute. But informative speakers--or at any rate school classroom lecturers--average only 100 words per minute. . . . By contrast, how fast do we listen? . . . Our best estimate after studying available objective reports would be that an easy, average cruising speed of thought for most college students would be at least 400 words per minute. (II, 22)

More recent research in perception is in general agreement with Nichols' statement. Thus, if recorded instruction was "speeded up" or increased in the number of words per minute recorded instruction could

be closely matched to the learner's ability to think. Fortunately, there are technological devices which will permit varying the playback of a tape recording without the frequency distortion inherent from simply speeding up the capstan of the playback machine. Pioneered by Fairbanks (II, 5; V, 1) at the University of Illinois, a device which permitted expansion or compression of recorded speech was developed. The machine varied the rate of playback without frequency distortion. Development of Fairbanks' device encouraged investigation into auditory perception. Most of the research in the application of "speeded" or compressed speech has been in connection with the education of the blind because of their dependence upon auditory stimuli. Even with extensive compressed speech research since 1954, those who produce and distribute recorded materials to the blind have been slow to adopt the innovation. Dr. Ronald Brieland, in the keynote address to the American Association of Instructors of the Blind, noted: "Even a useful, effective technique takes a long time to get accepted. . . . Not much has happened in the twelve years since it was presented." (III, 3) Likewise, the literature makes frequent reference to the potential application of compressed recordings for the instruction of the non-visually handicapped student. (IV, 5; IV, 3; II, 25) While some utilization of compressed speech

recordings has been reported in the literature, only one application of compressed speech was reported at the Audio-Tutorial Systems Conference held at Purdue University in October, 1969. Herrick (III, 5) reported that compressed recordings were used for review purposes; no empirical research data were presented. Since audio-tutorial methodology uses audio tape recordings, apparently then, compressed tape recordings have potential for providing recorded materials at different rates of speed and for presenting information at a rate more nearly matching the thinking or information processing capacity of the learner. The present study will assess the effectiveness of compressed recordings as a communication medium in independent instruction.

The final area of interest for the present study is directly concerned with the application and effectiveness of compressed speech as a medium of instructional communication. Independent instruction utilizing audio tape recordings permits the student to start, stop, and repeat portions of the recording to which he is listening. The crucial question is whether the utilization of time-compressed recordings actually results in a saving of time. This question and the others previously mentioned form the major areas of concern for the present study.

Organization of Dissertation

This chapter has been concerned with the need for the present study and the purpose and specific aims of the study. Chapter II reviews related literature and research. Chapter III presents the procedure of the study. The results and analysis of the data are contained in Chapter IV, and Chapter V is concerned with a discussion of the results, conclusions, and a summary.

CHAPTER II

RELATED LITERATURE AND RESEARCH

This chapter will review the literature and research in the three major elements of the present study: (1) the audio-tutorial and other tape recorded instruction at the collegiate level, (2) compressed speech, and (3) the interaction between personality characteristics and collegiate level instruction. The chapter concludes with a summary of the principle ideas drawn from the literature.

Applicable Literature on Recorded Instruction at the Collegiate Level

The audio-tutorial method (I, 7) developed at Purdue University in 1961 is perhaps the most widely adopted method of instruction at the collegiate level which makes systematic use of audio tape recordings. The basis for the audio-tutorial method is the emphasis on student learning rather than on the mechanisms of teaching. The audio-tutorial method is in accordance with contemporary behavioral learning theory and its educational application. The method as described by Postlethwait is composed of three

major elements: (1) general assembly session, (2) small assembly session, and (3) independent study session. The general assembly session is similar in nature to the lecture portion of the usual college level lecture-laboratory science course. The main purpose of the general assembly session is that it is used to present those kinds of activities best done in a large group. Usual activities include presentations by a guest lecturer, showing of long films, review sessions, or for examinations. Attendance is often optional. The second element of the audio-tutorial method is the small assembly session. The small assembly session is a small student group that meets with an instructor to terminate a week's work with oral and written quizes. Students are expected to respond in some detail to questions posed by the instructor. In the small assembly session, the student acts as a teacher, explaining a concept or a principle in sufficient detail that others in the group are able to understand what he is saying. The third element of the audio-tutorial method is the independent study session. It is in this portion that tape recordings are used for instruction. Postlethwait states:

> In the audio-tutorial booth, the taped presentation of the program is designed to direct the activity of one student at a time; the senior instructor, in a sense, becomes the student's private tutor. It is important to emphasize at

> this point that the tape represents only a programing device and that the student is involved in many kinds of learning activities. Further, it should be noted that those activities which by their nature cannot be programed by the audio tape are retained and presented in other ways. Flexibility and independence, accompanied by helpful guidance, when necessary, are the key concepts of the approach. (I, 7, p. 7)

In the independent study sessions, the student uses a variety of objects in his immediate environment whichever most appropriately suits his own needs for attaining the objectives of the instruction. The learning environment is set up by the instructor prior to the student's participating in the independent study session and may include live specimens, plants, models, mock-ups, or whatever materials are appropriate to the objectives of the lesson. The student, when listening to the tape recording, is instructed to participate in a variety of activities which will help him to attain the objectives. For example, he may be directed to look at a slide on a projector, to feel the leaves of a plant to learn of the texture, to test the hardness of a mineral, or to cut a specimen of tissue to examine under a microscope. The student takes an active role in his learning experience and therefore is responsible for his own learning. The student is also given the responsibility for making his own schedule and may decide to sit through a lesson in its entirety or to participate in

only a portion of the lesson and delay the remainder. He also has the opportunity to repeat or skip ahead in the lesson as he so pleases.

Postlethwait (I, 7, p. 97) commenting on the effectiveness of the audio-tutorial method states that there is a direct relationship between the number of hours that the student spends in the independent study session booth and achievement as measured by written examinations. While cautioning against generalizing from his data, Postlethwait feels that the audio-tutorial method can be an effective laboratory for observing the way students learn by varying instructional procedures.

A detailed study by Meleca (II, 8) comparing the traditional laboratory approach with the audio-tutorial method analyzed the relationship between student abilities and level of achievement for each group. Studying second semester biology students at Syracuse University, Meleca reports that the section employing the audio-tutorial method was significantly more effective than the regular course in biology. Using test instruments including the Scholastic Aptitude Test and Sequential Tests of Educational Progress published by the Educational Testing Service, he stated that these two tests were effective predictors of achievement in the audio-tutorial course. For example, students showing high aptitude in mathematics

and biology achieve at a higher level in the audio-tutorial course than comparable students in the regular course. Students with strong backgrounds in science and biology, however, achieve at a higher level in the regular group than students with comparable backgrounds in the audio-tutorial group. In an analysis of the amount of time spent in the audio-tutorial booths, Meleca states that students who lacked the strong background variables compared to their high ability peers were able to offset this apparent handicap by spending more time in the booths to reach the same level of achievement. His conclusions in respect to time and achievement confirm the findings of Postlethwait. Meleca fails to mention, however, the most effective tape length or rate of delivery on the tape.

In a doctoral dissertation research study comparing audio-tutorial and traditional methods in an introductory home economics food and nutrition course at Purdue University, Tope (III, 14) planned audio-tutorial and traditional methods based upon the same behavioral objectives. The course was taught by three experienced instructors, with each instructor having at least one section by each of the two methods. She compared the two groups on the basis of student grade-point average, Scholastic Aptitude Test verbal and mathematics scores, high school rank,

college chemistry grade, departmental pretest score, and student reports of prior experience with food preparation. Written examinations given to the students were the criteria for evaluating the effectiveness of the two methods. The results of the study revealed no significant difference (p .05) between the audio-tutorial and the conventional groups except that more (p .01) students in the conventional group had taken senior high school home economics than those in the audio-tutorial group. A review of the correlations among the descriptive variables within the two groups indicated a significantly high (p .01) correlation between achievement and departmental pretest and relatively high correlations between achievement and the other student measures listed above. She also kept time records for each of the two groups, with the results indicating that there was no significant difference in the amount of instructional time between the two groups. Tope concluded that success in the audio-tutorial home economics course was related to academic ability rather than prior experience with foods. She did not make any reference to optimum tape length or rate of delivery.

Another comparative study between audio-tutorial and lecture methods of teaching as reported by Stuck involved the teaching of school law to

seniors at Iowa State University. A list of eighteen concepts was taught by lecture to a control group and the same concepts were taught by audio-tutorial methods to an experimental group. The audio-tutorial materials were designed in such a manner that it permitted the student to be placed in a simulated school where he was expected to solve problems relating to the concepts. Stuck's study revealed that the audio-tutorial method was significantly (p .01) more effective than the lecture method. However, no significant relationships were found between achievement and student teaching, which about half of the students had taken previously. In addition, there was no significant relationship between achievement and grade-point average. Students kept records of the amount of time in studying by each of the two methods. Mean time for the experimental group was 6.01 hours and for the control it was 8.32 hours. Stuck concluded:

> It is evident that there was an economy of time (38.44 per cent) by the use of these materials. The audio-tutorial group did significantly better than did the lecture group, but had there been no learning differences, the experimental treatment should be used for the time-saving feature. (II, 31)

He did not report anything in regard to optimum tape length or rate of delivery.

Other comparative studies between audio-tutorial and more conventional methods are also reported by Lamont (III, 6), Weaver (III, 15), and

Sparks (III, 13). None of these studies, as in others previously mentioned, make any reference to optimum or even preferred tape lengths or rate of delivery.

Herrick (III, 5) reported the use of audio-tutorial methods in a multi-disciplinary laboratory instruction in medicine. A variety of media was used in instruction including the use of compressed speech. Students have both regular and compressed tapes available to them. Tapes were compressed to 70 per cent of the original production time; however, no statistical results are reported with respect to time saved or achievement.

While the present writer recognizes that comparative studies are subject to grave criticism by serious researchers, their consistency in reporting the effectiveness of the audio-tutorial method cannot be overlooked. Lumsdaine cautiously defends comparative media research by stating:

> Their purpose may be propagandistic, in the interest of gaining support for more incisive research and development, or may represent other heuristic aims, such as testing the worth of a general approach before proceeding; or to provide experiences or hypotheses about specific factors that may be a useful background for planned future experiments; or to establish that a sufficient range of effects can be achieved to insure that a methodology can profitably be further pursued along similar lines; etc. (II, 18, p. 598)

Commenting on research in audio-tutorial methods, Novak (III, 9) emphasizes that the audio-tutorial methodology presents a systematic way of

monitoring student learning and permits the researcher to try two or more sequences of instruction for the attainment of learning objectives. The comparative studies as described by Novak, however, contrast sharply with the poorly controlled comparative studies so widely criticized in research literature.

While there have been several studies comparing the audio-tutorial and conventional methods, there are relatively few well designed studies assessing the effectiveness of audio-tapes in college level instruction.

A study at Antioch College (III, 1) reported the results of a two year experiment in comparing traditional instruction with audio-tape instruction which employed the language laboratory. Findings indicated a savings in instructional time without any consequent loss in achievement. Audio tapes also permitted more supervised learning for each student.

Bell (III, 2), in a study analyzing audio tapes for direct instruction, stated that there was no significant difference with respect to achievement by males or females and that students generally preferred tapes shorter than twenty-one minutes in length as compared to those longer than twenty-one minutes. There was no mention concerning the most effective rate of delivery in the instructional tapes.

Several other studies in the use of audio tapes in the elementary and secondary schools are reported in the literature. These studies, however, will not be reviewed in the present study because of the inherent difficulty in trying to generalize to the post high school level those findings which are researched on the K-12 level. In this regard, Dubin and Taveggia (I, 2, p. 7) emphasize that the clientelle and teaching learning situation in higher education have very different characteristics from those of the K-12 settings. Student learning rates, ages, maturation level, working hours, and marital status represent only a few of the differences that have been cited between K-12 and college students. The relatively permissive atmosphere of non-required class attendance, voluntary subject selection, and instructor preparation have demonstrated several differences between the two.

Applicable Literature on Time-Compressed Speech

Time compressed speech is recorded speech in which the word rate has been increased by means of special recording equipment. Increasing the word rate thereby reduces the time required for a given message. On the other hand, time expanded speech is that in which the word rate has been decreased, thereby increasing the time required for a given

message. Time-compressed or expanded speech is the result of specially processed audio tape recordings, which when played on a standard tape recorder will be reproduced at a rate which differs from the normal rate of delivery. The present study and review of literature will concern itself only with time compressed speech.

There is some variation in the literature concerning measures of normal speaking rate of the English language. Nichols and Stevens (I, 5, p. 78) have stated that the normal rate is about 125 words per minute. A slightly higher and variable rate was reported by Taylor (I, 9, p. 14), who speculated that 135-175 words per minutes is a normal and preferred rate. Foulke (IV, 1) states that the normal oral reading rate is approximately 175 words per minute. While a trained speaker can read at a higher rate there is a limit when intelligibility becomes difficult. Then too, there is the difficulty for the rapid speaker to maintain his speed for any but short lengths of time.

The primary reason for interest in speeding rate of speech is that there is some evidence that listeners are able to comprehend at a much higher rate of speed. Estimates suggest that an average speed of comprehension is 400 words per minute, with the speed going as high as 800 words per minute.

(II, 22) An early study utilizing trained, rapid speakers is reported by Goldstein (I, 3) who experimented with college students at Columbia University. Trained speakers read paragraphs from several reading comprehension tests at various rates of speed. He stated that 322 words per minute resulted in some comprehension, but that the maximum rate of delivery was limited by the rate at which each reader was able to speak. Using modified recorded speech, Garvey (IV, 4) stated that accelerations in delivery rate could be made without requiring the reader to speak more rapidly. Further development of Garvey's technique by Fairbanks (II, 5; II, 6) has resulted in research suggesting that a two to three time increase in speech rate is within the capability of the average listener. More recent research by Foulke (II, 9) working with the blind and by Orr (IV, 5) with the use of compressed speech as an educational medium has resulted in increased interest in compressed speech.

Interest, however, is not enough to make compressed speech an accepted educational medium. While the research indicates that compressed speech has great potential as an educational tool, there is the problem of the technology involved in processing recordings resulting in an acceptable compression.

The simplest way of changing the word rate of recorded speech is by reproducing it at a different rate than that used during the original recording. If the playback speed is slower than the recording speed, the word rate is decreased and the speech is expanded in time. If the playback speed is faster than the recording speed, the word rate is increased and the speech is compressed in time. An example of compressed speech by the speed changing method would be playing a tape recording at 7 1/2 inches per second that was recorded at 3 3/4 inches per second. There are, however, some serious difficulties encountered by expanding or compressing speech by such a method. The main problem is that of the resultant shift in the sound frequency due to the change of speed. For example, if the speed is doubled the component frequencies are also doubled, and the overall vocal pitch will be raised one octave. If the speed is halved the opposite effect will occur. While the literature has several studies measuring the effect of speech manipulated by the speed changing method it has only limited utilization because of the frequency distortion mentioned above.

At present, the most widely used method for changing the word rate of recorded speech is by the sampling method. The sampling method was first investigated by Garvey and Henneman (IV, 4) using what

they called the chop-splice method. The chop-splice method involves cutting a tape recording every one-quarter of an inch from beginning to end, and discarding alternate pieces. The remaining pieces are then spliced together to make a reconstituted tape that is half the length of the tape as originally recorded. The playback of the tape processed by the chop-splice method will sound normal as far as the pitch of the speaker's voice is concerned, although it will be compressed in time by 50 per cent. While this method results in compressed speech, it is of course extremely tedious and without practical value because of the labor involved to make such a tape. Garvey and Henneman humorously commented that they never wanted to see another tape splicer after completing their study.

An electro-mechanical system for automatically discarding segments of speech from a recorded tape is reported by Fairbanks, Everitt, and Jaeger. (II, 5; II, 6) Their system uses four playback heads mounted on a rotating drum to scan a magnetically recorded tape. The effective time length of each speech sample scanned and retained is equivalent to the speech time on each piece of tape spliced together in the chop-splice method, and is called the sampling interval. The sampling interval is determined by the revolutions per minute of the rotating head assembly. The time

length of each speech sample eliminated is similar to the speech time on each piece of tape discarded in the chop-splice method, and is called the discard interval. The discard interval is determined by the speed of the magnetic recording tape around the head assembly. The output is normally re-recorded onto another tape for later use in its compressed form. The resulting product of the Fairbanks system is thus equivalent to the output produced by the chop-splice method, but is obviously less tedious. The electro-mechanical sampling method currently is the most well known and frequently employed method for changing the word rate of recorded speech.

More recent developments in equipment for changing the word rate of recorded speech include methods which incorporate the capabilities of the computer. Using the computer for compression or expansion of speech is still under development and, no doubt, will be of significance in the future.

The Harmonic Compressor, recently developed by the Bell Laboratories, permits making recordings of the human voice which can be played at twice normal speed while retaining normal voice pitch. Root (III, 11) describes the Harmonic Compressor by stating that it divides in half the frequency components (harmonics) in a voice recording while preserving the original time duration. By doubling the

speed of the resulting half frequency recording in playback, the frequency components are restored to their original values. The result is a normal pitch double speed recording. The chief limitation of the Harmonic Compressor, however, is that it limits output to only speech compressed to double the normal speed.

Changing the word rate of recorded speech raises the question of the measurement of the resultant output. Foulke (V, 2, p. 6) states that for the purpose of a measure of intelligibility, single words are compressed, and it is meaningless to speak of the word rate of a single word. In these cases, specification of reproduction output must be stated in terms of compression or acceleration. An example would be compressing a word 50 per cent; that is, it is reproduced in half the time. A word compressed 40 per cent would be reproduced in 60 per cent of the original production time, and so on. Foulke states that if compressed speech is to be specified in terms of percentage of compression, the word rate of the input recording should be determined and stated. Since there isn't any "normal" word rate that can be safely assumed, the number of words per minute and degree of compression should be adequately descriptive. On the other hand, a strong case against word per minute original and compressed rates has been

marshalled by Miron and Brown (II, 21) who suggest that measurement is much more complex and requires more precise measurement techniques. They suggest that a spoken message may vary with respect to three attributes: (1) rate in terms of syllables and words and the associated variability of these measurements, (2) distribution of pause and phonation time, and (3) information measures of the message content.

While there is some limitation to the word per minute measure, the word per minute measure is prevalent in the literature and is generally accepted. The weakness of the word per minute measure is that there is a linear negative relationship between the number of words in a given time period and word length. That is to say, as words become longer, as in the case of technical or scientific speech, the number of words per minute will diminish. Miron and Brown (II, 21) state that the syllable-to-word ratio influences the rate a speaker is able to sustain. They report that an analysis of the English language has a mean syllable-to-word ratio of 1.309 with an associated standard deviation of .641 syllable. For purposes that require a high degree of description, the syllable-to-word ratio would appear to be a practical measure when used along with the more conventional measure of words per minute.

Much of the research in the use of compressed speech has been under controlled conditions where subjects listen to spoken or recorded reading selections. Frequent reference to the Nelson-Denny reading test is made in the literature. (II, 11; III, 10; IV, 5) The reason for the use of reading tests is these tests are well constructed in regard to vocabulary and have valid measurement instruments designed for each reading selection.

In the research using recorded selections from prose or textual materials there is frequent reporting of the reading difficulty of selections by the use of the Dale-Chall formula for readability. (II, 27; IV, 2) Other researchers, including Goldhaber and Weaver (II, 13), utilize the Flesch rating scale of reading difficulty. Either the Dale-Chall or the Flesch rating scales of difficulty are generally accepted by researchers as indicies of reading difficulty and serve the purpose of indicating the complexity and difficulty of the material recorded. Measures of reading difficulty, as well as the word rate previously indicated, are important in reporting comprehension of compressed speech.

A number of studies have been made to determine the relationship of rate of speech with degree of comprehension. Harwood (II, 15) discovered an insignificant loss as word rate was increased. He reported

speeds of 125, 150, 175, and 200 words per minute resulted in no significant difference in comprehension. Fairbanks et al. (II, 6) found little difference in the comprehension of messages presented at 141, 201, and 282 words per minute. Similar results are reported by Parker (III, 10) who studied the application of compressed speech to junior college students and by Eckhardt (III, 4) who studied college students learning by compressed speech in a programed multi-media presentation. Eckhardt's study revealed that compressed speech in a programed presentation which was compressed at two rates, 25 and 40 per cent compressions, resulted in a time gain by the same percentage without comprehension loss in excess of 2 per cent. When studies are considered collectively their relationship indicates that listening comprehension declines at a slow rate as word rate is increased, until a rate of approximately 275 words per minute is reached, and at a faster rate thereafter. (IV, 2, p. 19)

Comprehension is also a function of individual differences. Parker (III, 10) demonstrated that aptitude was not a significant factor in compressions up to 33 per cent, but low aptitude students had a significant loss in comprehension beyond 33 per cent compression. High aptitude students, on the other hand, were able to comprehend without significant

loss with compressions up to 50 per cent. Studying U.S. Army inductees, Sticht (II, 29) reported that listening was as effective as reading in promoting the recall of factual information from simple and complex passages for the average and low aptitude groups. The higher aptitude groups comprehended to a greater degree than their lower aptitude peers. In a study of comprehension as a function of academic grade level, Goldhaber and Weaver (II, 13) showed that junior high school listeners outscored college underclassmen at normal and compressed versions of a recorded selection. They admit, however, that these differences may have been attributable to the information presented in the recorded materials. The sex of the listener as a function of comprehension is inconclusive at present. Goldhaber and Weaver (II, 13) also presented time-compressed recorded materials to college freshmen; statistical analysis showed that males outscored females at four rates of presentation and each of three levels of difficulty (p .05). Other studies comparing male and female listeners have revealed no sex related differences in listening comprehension for word rates ranging from 174-475 words per minute. (II, 10; II, 25)

Listener acceptance of compressed speech, when reported, has been favorable and although definitive research is lacking, Foulke (II, 8), who

studied acceptance attitudes of blind listeners, reported favorable acceptance of compressed speech. Foulke and Sticht (II, 10), studying preferred rates of compression, found that college undergraduate students prefer 204-212 words per minute with males preferring the faster rate. Another study by Foulke (II, 8) reported inconclusive results in attempting to measure an interaction between word rate of the listening selection and the voice quality and reading style of the reader. He did state, however, that the male voice was generally preferred by blind students listening to compressed speech.

A few studies have attempted to find means of increasing listener comprehension and retention of compressed speech. Orr and Friedman (II, 24), using three matched groups of college students, administered a passage at 375 words per minute. Results indicated that the use of pre-stimulus list of key words drawn from the passage did not result in any significant difference (p .05) in comprehension. Similar results were obtained when subjects were allowed a short period to study a precis prior to listening to the selection. Use of repeated listening periods was the object of a study by Sticht (II, 28), who administered repeated compressed recordings of literary material to groups of Army inductees who were divided into groups according to

aptitude. His results indicated that repeated listening to the compressed recordings did not result in significantly increased comprehension regardless of aptitude. He stated that slightly improved results, though not significant, were obtained, but suggested that the time saved by the compression method might be profitably used to selectively extend or review important material.

Rest breaks for those listening to compressed tapes was the object of study by Orr and Friedman. (IV, 5) The experiment, which provided frequent rest breaks, concluded with finding that rest breaks do not result in any advantage.

Conversely, practice in listening to very rapid compressed speech does result in significant improvement of comprehension. (II, 32; II, 25) Both studies reported the positive effects of practice; however, the period of practice time for optimum gain is inconclusive.

Studies of the instructional application of compressed speech are few in number. Only one report of compressed speech was given at the 1969 Audio-Tutorial Systems Conference at Purdue University. (III, 5) The report indicated that compressed speech recordings were employed for review purposes; no research was indicated. No new reports of compressed speech were given at the 1970 conference.

A study utilizing a tape-slide instructional program designed to teach recognition of behavioral objectives employed tapes at four different rates of presentation is reported by Anderson. (II, 1) Using tapes at 150, 200, 250 words per minuce, and 300 words per minute with the message repeated, Anderson's results showed no effect of repeating at the higher degrees of compression and that students of high ability are able to comprehend at the high rates of compression. He concluded by stating that the likes and dislikes of tape-slide instructional programs probably should not be considered if performance alone is the factor. Although he did not report the administration of an attitude survey in his article, he evidently felt there was some negative reaction to compressed speech tape-slide instructional programs.

A later study of individualized compressed speech audio-tape-slide presentation by Perry (II, 26) compared recall and application scores of college students divided into compressed, regular, and no presentation groups. The analysis revealed no significant difference between compressed and regular groups, with a significant difference (p .05) between the compressed-regular groups and the no treatment group.

A review of the research reveals only one study testing the effectiveness of compressed speech

instruction where economy of time was mentioned. Eckhardt (III, 4) studied the application of two rates of presentation with Air Force inductees who received multi-media programed instruction as a group. Within bounds of the study, the high aptitude subjects were able to accept multi-media programed instruction with compressed tapes in 40 per cent less time with no significant loss in learning (p .05). He concluded by stating:

> Since the proposed technique of accelerated multi-media programed instruction presentations was not equally effective with all subjects, more specific descriptions of subjects in aptitudinal terms would permit the selection of an instructional rate better suited to the learning of a specific group. No longer can educators and training specialists afford to operate with just one instructional design or approach geared to the average student. (III, 4)

Applicable Literature on the Interaction Between Personality Characteristics and College Level Instruction

Even the most casual observer of the educational scene in our nation's colleges and universities can see the trend toward the individualization of instruction by observing the profusion of honors programs, independent study programs, the expanded library holdings, increased use of technology, and the like. These are but a few examples which are convincing evidence of a recognition that the college curriculum is for the student rather than the student for the college curriculum.

There is nearly universal acceptance that individual differences among students should be taken into account in educational planning, but clear-cut answers have not been forthcoming. Perhaps the most important requirement for the individualization of instruction is the availability of a wide variety of instructional materials and media from which to select. An individualized learning system must include alternate modes, or learning procedures, by which any particular objective can be reached. (II, 2)

Writing on the research problems of individual differences, Travers writes:

> Individualized programs of instruction that attempt to adapt to individual differences fall into two broad categories: The one type of program adjusts the speed with which all pupils pass through the same program of instruction with the same content; the second type adjusts the content of the program to each individual student. (I, 10)

He continues by stating that only the first of these two types of programs have been studied to any extent.

Programed instruction is a commonly used method of individualized instruction. Programed instruction is of two major types: (1) linear, where the learner regardless of ability or other characteristics proceeds through the entire program without deviation, and (2) branching, where several alternate routes through the program are provided to the

learner depending upon his response. Stourow, in his section "Programed Instruction" of the Encyclopedia of Educational Research (II, 30) states that linear programs are more widely used than branching, and studies relating to programed instruction have concerned themselves with approximately 40 per cent college students, 20 per cent high school students, and the remainder with other groups.

Studying the effect of autonomy need upon achievement in a programed psychology course at the college level, Lublin (II, 17) found that low autonomy need subjects scored significantly higher than the high autonomy need subjects. Students who preferred solitary study achieved more than those students who preferred group learning.

Doty and Doty (II, 4) found that significant correlations were observed between achievement in programed instruction and the characteristics grade-point average, social need, and creativity. When the effects of grade-point average were analyzed, they found that social need is an important variable in the programed learning situation. One highly reputed aspect of programed learning is that the learning situation is essentially an independent one in which each student's pace is self-regulated. A common assumption is that learning is facilitated by

the elimination of interference from individual differences in students in respect to speed, competition with other students, and from other social factors. Doty and Doty state that these characteristics of programed instruction may be deterents for students characterized with high sociability needs. They also state that there is some evidence that programed instructional methods restrict originality or creativity of thinking on the part of the learner.

The mainstay of college level instruction has been the more traditional lecture method, group discussion, and tutorial study. An experiment comparing the effectiveness of these three methods showed that there was no significant difference in achievement and no significant relationship between teaching method and student characteristics. (II, 14)

In an experiment employing twenty-four measures of personality characteristics of students in an elementary psychology course, an analysis of the data obtained revealed little conclusive results except in the realm of achievement. High achieving females preferred small group and independent study sessions to lectures. (II, 16)

Beach (II, 3) studied the relationship of sociability to academic achievement in an advanced educational psychology course. He established four experimental groups; these groups, characterized by

varying degrees of student interaction and student-teacher contact, included lecture, interactive discussion, small instructorless groups, and independent study groups. A significant degree of relationship was found between sociability and achievement in the lecture and small instructorless groups. That is, the less sociable student had greater achievement than the more sociable student in the lecture and the more sociable student in the small group sections.

Somewhat different results are reported by McCullough and VanAtta (III, 7) studying the interaction between certain student characteristics and independent study. They found that students who are less rigid and less in need of social support are likely to profit more from independent study than students scoring high in these characteristics.

Concluding a review of research in teaching methods in higher education, McKeachie states:

> It is clear that there is no one best method for all goals, students, or teachers. Rather the best method is a function of each of these variables. (II, 19)

He concludes by underscoring the necessity for further comparative research in teaching methods in relation to educational objectives and measures of relevant student characteristics.

Summary

A review of the literature related to tape recorded instruction at the college level, compressed speech, and the interaction between student personality characteristics and instruction has been presented with studies that bear upon the present study.

Comparative research, because of inherent difficulties in controlling the necessary variables, has not been consistent in supporting any one method, but in light of the most recent research, audio-tutorial methodology appears to be superior or at least as good as traditional methods. Research, however, has been lacking in describing the most effective characteristics of the tape recorded stimulus, and steps need to be taken to more accurately describe the more effective tape recordings used in the audio-tutorial instruction.

The studies in regard to compressed speech point to great potential as a communications device or medium for speeding up the transmission of information. There is strong support for the use of compressed speech as a highly efficient and effective medium for high aptitude learners of either sex. While much of the research has been basic in nature, research of the basic type has established a substantial foundation for further applied research in

the application of compressed speech in an educational setting.

The research on the possible effects of personality characteristics upon instructional method at the collegiate level has been meager and inconclusive. There is some evidence that there is a relationship between sociability, creativity, and instructional methods. There are also encouraging factors that audio-tutorial instruction, which has some of the characteristics of programed instruction, is better suited to certain kinds of student personality characteristics.

There are presently no studies available in which compressed speech is applied to audio-tutorial methodology where student personality characteristics were assessed.

CHAPTER III

DESIGN AND PROCEDURE

The general purpose of this study is to assess the effectiveness of recorded compressed speech as an instructional medium and to find any degree of relationship between achievement and the personality characteristics of creativity and sociability. The instruments employed were the Remote Associates Test used to measure creativity and the Thorndike Dimensions of Temperament test used to measure sociability.

The Population and the Sample

This study was conducted during the fall quarter of 1970 at Mankato State College, Mankato, Minnesota. The student participants were enrolled in the course Plant Biology, numbered 1404, in the department of Biology. The course, normally for freshmen, is one that students may elect to meet their general education requirement in science. The enrollment of sixty-four students was randomly divided into two groups by means of a random number table. The control group numbered thirty-three.

They were instructed with normal speed tapes, and the experimental group of thirty-one was instructed with time-compressed tapes. Table 1 summarizes information regarding the characteristics of each group.

Pilot Study

A two part pilot study was made during the winter and spring quarters of 1970. Phase I, held during the winter quarter, was intended to assess the acceptability of compressed speech by the students within Biology 1404 and to devise a system by which accurate time records could be attained. A time card was designed and printed for student use in an electric time clock. (See Fig. 1.) The time card was used to record the beginning and completion of the student's independent study session. Each time card was used only once. The student was required to write the exercise number and his name on the time card and place the card in a collection box adjacent to the time clock. The time cards were periodically collected and tallied on a master time sheet on which records were kept for each student for each of the exercises. Since one of the primary purposes of Phase I of the pilot project was to dev. a system by which accurate time records were attained, nothing was done with the time records except to observe

TABLE 1

DESCRIPTIVE INFORMATION, CONTROL AND EXPERIMENTAL GROUPS

Descriptor	Control Group[a]	Experimental Group[b]
Age in Years		
Range	19-24	18-32
Mean	19.6	20.3
Sex		
Males	18	15
Females	11	13
Grade-Point Average		
Mean	2.56	2.66
Variance	.488	.290
Standard Deviation	.70	.54
ACT Test Scores		
Mean	22.11	21.83
Variance	20.70	12.00
Standard Deviation	4.55	3.47
Creativity Test Scores		
Mean	14.42	13.73
Variance	19.57	12.07
Standard Deviation	4.42	3.47
Sociability Test Scores		
Mean	0.0	-1.04
Variance	61.90	45.75
Standard Deviation	7.87	6.76

[a] N = 29 [b] N = 28

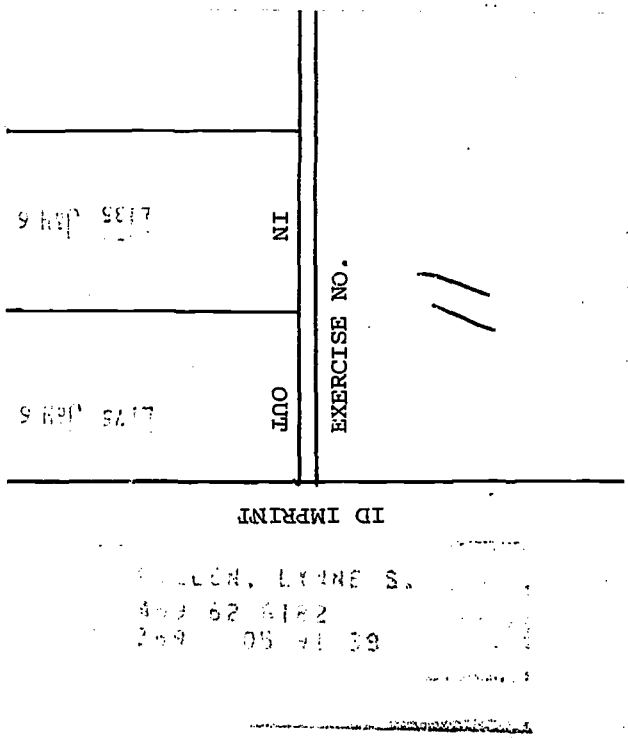

Fig. 1.--Time Card

student behavior patterns in regard to time and to help determine the feasibility of the present study. Revisions of the time card and distribution and collection procedures showed that careful maintenance of the system would produce time records with a high degree of accuracy.

The second objective of Phase I of the pilot study was to determine student acceptability of time-compressed tapes. Accordingly, the optimum degree of compression for the reading style and voice characteristics of Dr. Verona Burton, the course professor, was sought. Dr. Burton recorded, with quality recording equipment, four selections of the Nelson-Denny Reading test on high quality tape, and these recordings were compressed to four different rates of speed. The Nelson-Denny Reading test is frequently mentioned in the literature as being employed as a listening comprehension test when assessing the effectiveness of compressed speech. The test consists of a reading selection of approximately 150-250 words and is followed with an examination consisting of multiple-choice items. The recordings were sent to the Perceptual Alternatives Laboratory at the University of Louisville where they were compressed to 80 per cent, 70 per cent, 60 per cent, and 50 per cent of the original production times.

After instructions were given, each reading selection of the test was played to a group of approximately twenty students, who then answered the test items relating to the reading selection that they had just heard. In total, the four reading selections, at each of the four rates of compression, and the normal recordings were played to separate groups of students. Each group of students listened to the four selections of the tests at one rate of speed. All five groups were given the tests at the same time but in separate rooms. The answer sheets were scored, using electronic test scoring equipment, and the results were analyzed to determine the student achievement at the different rates of speed. The test scores were consistent for the groups who listened to tapes at the following rates of speed: the normal tapes, 80 per cent, 70 per cent, and 60 per cent compressions. The 50 per cent compression resulted in a substantially higher error rate, indicating a low comprehension level, and was judged unacceptable. Since the 60 per cent compression rate resulted in the highest rate of compression without a significant loss of comprehension, it was chosen as the most desirable degree of compression for recording the instructional tapes for the course. The results of the experiment were consistent with other studies reported in the literature. (III, 10; III, 4)

The audio-tutorial instructional tapes used were twenty-two in number, with a mean time of approximately twenty-one minutes at the normal rate and fourteen minutes at the compressed rate. The tapes were identical in regard to content and differed only in the amount of time for listening from beginning to end. For further information about tape times, see Tables 2 and 3.

After recording and processing, the instructional tapes were then used in independent study sessions. The second Phase I objective was to determine student acceptance of compressed recordings. The procedure followed was to randomly divide the class of seventy-three students into two groups, with one group being assigned to compressed tapes and the second group assigned to normal tapes. Each group was required to remain with its assigned tape type for the first third of the quarter; the second third of the quarter the groups were then changed. That is, the group that had the normal tapes for the first third of the quarter were changed to compressed tapes the second third of the quarter. The students were not permitted to change from one type of instructional tape to the other during either of the first two-thirds of the quarter.

The last third of the quarter was used to permit the students to choose either type of tape. The

TABLE 2

TAPE TIMES

Exercise	Regular		Compressed	
	Min.	Sec.	Min.	Sec.
1	20	7	11	3
2	15	29	8	23
3,5,10	15	30	8	31.5
11	19	3	11	13
12	8	28	5	55
13	16	46	13	9.5
14	17	20	10	31
15-16	24	21	15	6.5
17	12	47	7	17
18-19	25	--	15	26
27	23	10	14	2
28	29	25	17	32
29	21	47	13	42.5
30	24	27.5	15	11.5
33-34	21	17	13	7
35-36	18	37	11	13
37	23	25	14	19
38	25	50	15	21
39	23	43	14	--
40-41	34	34	16	20
42	16	32	10	30
24-25	36	55.5	22	12

TABLE 3

SUMMARY OF TAPE TIMES

Descriptor	Regular	Compressed
Total Time	7 hours 58 minutes	5 hours 14 minutes
Mean Time Per Lesson	21.7	14.3

check out procedure used with the system indicated that approximately 80-85 per cent of the students chose compressed tapes when given free choice. Some students chose to listen to the normal tapes when going through a lesson the first time and then listened to a time-compressed tape when reviewing. Other students would choose one of the two types and stay with it for the remainder of the quarter. Although the experimental procedure was not rigidly defined or maintained, the main purpose at this point was to demonstrate to Dr. Burton that compressed tapes were useful for independent study and would not jeopardize the quality of instruction.

Phase II of the pilot study was done during spring quarter, 1970. The main objective was to assess the efficiency and effectiveness of time-compressed tapes during a quarter long period of time. Efficiency was assessed by an analysis of time records kept for each student in the experimental and control groups; effectiveness was determined by three newly written and validated objective examinations given during the length of the quarter. Results of Phase II of the pilot study are shown in Tables 4 and 5. A major conclusion was that Phase II of the pilot study had successfully demonstrated the efficiency and effectiveness of time-compressed tape recordings and that a more comprehensive analysis was feasible.

TABLE 4

SUMMARY OF PILOT STUDY TEST SCORES

Test	Regular[a]	Compressed[b]
1 (50 Points)		
Mean Score	38.3	38.4
Variance	47.61	45.25
Standard Deviation	6.9	6.5
2 (50 Points)		
Mean Score	35.2	36.6
Variance	50.47	67.24
Standard Deviation	7.1	8.2
3 (100 Points)		
Mean Score	66.7	70.9
Variance	127.69	141.61
Standard Deviation	11.3	11.9

[a] N = 42

[b] N = 37

TABLE 5

SUMMARY OF PILOT STUDY TIME

Unit	Regular	Compressed
First Third of Quarter		
Mean (hrs.)	9.56	10.39
Variance	9.73	9.24
Standard Deviation	3.12	3.04
Second Third of Quarter		
Mean (hrs.)	8.41	7.24
Variance	2.99	8.07
Standard Deviation	1.73	2.84
Final Third of Quarter		
Mean (hrs.)	3.92	3.25
Variance	4.33	2.75
Standard Deviation	2.08	1.66

The Experimental Procedure

Due to the difficulty of conducting long term laboratory-experimental research where instructional variables may be adequately controlled, the present study was a field experiment. This approach was desirable for assessing the effectiveness and efficiency of time-compressed tapes; comparing them to normal tapes; and determining the relationships between personality characteristics and audio-tutorial instruction over an eleven week period. The instructional variables were held constant for each group. The teacher variable was controlled by having Dr. Burton, the course professor, record all the audio-tutorial instructional tapes. These tapes were then administered to the control and experimental groups in their normal and time-compressed versions. The tapes were identical except for rate; the normal tapes reproduced in 100 per cent of the original production time and the compressed tapes reproduced in 60 per cent of the original production time.

Design

Long term field experiments such as this one are burdened with the difficulty of controlling unexpected variables during the course of the experiment. For example, students were expected to participate in all twenty-two exercises during the quarter and to

pay close attention to keeping time records for each exercise. There were some who did not complete all exercises. Five students dropped out of the course or out of college during the quarter; some students failed to turn in complete time cards. While these variables were not under the control of the experimenter, students were reminded by their professor that they were to complete all exercises and to pay close attention to time cards. The students who dropped out or missed lessons were beyond the control of the experimenter. Most time cards, however, were corrected after the student was seen by Dr. Burton.

The registrants in the course during fall quarter, 1970, numbered sixty-four. At the first meeting of the course the class was given three examinations. The first examination was a pre-entry written objective examination designed to measure cognitive knowledge of the course material. The students were also given the Remote Associates Test and the Thorndike Dimensions of Temperament test.

Students were instructed in the operation of the equipment for use in the learning carrel consisting of a Kodak Carousel slide projector, a Norelco cassette tape player, and a microscope. They were informed of the purposes of the Educational Resource Center and what carrels and space within

the Center they would find assigned to the course. They were instructed in the procedures to follow in checking out the cassette tape recording and the key for the carrel.

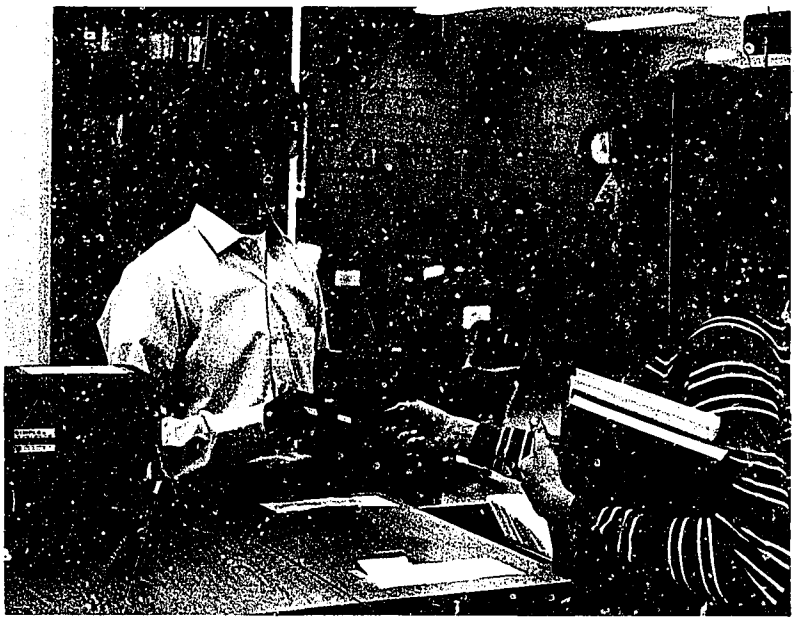

Fig. 2.--Attendant Checking out Materials and Equipment to Student

In operation, an attendant at the service counter checked out a tape player, the appropriate tape, and gave a time card to the student. (See Fig. 2.) The attendant was directed to check a list of students assigned to each of the two groups to

make sure that he was given the correct tape. Time cards were color coded and tapes were color coded by colored label to eliminate errors.

Exercises were changed on Wednesday afternoons, a procedure which took about two hours for the set up of the ten carrels. Students had access to the carrels and live plant area for approximately eighty hours each week except during the Thanksgiving break and during bomb scares when the building had to be evacuated. (See Figs. 3 and 4.)

At the end of the quarter, the students were given an alternate form of the examination which they took the first day of the class.

As already mentioned, the difficulty in controlling the student and student-related variables is an expected hazard during long term studies. Finding an efficient, yet sufficiently powerful, statistical test to assess the effectiveness of the instructional tapes presented at two different rates of speed and to determine the relationship between the personality factors measured and achievement was important. The use of the standard parametric tests, such as the familiar t, F, and Pearson Product-Moment Correlation, was ruled out due to the influence of uncontrolled variables. The parametric tests require a normal distribution, an impossibility in the present study because of the uncontrolled variables.

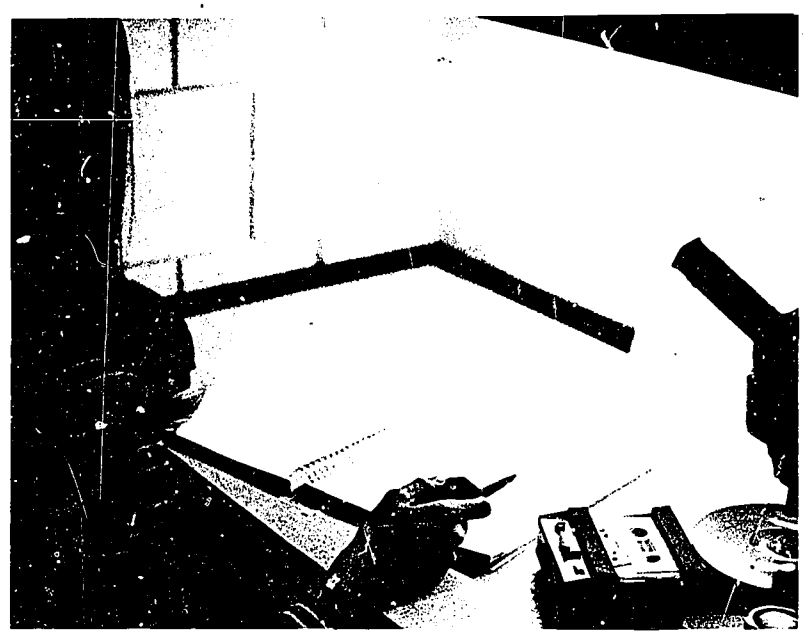

Fig. 3.--Student in Audio-Tutorial Carrel

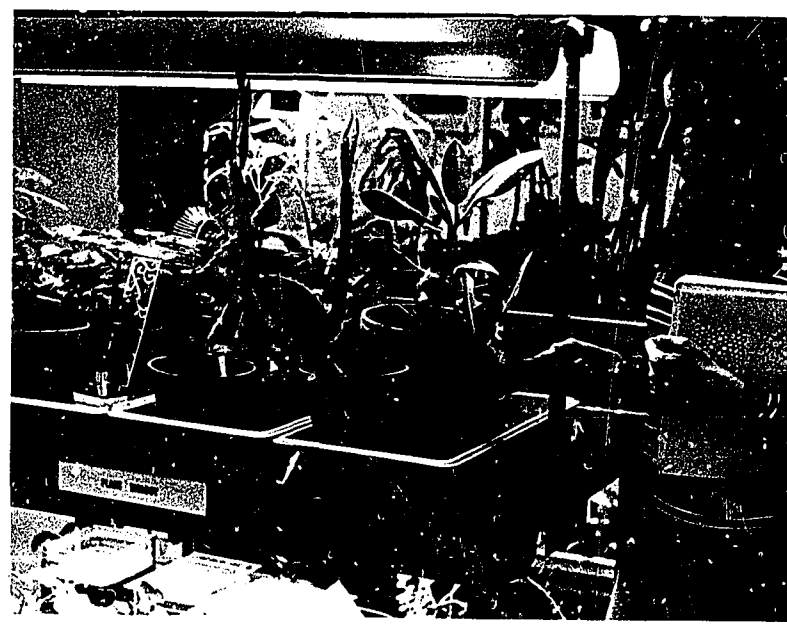

Fig. 4.--Student Viewing Live Plant Exhibit

The Mann Whitney U test was chosen because it is regarded as the most powerful non-parametric test and because it avoided the t test's assumptions. (I, 4, p. 635) With a sample size of twenty-eight or twenty-nine as in the present study, the Mann-Whitney U test approaches the power of the t test. (I, 8, p. 116) The relationship between the personality variables and achievement was determined by use of the non-parametric Spearman Rank Correlation Coefficient r_s. Siegel states:

> The efficiency of the Spearman Rank Correlation r_s when compared with the most powerful parametric correlation, the Pearson r, is about 91 per cent. That is, when r_s is used with a sample to test for the existence of an association in the population, and when the assumptions and requirements underlying the proper use of the Pearson r are met . . . then r_s is 91 per cent as efficient as r in rejecting H_o. (I, 8, p. 213)

When N is equal to or larger than eight, the sampling distribution is practically indistinguishable from the normal distribution; therefore, with N sizes of twenty-eight and twenty-nine, the tables for the normal curve may be used for determining probability. (I, 8, p. 220)

Achievement, as measured by the pre-test and the post-test, was assessed by determining the modified gain score. As defined by Mager (II, 20, p. 42), the modified gain score is a more sensitive measure of behavioral change than the simple gain score.

Whereas the simple gain score rates a gain from zero to 10 per cent as equal to a gain from 90 to 100 per cent, the modified gain score tells us how much of the possible improvement was actually realized, thereby compensating to some extent for the problem of unequal difficulty along the gain continuum.

Materials and Tests

Two psychological tests were chosen for use within the present study. The Remote Associates Test was selected because it was one of the few tests which measures the ability to think creatively. It is an instrument designed to measure individual differences in an ability considered to be fundamental to the creative thinking process. Creative thinking is defined by the test author as:

> The forming of associative elements into new combinations which either meet specified requirements or are in some way useful. The more mutually remote the elements of the new combination, the more creative the process or solution. (V, 5)

The test was given to the group and was timed for the required forty minutes. Although it is not a speed test, most individuals were able to finish the test within the forty minute period, and were able to attempt each of the thirty items at least once. The test results are determined by counting the number of correct item responses and can range from zero to thirty.

The Thorndike Dimensions of Temperament test was selected on the recommendation of Dr. Fred Knauer of the Mankato State College Counseling Center. The test is a self-report personality inventory through which the individual describes himself with respect to ten dimensions of temperament. The Thorndike Dimensions of Temperament test portrays the individual both as he sees himself and as others see him. Although the test manual states that it does not pretend to delve into deep layers of inner personality dynamics, the inventory appears quite successful in providing a differentiated picture of the individual's personality. (V, 6) While the test provides ten scales of personality, only the sociability scale was scored and used within the present study. Sociability, as described by the test author, is characterized by behaviors in which the individual may want to be with people or by himself, to be in the middle of things or by engaging in solitary activities. The score from each individual is given as a number, ranging from a minus twenty to a plus twenty.

The test used to measure cognitive knowledge in plant biology was developed by Dr. Burton. The test had undergone several revisions and was given to the students in two different forms, with one form used as a pre-test and the other as a post-test. The test, one hundred items in length, was multiple

choice in nature, with each item having no fewer than five distractors. The internal coefficient of reliability as measured by the Kuder-Richardson Formula 20 was .896.

The instructional materials for the course were developed or collected by Dr. Burton and consisted of a wide range of materials including live plants, charts, models, microscope slides, 2x2 slides, and audio tapes. The audio tapes, the dependent variable in the study, had been in use for two quarters prior to the quarter in which the present study took place. The scripts for the tapes were in their third revision and had reached a high degree of validity. A sample script is reproduced in the appendix. Each of the twenty-two lessons were correlated with a laboratory manual (I, 1) and make frequent reference to the manual during the time of instruction. Each tape recording was prefaced with a verbal statement of the behavioral objectives for the exercise and concluded with a summary statement. A random sample of six normal speed tapes indicated a range of 113-138 words per minute with a mean of 128 words per minute. The compressed tapes, compressed to 60 per cent of the original production time, ranged from 193 to 238 words per minute with a mean of 211 words per minute. Difficulty as measured by the Dale-Chall reading formula indicated a range of

8.03 to 9.93 with a mean of 8.98 or at the grade 13 level. The mean syllable to word ratio (II, 21) was 1.83, somewhat higher than the 1.309 mean for the English language. The rate of speech used by Dr. Burton was within the preferred range as suggested by Foulke and Sticht (II, 10) and the vocabulary was somewhat more difficult, but right at the college freshman level of difficulty. Judging by these measures, the instructional tapes were well suited to the educational level of the subjects who participated within the experiment.

Method of Analysis

The modified gain scores and the mean time per lesson for each individual were totaled for the control and experimental groups and the level of significance was determined by use of the appropriate test.

A correlation was computed on each of the personality measures and the modified gain scores, with the level of significance determined by use of the appropriate test. Correlations were run on achievement as measured by the modified gain score and average time per lesson for students in each group.

Specifically, the purpose of this study was to seek answers to the following questions:

1. Is there a difference in achievement between those students learning from time-compressed recordings and those learning from normal recordings?

2. Is there a time saving advantage for those students learning from time-compressed recordings as compared to those learning from normal recordings?

3. Is there a significant relationship between the personality characteristics of creativity and sociability and students who learn via audio tapes at the two different rates of speed?

These questions were explored by testing the following null hypotheses:

1. There is no significant difference in achievement as measured by an instructor made paper and pencil test between students who learn from time-compressed recordings and those who learn from normal recordings.

2. There is no significant difference in time spent in independent instruction between students who learn from time-compressed recordings and those who learn from normal recordings.

3. There is no significant relationship between creativity as measured by the Remote Associates Test, sociability as measured by the Dimensions of Temperament test and achievement by students who learn from either time-compressed audio recordings or normal recordings.

The .05 level of significance was specified as the region of rejection for the null hypotheses.

Summary

Sixty-four subjects, registrants in Biology 1404, at Mankato State College, Mankato, Minnesota,

participated in this study. All subjects were administered a biology pre-test, the Remote Associates Test and the Dimensions of Temperament test. The subjects were randomly assigned to two groups, the control group who were instructed via normal speed audio tape recordings and the experimental group who were instructed by audio tapes compressed to 60 per cent of the normal production time.

Time records for each student were maintained on all of the twenty-two exercises during the quarter lasting eleven weeks. All students received the same instruction with the dependent variable being the rate of presentation on the tape recordings. A post-test was administered at the end of tne quarter and a gain score determined for each individual.

The hypotheses to be tested were listed.

CHAPTER IV

ANALYSIS OF THE DATA

This chapter presents the statistical analysis of the data and the results obtained. The first part of the chapter describes the subjects as noted in Chapter III. The second part of the chapter presents the data and applies the appropriate statistical tests of the three null hypotheses stated in this study.

Description of the Subjects and Data

Table 1, page 43, presents information of the subjects after they were randomly assigned to either the control or experimental groups. Note that the number of subjects are four fewer in the control group and three fewer in the experimental group than at the beginning of the quarter in which the experiment began. The decline in the number of subjects in both groups is due to the uncontrolled variables as described in Chapter III.

The data collected by the experimental procedure are presented in Tables 6 through 16. Table 6 presents the pre-test, post-test, and modified gain

scores for the control group; Table 7 does likewise for the experimental group, and Table 8 presents a comparative summary of the test data for the two groups. Table 9 presents mean time per lesson for the control group; Table 10 does likewise for the experimental group, and Table 11 presents a comparative summary of the mean time per lesson for the two groups. Table 12 presents the creativity scores as measured by the Remote Associates Test and the modified gain scores for the control group; Table 13 does likewise for the experimental group. Table 14 presents the sociability scores as measured by the Dimensions of Temperament test and modified gain scores for the control group; Table 15 does likewise for the experimental group. Table 16 summarizes the creativity and sociability measures in relation to gain.

Tests of the Null Hypotheses

Hypothesis 1:

> There is no significant difference in achievement as measured by an instructor made paper and pencil test between students who learn from time-compressed recordings and those who learn from normal recordings.

As can be noted from Table 8, the simple difference in modified gain scores between the control and experimental groups was .0203. Expressed

as a percentage there is a 3.8 per cent difference with a corresponding z score of .359. Probability, therefore, is .640 as observed from a normal distribution table. The control group scored slightly lower than the experimental group on both the pre-test and the post-test. Simple gain expressed in test score points for each of the two groups is very similar, but the modified gain score compensates to some extent for unequal difficulty along the gain continuum thereby explaining the difference in modified gain scores.

The fact that the experimental group who used time-compressed recordings achieved slightly more than the control group who used the normal recordings cannot be considered statistically significant based upon the data derived from the experiment. Hypothesis number one must be accepted after consideration of the data.

Hypothesis 2:

> There is no significant difference in time spent in independent instruction between students who learn from time-compressed recordings and those who learn from normal recordings.

As can be noted from Table 11, the simple difference in mean time per lesson between the control and experimental groups is .129 hours, that is, the students learning from time-compressed tapes took

less time than those learning from normal tape recordings. Expressed as a percentage difference, there was an average time savings of 12.3 per cent for each lesson. The Mann-Whitney U test score of 460 resulted in a z score of .86 with a probability of .805 as observed from a normal distribution table.

This study indicates that students who learn from time-compressed tapes on a self-paced schedule do save some time over their regular or normal tape recording counterparts; however, the difference between the two groups in respect to time cannot be considered statistically significant. Based upon an analysis of the data from this experiment, hypothesis number two is accepted.

Hypothesis 3:

> There is no significant relationship between creativity as measured by the Remote Associates Test, sociability as measured by the Dimensions of Temperament test and achievement by students who learn from either time-compressed audio recordings or from normal recordings.

After treatment of the data by the Spearman Rank Correlation Coefficient and after applying the appropriate statistical test (Table 16), there is no significant relationship between the personality measures stated in the hypothesis and achievement shown by gain. The slight differences in r_s for the two groups can be attributed to chance and is not

statistically significant in either case. Z scores and probability are low in each measure.

Based upon the data derived from this experiment, hypothesis number three must be accepted.

Discussion

The factors of time and achievement were statistically treated by use of the Mann-Whitney U test and the appropriate test of significance was applied to each. An analysis of the data indicated no significant difference between the control and the experimental group in respect to the variables of time or achievement. The number of subjects participating in the study declined during the course of the eleven week quarter. That any significant changes would have occurred had they participated for the full term is doubtful.

The relative consistency of statistical results in the analysis of the relationship between the personality characteristics measured and achievement indicates that no significant relationship exists. The uncontrolled variables due to the decline of number of subjects would have little effect upon the analysis of the relationship between personality characteristics and achievement.

TABLE 6

PRE-TEST SCORES, POST-TEST SCORES, AND GAIN
CONTROL GROUP

Subject Number	Pre-Test Scores	Post-Test Scores	Gain[a]
C- 1	42	77	.729
C- 2	41	79	.644
C- 3	33	50	.253
C- 4	35	84	.753
C- 5	35	42	.119
C- 6	28	62	.472
C- 7	34	56	.333
C- 8	56	91	.648
C- 9	35	72	.569
C-10	31	59	.405
C-11	34	56	.333
C-12	36	57	.328
C-13	52	77	.520
C-14	38	65	.435
C-15	28	60	.444
C-16	45	83	.672
C-17	32	66	.500
C-18	36	62	.406
C-19	43	74	.543
C-20	41	66	.423
C-21	34	63	.439
C-22	43	92	.859
C-23	48	85	.711
C-24	33	48	.223
C-25	20	65	.562
C-26	41	54	.220
C-27	42	70	.482
C-28	26	53	.364
C-29	35	76	.630

[a]Modified Gain Score

TABLE 7

PRE-TEST SCORES, POST-TEST SCORES, AND GAIN
EXPERIMENTAL GROUP

Subject Number	Pre-Test Scores	Post-Test Scores	Gain[a]
X- 1	48	66	.346
X- 2	28	75	.652
X- 3	29	92	.887
X- 4	34	56	.333
X- 5	38	58	.322
X- 6	35	66	.476
X- 7	49	64	.555
X- 8	37	55	.285
X- 9	39	60	.344
X-10	39	60	.344
X-11	34	43	.166
X-12	52	80	.583
X-13	58	83	.595
X-14	37	70	.523
X-15	42	77	.603
X-16	36	46	.343
X-17	40	63	.383
X-18	39	61	.360
X-19	44	74	.535
X-20	45	67	.400
X-21	46	88	.777
X-22	51	92	.836
X-23	40	66	.433
X-24	41	82	.694
X-25	30	53	.328
X-26	45	86	.745
X-27	31	75	.637
X-28	42	78	.620

[a]Modified Gain Score

TABLE 8

SUMMARY OF PRE-TEST SCORES, POST-TEST SCORES, AND GAIN FOR CONTROL AND EXPERIMENTAL GROUPS

Group	N	Variance	Sigma[a]	Mean
		Pre-Test		
Control	29	56.6	7.51	37.14
Experimental	28	63.3	7.95	39.25
		Post-Test		
Control	29	163.7	12.80	67.03
Experimental	28	167.9	12.93	69.14
		Gain		
Control	29	.0301	.1735	.4834
Experimental	28	.0327	.181	.5037

Analysis of Differences in Mean Gain

Simple Difference	.0203
Percentage	3.8
Mann-Whitney U Test	383.5
z Score	.359
Probability	.640

[a]Standard Deviation

TABLE 9

TIME TOTALS PER INDIVIDUAL
CONTROL GROUP

Subject Number	Total Time[a]	Lessons Completed	Mean[b]
C- 1	29.46	20	1.47
C- 2	52.0	22	2.36
C- 3	10.67	15	.71
C- 4	16.21	20	.81
C- 5	16.71	21	.79
C- 6	18.99	22	.86
C- 7	16.33	21	.77
C- 8	23.02	22	1.04
C- 9	72.13	22	3.27
C-10	17.17	22	.78
C-11	25.86	22	1.17
C-12	13.22	18	.73
C-13	18.90	21	.90
C-14	10.87	19	.57
C-15	13.22	20	.66
C-16	26.34	22	1.19
C-17	11.18	17	.65
C-18	22.32	21	1.06
C-19	14.47	19	.76
C-20	9.69	12	.80
C-21	14.31	22	.65
C-22	25.17	22	1.14
C-23	20.33	21	.96
C-24	16.89	22	.76
C-25	29.69	22	1.34
C-26	10.98	16	.68
C-27	23.45	20	1.17
C-28	23.79	20	1.18
C-29	14.69	18	.81

[a]Reported in hours and hundreths of hours

[b]Reported in hundreths of hours

TABLE 10

TIME TOTALS PER INDIVIDUAL
EXPERIMENTAL GROUP

Subject Number	Total Time[a]	Lessons Completed	Mean[b]
X- 1	15.42	22	.70
X- 2	13.44	20	.67
X- 3	13.62	22	.61
X- 4	12.83	15	.85
X- 5	15.19	20	.75
X- 6	24.56	21	1.16
X- 7	15.29	20	.76
X- 8	9.90	15	.66
X- 9	9.05	16	.56
X-10	17.40	19	.91
X-11	16.59	17	.97
X-12	11.11	22	.50
X-13	19.71	20	.98
X-14	13.95	15	.93
X-15	35.21	22	1.60
X-16	19.08	21	.90
X-17	11.26	17	.66
X-18	25.57	21	1.21
X-19	15.03	21	1.71
X-20	15.03	14	1.07
X-21	43.71	22	1.98
X-22	16.29	21	.77
X-23	7.64	17	.44
X-24	16.02	21	.76
X-25	23.92	20	1.19
X-26	27.62	22	1.25
X-27	28.98	21	1.38
X-28	9.47	20	.47

[a]Reported in hours and hundreths of hours

[b]Reported in hours and hundreths of hours.

TABLE 11

SUMMARY OF TIME, EXPERIMENTAL AND CONTROL GROUPS

Group	N	Sum of Means	Variance	Sigma[a]	Mean
Control	29	30.04	.299	.547	1.036
Experimental	28	25.40	.121	.347	.907

Analysis of Differences in Mean Time

Real Time in hours	.129
Percentage	12.3
Mann-Whitney U Test	460
z Score	.86
Probability	.805

[a]Standard Deviation

TABLE 12

GAIN AND CREATIVITY SCORES, RANKED FOR SPEARMAN RANK CORRELATION COEFFICIENT r_s
CONTROL GROUP

Subject	Gain Score	Rank	Creativity Score	Rank	Difference
C- 1	.729	26	11	7	+19
C- 2	.644	22	6	2	+20
C- 3	.253	4	2	1	+ 3
C- 4	.753	27	20	27.5	- .5
C- 5	.119	1	17	21	-20
C- 6	.472	14	16	18	- 4
C- 7	.333	6.5	14	11.5	- 5
C- 8	.648	23	14	11.5	+11.5
C- 9	.569	20	16	18	+ 2
C-10	.405	8	17	21	-13
C-11	.333	6.5	10	5	+ 1.5
C-12	.328	5	17	21	-16
C-13	.520	17	15	15	+ 2
C-14	.435	11	13	9	+ 2
C-15	.444	13	8	3	+10
C-16	.672	24	21	29	- 5
C-17	.500	16	19	24.5	- 8.5
C-18	.406	9	15	15	- 6
C-19	.543	18	19	24.5	- 6.5
C-20	.423	10	16	18	- 9
C-21	.439	12	9	4	+ 8
C-22	.859	28	14	11.5	+16.5
C-23	.711	25	20	27.5	- 2.5
C-24	.223	3	14	11.5	- 8.5
C-25	.562	19	19	24.5	- 5.5
C-26	.220	2	19	24.5	-22.5
C-27	.482	15	11	7	+ 8
C-28	.364	8	15	15	- 7
C-29	.630	21	11	7	+14

TABLE 13

GAIN AND CREATIVITY SCORES, RANKED FOR SPEARMAN RANK CORRELATION COEFFICIENT r_s
EXPERIMENTAL GROUP

Subject	Gain Score	Rank	Creativity Score	Rank	Difference
X- 1	.346	9	17	22	-13
X- 2	.652	23	8	7.5	+15.5
X- 3	.887	28	12	11.5	+16.5
X- 4	.333	5	16	18	-13
X- 5	.322	3	3	1.5	+ 1.5
X- 6	.476	14	5	4	+10
X- 7	.555	17	15	14	+ 3
X- 8	.285	2	17	22	-20
X- 9	.344	7.5	16	18	-10.5
X-10	.344	7.5	16	18	-10.5
X-11	.166	1	17	22	-21
X-12	.583	18	21	27	- 9
X-13	.595	19	15	14	+ 5
X-14	.523	15	5	4	+11
X-15	.603	20	11	9.5	+10.5
X-16	.343	6	18	24	-18
X-17	.383	11	3	1.5	+ 9.5
X-18	.360	10	6	6	+ 4
X-19	.535	16	11	9.5	+ 6.5
X-20	.400	12	16	18	- 6
X-21	.777	26	20	26	0
X-22	.836	27	15	14	+13
X-23	.433	13	16	18	- 5
X-24	.694	24	22	28	- 4
X-25	.328	4	8	7.5	- 3.5
X-26	.745	25	19	25	0
X-27	.637	22	5	4	+18
X-28	.620	21	12	11.5	+ 9.5

TABLE 14

GAIN AND SOCIABILITY SCORES, RANKED FOR SPEARMAN RANK CORRELATION COEFFICIENT r_s
CONTROL GROUP

Subject	Gain Score	Rank	Sociability Score	Rank	Difference
C- 1	.729	26	- 2	12	+14
C- 2	.644	22	- 6	6	+16
C- 3	.253	4	+ 6	24	- 2
C- 4	.753	27	0	15	+12
C- 5	.119	1	+ 1	17	-16
C- 6	.472	14	+ 7	26	-12
C- 7	.333	6.5	- 2	12	- 5.5
C- 8	.648	23	- 9	4.5	+18.5
C- 9	.569	20	- 3	9.5	+10.5
C-10	.405	8	+16	24	-16
C-11	.333	6.5	- 2	12	- 5.5
C-12	.328	5	+10	27.5	-22.5
C-13	.520	17	-14	1	+16
C-14	.435	11	+ 3	20	- 9
C-15	.444	13	- 3	9.5	+ 3.5
C-16	.672	24	0	15	+ 9
C-17	.500	16	+ 2	18.5	- 2.5
C-18	.406	9	+10	27.5	-18.5
C-19	.543	18	- 5	7	+11
C-20	.423	10	- 9	4.5	+ 5.5
C-21	.439	12	+ 6	24	-12
C-22	.859	28	+ 4	21.5	+ 6.5
C-23	.711	25	-13	2.5	+22.5
C-24	.223	3	- 4	8	- 5
C-25	.562	19	+ 2	18.5	- .5
C-26	.220	2	+ 4	21.5	-19.5
C-27	.482	15	-13	2.5	+12.5
C-28	.364	8	0	15	- 7
C-29	.630	21	+14	29	- 8

TABLE 15

GAIN AND SOCIABILITY SCORES, RANKED FOR SPEARMAN RANK CORRELATION COEFFICIENT r_s
EXPERIMENTAL GROUP

Subject	Gain Score	Rank	Sociability Score	Rank	Difference
X- 1	.346	9	- 6	8.5	+ .5
X- 2	.652	23	+ 9	26.5	- 2.5
X- 3	.887	28	+ 8	25	+ 3
X- 4	.333	5	- 6	8.5	- 3.5
X- 5	.322	3	+ 2	19	-16
X- 6	.476	14	-13	1.5	+12.5
X- 7	.555	17	+ 1	17	0
X- 8	.285	2	+ 7	22.5	-20.5
X- 9	.344	7.5	- 3	13.5	- 6
X-10	.344	7.5	- 7	5	+ 2.5
X-11	.166	1	+ 1	17	-16
X-12	.583	18	- 2	15	+ 3
X-13	.595	19	- 7	5	+14
X-14	.523	15	- 6	8.5	+ 6.5
X-15	.603	20	-11	3	+17
X-16	.343	6	- 3	13.5	- 7.5
X-17	.383	11	+ 6	22.5	-11.5
X-18	.360	10	+11	28	-18
X-19	.535	16	- 7	5	+11
X-20	.400	12	+ 4	20.5	- 8.5
X-21	.777	26	- 4	11.5	+14.5
X-22	.836	27	+ 6	22.5	+ 4.5
X-23	.433	13	- 6	8.5	+ 4.5
X-24	.694	24	-13	1.5	+22.5
X-25	.328	4	- 4	11.5	- 7.5
X-26	.745	25	+ 1	17	- 8
X-27	.637	22	+ 9	26.5	- 4.5
X-28	.620	21	+ 4	20.5	+ .5

TABLE 16

SUMMARY, CREATIVITY AND SOCIABILITY MEASURES IN RELATION TO GAIN

Group	Creativity			Sociability		
	r_s	z	p	r_s	z	p
Control	.153	.80	.79	.126	.66	.75
Experimental	.04	.21	.58	.099	.51	.69

CHAPTER V

SUMMARY AND CONCLUSIONS

There were two main purposes of this study. The first purpose was to measure the effectiveness and efficiency of time-compressed speech compared to normally recorded audio tape recordings as an educational medium in an audio-tutorial system. The second purpose was to determine the degree of relationship between the personality characteristics of creativity and sociability as to achievement.

Creativity was defined as that characteristic of an individual measured by the Remote Associates Test and sociability as that measured by the sociability scale of the Thorndike Dimensions of Temperament test. The experiment was conducted in the fall of 1970 in the facilities of the Educational Resource Center at Mankato State College, Mankato, Minnesota.

Subjects participating in the experiment were those students who enrolled in Biology 1404, a freshman level course which is one of the courses students may take to satisfy their general science requirement. The subjects, numbering sixty-four, were randomly divided into two groups, with

thirty-three in the control group and thirty-one in the experimental group. The control group was instructed via normally recorded audio tape and the experimental group via time-compressed audio tape recordings. By the end of the quarter there remained twenty-nine subjects in the control group and twenty-eight in the experimental group due to dropouts and other uncontrolled factors.

The subjects were given three examinations during the first two class meetings. They were given a pre-test designed to measure cognitive knowledge in plant biology. They were also given two standardized tests, the Remote Associates Test and the Thorndike Dimensions of Temperament test, which were used to measure the two personality characteristics analyzed in the study. At the end of the eleven week quarter the subjects were given an alternate form of the pre-test used for measuring knowledge of course content.

The audio tapes employed by the control and the experimental groups were identical except that the tapes used by the experimental group were compressed to 60 per cent of the original production time. The degree of compression was determined by empirical means and agreed with the findings of research previously mentioned. Scripts for the tapes were all written by Dr. Burton, the course professor. The twenty-two lessons averaging about twenty minutes

in length were all recorded by Dr. Burton. The master recordings were sent to the University of Louisville where a compressed duplicate was made. Duplicates of the normal and compressed recordings were then made on tape cassettes for use by the students on an individual basis. The students attended two lectures per week and met their laboratory requirements by participating in the individual study sessions in closed study carrels within the Educational Resource Center. The individual student picked up a cassette for the week's exercise, a tape recorder, and a key to a carrel at the Center service counter. He kept a record of his time on a card, using an electric time clock used exclusively for the experiment. Students were able to meet their laboratory requirements by attending the individual study sessions at any time during the approximately eighty hours that the Center was open each week.

Records of test scores and time were maintained for all subjects participating within the experiment. The records formed the basis of the data for statistical analysis. The average time per lesson for each student was computed. The gain score for each student was determined. The appropriate statistical tests were performed upon the data and test scores to determine significance and provide information with which to make a decision in regard to the hypotheses.

Limitations of the Study

This study was conducted at Mankato State College, Mankato, Minnesota, a college of approximately 14,000 students, located in a city with a population of about 37,000 in north central United States. Students at Mankato State College compare favorably with students throughout the United States with a composite ACT score of 21.5 compared to a state composite of 21.7 and a national composite of 20.3. Should the study be replicated with students differing markedly there may be different results. The use of compressed speech with its high rate of speed in areas of the nation where normal speaking rate is slower may result in different findings.

The extent to which the results of this experiment could be generalized to audio-tutorial or other self-paced independent instruction via audio tape recordings would very likely be dependent upon the following factors:

1. The rate of speech of the teacher being recorded for the instructional tapes.
2. The characteristics of the material being recorded for the instructional tapes. These characteristics would include such factors as vocabulary, difficulty, and syntax.

3. The characteristics of the voice being recorded. These characteristics would include such factors as sex, frequency, and intelligibility.
4. The pedagogic characteristics of the recorded lessons.
5. The degree of freedom by which students may set their own schedules and regulate the amount of time they wish to spend with the recorded lessons.
6. The extent to which the two personality tests used are accurate indicators of the characteristics measured.

Results

The experiment was designed to answer three specific questions:

1. Is there a difference in achievement between those students learning from time-compressed recordings and those learning from normal recordings?

From the results of this study it appears that there is no significant difference in achievement between students learning from normal or from compressed recordings.

2. Is there a time saving advantage for those students learning from time-compressed recordings as compared to those learning from normal recordings?

The results of this study indicate that there is a 12.3 per cent savings of time for the time-compressed recording group; however, the savings in time is not statistically significant.

3. Is there a significant relationship between the personality characteristics of creativity and sociability and achievement by students who learn via audio tape at the two different rates of speed?

The results of the study indicate that there is very little relationship between the personality characteristics measured and achievement.

Incidental to the major findings of the study and in agreement with studies previously discussed, a finding was that achievement is in direct proportion to the amount of time spent with significance beyond the .01 level. Furthermore, most students are enthusiastic about the audio-tutorial method of instruction and state its main strength is that it permits them to regulate their own schedules and pace themselves independently. (See the appendix for the results of an attitude questionnaire.) In observing student behavior in using time-compressed recordings there appears to be an adjustment period for students to become accustomed to listening to the high rate of delivery. After about two or three hours of use, students generally state a preference for the compressed tapes. In studying the data, at the beginning of the quarter there is little difference in time

between students learning from compressed tapes and those learning from normal tapes. As the adjustment period passes the difference in time for each group grew markedly different.

Educational Implications

The major findings of this study indicate that there is no important advantage or disadvantage for employing time-compressed audio recordings in a learning situation where students learn independently on a self-paced basis. Although, as previously stated, there is a 12.3 per cent efficiency advantage for the compressed group and while this figure is not statistically significant the advantage may be considered by some as important enough for adopting the use of compressed recordings for audio-tutorial instruction. With more efficient use of equipment and space, costs of instruction may likely decline.

The results strongly indicate that high rates of speech delivery should be employed when producing recordings for audio-tutorial or other self-paced independent instruction using tape recordings. Rates approaching 210 words per minute should result in equal results assuming intelligibility is not affected.

Suggestions for Further Research

Due to the difficulty caused by uncontrolled student variables incurred during the course of an eleven week study, replicating this study using a more stable group of subjects would be highly desirable. If such a study was to be made the research design and statistical analysis could be performed using the more powerful parametric statistical methods.

It may also be desirable to replicate this study with higher aptitude students. As mentioned in Chapter II, subjects with higher aptitude are more capable of learning from time-compressed recordings than their lower aptitude peers. If such a study were to be made, a more significant time-saving advantage may be shown.

This study employed tape recordings at two different rates. Replicating the experiment using tapes at several rates of compression including more highly compressed recordings may be significant.

Since there is suggestion incidental to the study that there is a period of adjustment to compressed recordings the experiment should be replicated employing a training period for the purpose of permitting students to become accustomed to the higher rates of presentation. Another possibility would be to slowly increase the degree of compression during

the course of the experiment to assess efficiency and effectiveness.

In the present study, the instructor's rate of speech delivery was relatively slow. The study may be replicated employing tapes which are recorded at several rates of speaking without using compression techniques. Such a study would obtain information suggesting an optimum rate of delivery for audio-tutorial instruction.

The study might have been replicated by employing some of the different personality measures. Some personality factors may be significant in determining the effectiveness of audio-tutorial instruction for some individuals.

The effect of aptitude upon efficiency and effectiveness might have been assessed by more sophisticated research design and statistical analysis.

Retention after a period of time has elapsed might have been assessed by a follow-up study. Such a study would be valuable to determine if the rate of delivery has any effect upon long term retention of the course content.

APPENDIX

APPENDIX

STUDENT ATTITUDE QUESTIONNAIRE

A questionnaire designed to measure student attitudes towards the audio-tutorial teaching method and the recordings employed was administered anonymously to the students enrolled in Biology 1404 during the last class meeting. The students were instructed to indicate whether they had used the compressed or regular audio-tapes. The questionnaire was in two parts: (1) seven items in which the student was to indicate his attitude by choosing one of the three or five statements best describing his feelings, and (2) three questions intended to assess his attitude through written comments. The results of the questionnaire are listed below.

1. Did you feel you have learned_____than you would have had this course been taught in the traditional manner?

	Regular Per Cent	Compressed Per Cent
A. more	58.8	60.6
B. about the same	41.1	30.3
C. less	-0-	9.0

2. Would you say that your opportunity for further in-depth investigation into subject areas that interested you personally were____by the audio-tutorial system as compared to the traditional approach?

	Regular Per Cent	Compressed Per Cent
A. hampered	8.8	3.0
B. about the same	35.2	48.4
C. enhanced	55.8	48.4

3. To what degree was this course instrumental in positively influencing your study habits?

	Regular Per Cent	Compressed Per Cent
A. very much	14.7	20.0
B. much	55.8	37.1
C. average	20.5	25.9
D. little	8.8	8.5
E. very little	-0-	8.5

4. Laboratory courses in biology have earned a reputation through the years, as have most other courses. Your personal anticipation of what this course was going to be like was:

	Regular Per Cent	Compressed Per Cent
A. dreaded to the point of avoidance	2.9	-0-
B. bad	8.8	19.3
C. average	41.1	29.0
D. above average	32.3	22.5
E. I looked forward to taking the course	14.7	29.0

5. Your final overall opinion of this course is:

		Regular Per Cent	Compressed Per Cent
A.	excellent	23.5	12.1
B.	above average	52.9	54.5
C.	average	20.5	21.2
D.	below average	2.9	12.1
E.	poor	-0-	-0-

6. If you had a choice of taking another course employing the same instructional methods would you:

		Regular Per Cent	Compressed Per Cent
A.	avoid it at all costs	-0-	3.0
B.	try to avoid it	2.9	9.0
C.	don't care	14.7	15.1
D.	take it	76.4	54.5
E.	take the course at my earliest opportunity	5.8	18.1

7. Your opinion in regard to the amount of time spent in study within the carrel was:

		Regular Per Cent	Compressed Per Cent
A.	it could have been longer	17.6	3.0
B.	about the right amount of time	32.3	36.3
C.	I have mixed feelings	23.5	30.3
D.	somewhat long	26.4	24.2
E.	it took far too much time	-0-	6.0

8. What did you like best about the audio-tutorial study system?

Regular: (sample comments)

"No set labs."
"Private lab session on my own time."
"Having slides on projector with tape moving at my own pace."
"Being able to go back over the material if I didn't understand it."
"You could do the work when you felt like it and take as much time as you liked."
"I could do it at my own convenience and when I was in the mood. I was by myself."
"Ease of working in lab, easy access to material."
"You could shut off the tape and go back over the material again."
"It made me work harder to get the job done."
"I liked the method of individualized study. I dislike large classes."
"No special assigned time to go to lab--also everything was there to study and not having to look for it."

Compressed: (sample comments)

"Working on your own and at your own rate."
"You could go over and over the material until you comprehended it."
"Personal contact with instructors."
"The ability to do labs anytime and being able to go back and review."
"You're on your own to make it."
"After becoming used to the compressed tape I was able to learn more in less time."
"Do it at your own time and able to shut off tape and get a certain point."
"The privacy in learning."
"Tapes help me get basic material out of the way fast so I could have more time for slides and outside class study."
"It made me think. Maybe a little too much sometimes."
"Independence."

9. What did you like least about the audio-tutorial study system?

Regular: (sample comments)

"Questions had to be asked later if one did not catch it."
"The tapes went too fast for the amount of material covered."
"Time consuming. I don't think I could have handled two courses employing same method of presentation."
"No help if the instructor wasn't around."
"Sometimes I get confused."
"Nothing special I dislike."
"The checking in and out."
"It was sometimes too long and boring so I lost interest."
"It got pretty monotonous toward the end."
"Because I was not forced to go, I sometimes let it go till the last minute and then I had to rush."

Compressed: (sample comments)

"Nothing really was all that bad about it."
"At certain times of the day the carrels were always filled."
"Problems arising from faulty equipment."
"Time consuming."
"No instructors there when you needed them."
"The compressed tapes."
"I could not budget my time well enough."
"The compressed tapes. They would have been OK for a true science major with great aptitude for the course, but for me they hindered what I could have learned."
"Only when the slides were mixed up or something wasn't there."

10. What did you like or dislike about the tape recordings used for this course?

Regular: (sample comments)

"I thought for my background the tapes tried to cover way too much ground. I would have preferred going much slower."
"Sometimes it went slowly and I felt I was wasting time. I liked it because I could have things repeated at any time and note taking was easy."
"Some of the tape had words which were hard to understand."
"Nothing."
"Easy to use."

"All had good quality sound, were easy to understand."
"A few were muffled but most were all right."
"I liked them quite well."
"Too much useless information to consume time."
"Easy to understand, well put together."
"I liked the tapes, coincided with rest of material."
"Easy way to learn and interesting."

Compressed: (sample comments)

"There was nothing I disliked, completely satisfactory."
"I didn't think I would like compressed tapes, but once I got used to them, the regular seemed too slow."
"I didn't like the speed of the compressed tapes."
"I'm sure glad I was on compressed tapes--it saved so much time."
"Compressed tapes were too hard to follow and I always had to stop and rewind them."
"Had to repeat them so often."
"I liked the speed--provides for more concentration."
"Compressed tapes helped to reduce time in the carrel."
"I liked the music at the beginning."
"There wasn't enough music at the beginning."
"Except for the poor tapes, I thought it was great."

SAMPLE SCRIPT

The following is a sample script used by the instructor in recording the tapes used in the audio-tutorial laboratory. The reading time for this script was nineteen minutes, three seconds.

Exercise 11

This tape is prepared for General Botany--The Study of the dicot stem, Exercise 11. We will learn:

1) to recognize the different kinds of tissues in stems;
2) attempt to trace the origin of these tissues from the terminal meristem;
3) relate the development of dicot woody tissues from the dicot herbaseous stem.

We will look at the stem not only as an organ as we see it today, but as an organ which had its origin in the cells of yesterday, and an organ which probably will be different tomorrow. We are, therefore, adding time to our understanding and interpretation of the stem. When we study structure in relation to time, we call this developmental anatomy.

Turn to exercise 11, page 67 of the manual, and read Dr. Dean's introduction to the study of the stem. Turn off the tape player and read Section A. We will use the geranium as an example of a dicot

herbaceous stem instead of sunflower. Note the color of the stem.

Read Section B--Cross Sections of an Herbaceion Stem--

Use the razor blade to cut a thin cross section of a petunia stem, mount the section in water, cover with a cover glass. Your section is thin enough if the epidermal cells do not look green. Which part of the cross section has cells with chloroplasts? Study the slide using the low power magnification of the microscope.

The first illustration should be a diagram. We can use this to build vocabulary, learn tissue characteristics, and locations within the stem.

No. 1. is pith
2. annular vessel
3. spiral vessel
4. xylem or wood fiber
5. reticulated vessel
6. pitted vessel
7. cambium
8. companion cell
9. siere plate
10. siere tube element
11. bast fibers
12. starch sheath
13. cortical parenchyma
14. collenchyma
15. epidermis with cutisle
16. sclerenchyma
17. phloem
18. xylem

Now look at the next illustration, a photomicrograph of a cross section of a sunflower stem. The layer of cells around the outside of the stem is

referred to as epidermis, the same term we used for the outer layer of cells in the leaf. Just as you found occasional plant hairs and guard cells in the epidermis of the leaf, so you will find some occasionally in the epidermis of the stem. You have a prepared slide of sunflower in your slide box. Look at it and locate the epidermis. Any plant hairs? Don't look too long for guard cells. They aren't very common. Just inside the epidermis are a number of layers of cells. In the photomicrograph it looks like about a half a dozen layers of cells. The cells toward the outside have darker outline than the cells toward the middle of the stem. This area of the stem is called the cortex.

There are two kinds of cells in the cortex. Those toward the outside with the thicker walls are collenchloyma cells. These are the same kind of cells we found in the vein area of the leaf. These cell walls have deposits of hemircellulose. The thin walled cells are parenchyma. Parenchyma show little differentiation and under certain conditions can be stimulated to undergo cell divisions. The outer cells are often referred to cortical collenchloyma. Cortex tells you the location in the stem. Porenclyma tells you the kind of cell. In the very center of the stem in the screen, you can see some large cells which look empty but are not. They have a very large

vacuole. These are also parencylma cells but here these parenclyma cells are in the pith. On your prepared slide, you might occasionally find a crystal in one of these cells. In between the pith and cortex, there is a ring of vascular bundles. On the screen you can see three distinct areas in each bundle. You may not see cells with as thick walls toward the outside of the vascular bundle in your slide. The cells in your slide are younger. These cells will be sclerenclyma or fiber cells. The cells with the distinct holes or lacuna in the part of the bundle toward the pith are the xylem cells. They will appear red on your prepared slide. In between the sclerenchrgma and xylem you will find the phloem. These are the cells with the walls stained green between xylem and sclerenclyma. Leave your stem slide on your microscope and look at the next photomicrograph. As we locate the different tissues in this longitudinal view, try to watch them with the same tissues in the cross section of your prepared slide. The outside layer of cells is the epidermis. Immediately inside the epidermis begins the cortex and its cortex until you see the red stained cells. Notice that outer cells of the cortex are longer and with thicker walls and protoplasm. These are the collenchyma. The inner cells of the cortex have thin walls, are shorter, more nearly square and have

protoplasm. These are the parenclyma cells. The red stained cells, some with red stained spiral markings on the wall, belong to the vascular bundle. These are xylem cells in the bundle. The cells on the far side of the vascular bundle which look like the cortical parenchyna are the parenchyna cells of the pith. You can see a part of a bundle at the edge of the picture.

The next illustration you have a photograph under higher magnification of a single vascular bundle. The reference in your manual is in section C. You see the epidermis and below is the cortex but most of the screen is filled with vascular bundle. The dark red stained cells toward the inside of the atem are the sclerenclyma cells. I believe you'll find the photograph better than your slide for scherenclyma. The red stained cells toward the center of the stem, the sylem, and the green stained cells with protoplasm in between the sclerenhyma and the xylem, these are the cells to the phloem. Put the classification information on your paper in the upper left hand corner. This is an example of an Emhyofhyte, Tracheophyte, the xylem is a critical aspect of this part of the classification, and Angiosperm, and finally a dicot. It is not important to remember that this is a sunflower stem but it is very important to remember that these features which

we have just examined are characteristics of dicot herbaceous stems.

Now let's turn our attention to where their tissues came from. In this we will use the last photomicrograph for this exercise; a longitudinal section of a stem tip. The prepared slide is a longitudinal section of a coleus stem tip. In this case the prepared slide is superior to the photomicrograph. The bumps of cells along the side of the tip occur in pairs. The upper round one is the bud primordium, and the longer are in the leaf primordium. In some of the older leaf primordia on the screen, you can tell which cells will become vascular tissue, which will become epidermis and in between the cells which will give rise to polisode and spongy mesophyll.

In the stem portion look for some long thin cells. These long thin cells forming a strand in the stem are the cells which will become the vascular bundle. Most of the stem area on the screen consists of cells of the pith. The cells between the strand and the epidermis are the cells of the cortex. On your prepared slide you should be able to find: (1) bud primordism, leaf primordism, epidermis, provascular bundle, cells which will be potissde, and spongy mesophyll, pith, and cortex. Some of the pith cells on the screen have dark masses of dye in

the cells because they happen to be cells which contain tannins. This is not common.

In this exercise we have (1) learned to recognize the many kinds of cells that go into the organ we call a stem; (2) examined the relationship of these cells to each other. The organization of cell within the stem which we have looked at is typical of dicot herbaceous stem; (3) attempted to trace the origin of these tissues to the terminal meristem.

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1966, Mankato State College, Director, NDEA Institute for Educational Media Specialists.

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