# THE EFFECTS OF TIME COMPRESSED VIDEOTAPE PRESENTATIONS ON COMPREHENSION OF ELEMENTARY PUPILS

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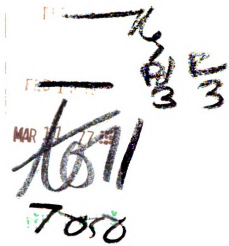

ABSTRACT

THE EFFECTS OF TIME COMPRESSED VIDEOTAPE PRESENTATIONS ON COMPREHENSION OF ELEMENTARY PUPILS

by

James E. Sanders

The purpose of this study was to investigate the effects of time compression of a videotape presentation on the comprehension of subject matter by fourth-grade elementary school pupils. The major concern in the study was to determine if the comprehension of pupils receiving compressed videotape information differs significantly compared to pupils receiving the same information by videotape at the normal speaking rate. Another concern was to analyze the post-test scores of pupils taking a pre-test and those not taking a pre-test to determine if there was a significant difference.

A sample population of eighty randomly selected subjects was randomly assigned to eight treatment groups. The treatment groups were classified by compression levels of 0, 20, 40 and 60 per cent and pre-test or no pre-test. All groups received the same content message at different rates of compression.

The videotape, "The Inclined Plane: A Simple Machine," served as the stimulus material for the study. The original

narration was recorded at 127 words per minute and was compressed to 154, 206 and 309 words per minute using the sampling method at the Perceptual Alternatives Laboratory, University of Louisville, Louisville, Kentucky. After viewing the videotape, the subjects were given a comprehension test. The tests were scored and the scores were then compiled for analysis.

The analysis of variance was used to determine if there was a significant difference in the comprehension scores of pupils viewing a videotaped program at the normal oral speaking rate and the comprehension scores of pupils viewing 20, 40 and 60 per cent time-compressed versions. The Duncan's Multiple-Range Test was used to determine between which compression rates there was a significant difference in comprehension scores of subjects. The analysis of variance was also used to determine if there was a significant difference in the comprehension scores of pupils taking a pre-test and those not taking the pre-test. The .05 level of confidence was used to test the two hypotheses and the Duncan's test for significance.

The analysis of the data concerning the comprehension scores of pupils viewing a videotaped program supported the following conclusions:

1. The information processing system was a single-channel system and was selective at any given time among the different cues. The significant decrease in comprehension scores was above the 275 words per minute level. The results

of audiovisual compression was similar to audio only compression.

2. The administering of a pre-test to fourth-grade pupils did not sensitize pupils to subject matter of a compressed videotape presentation and did not invalidate or significantly affect the post-test scores.

# THE EFFECTS OF TIME COMPRESSED VIDEOTAPE PRESENTATIONS ON COMPREHENSION OF ELEMENTARY PUPILS

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James E. Sanders

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# THE PROBLEM

## Purpose of the Study

The purpose of this study was to investigate the effects of time compression of a videotape presentation on the comprehension of science subject matter by fourth-grade elementary school pupils. The major concern in the study was to determine if the comprehension of pupils receiving compressed videotape information differed significantly compared to pupils receiving the same information by videotape at the normal speaking rate. Another concern was to analyze the post-test scores of pupils taking a pre-test and those not taking the pre-test to determine if there was a significant difference.

## Need for the Study

How can information best be transmitted with speed and reliability? This problem of efficiency in learning has been of considerable interest in the United States. Yet the knowledge explosion unparalled in the history of human existence has hindered attempts at efficiency. During the past twenty years, however, since Fairbanks and Associates announced the successful development of the speech compressor, time-compressed speech has proved to be an efficient and

rapid means of audio transmission.[1] In addition, a study by Woodcock and Clark has also provided evidence that high-speed listening can be an efficient means of learning for elementary school pupils.[2]

The large volume of information that must be transmitted daily, the increased cost of communicating such information, the lack of time available to acquire such information, and staying abreast of essential findings have constituted a seemingly insolvable problem for classroom teachers.

Until now almost every approach to solving this problem has relied primarily upon the conventional communication technology and techniques. Very few, if any, really revolutionary means for handling information and time barriers have been developed. The increased availability of portable videotape units for small group and individual use in schools has accelerated the demand for videotapes for teaching and learning. Consequently, an efficient method of presenting audiovisual material is desirable. Perhaps, then, time compression of information presented by means of television is the solution for efficient and effective learning without significant loss of comprehension.

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[1]C. Fairbanks, W. L. Everitt and R. P. Jaeger, "Method for Time or Frequency Compression--Expression of Speech." Transactions of the Institute of Radio Engineers Professional Group on Audio, 1954, AU 2, pp. 7-12.

[2]Richard W. Woodcock and Charlotte R. Clark, "Comprehension of a Narrative Passage by Elementary School Children as a Function of Listening Rate, Retention Period, and I. Q." The Journal of Communications, XVIII(September, 1968), p. 259.

## Theory Underlying the Study

In the review of related research concerning audio and audiovisual compression, many of the studies have been reported without any predictions based on theory. Nearly all of these have simply reported the results of experiments which lack hypotheses derived from theory.

The theoretical orientation of this study lay within the general framework of the cue summation principle of learning theory as interpreted by Severin. Specifically, Severin says this principle of learning theory predicts that learning is increased as the number of available cues or stimuli is increased.[3] Hoban and VanOrmer cited studies indicating that pictures added to auditory material were more effective than auditory material alone.[4] Severin, in a summary of research by Wesley and Barrow, reported that television versions produced greater learning than radio versions of an information program and that concepts presented in both audio and video were more salient than concepts presented by audio only.[5]

Miller also suggested the possibility of applying the cue summation principle to multiple-channel communication, since related cues in two channels should summate and result

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[3]Werner Severin, "Another Look at Cue Summation." AV Communication Review, XV(Fall, 1967), p. 237.

[4]C. F. Hoban and E. B. VanOrmer, "Instructional Film Research." (University Park: Pennsylvania State University) SDC 269-7-19, 1950, p. 143.

in a gain while unrelated cues should cause interference and a loss.[6] Cue summation, however, predicted that learning was enhanced by a multi-modality communication with additional relevant cues.

In yet another study, Broadbent has proposed that a nervous system acts as a single channel with a limited capacity.[7] In other words, information from only one source gains access to the nervous system at any given time. The model applies only when the information handling capacity of the system is near to being fully utilized. Broadbent goes on to predict that the system may jam if two or more messages with high information content are received through two different internal channels at the same time. According to Travers, the single-channel communication theory is in accord with theoretical models developed by psychologists interested in perception and information transmission and with emerging theoretical conceptions in physiology.[8]

Cherry, a communications engineer, has also concluded that the utilization of information by humans can be represented by a single-channel system.[9]

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[6]Neal E. Miller, "Graphic Communication and the Crisis in Education." AV Communication Review, V(December, 1957), p. 78.

[7]D. E. Broadbent, Perception and Communication. (New York: Pergamon Press, 1958), p. 297.

[8]Robert M. Travers, "The Transmission of Information to Human Receivers." AV Communication Review, XII(Winter, 1964), p. 374.

[9]E. C. Cherry, "Some Experiments on the Recognition of Speech with One and Two Ears." Journal of the Acoustical Society of America, XXV(1953), p. 975.

All of these models of a single channel through which all modalities enter the central nervous system contained a "filter" of one type or another to exclude stimuli.

Van Mondfrans and Travers concluded that "the use of two sensory modalities has no advantage over one in the learning of material which is redundant across modalities."[10] Their work did not deal with material presented through two channels which are non-redundant; instead, they concentrated on verbal material in both channels and avoided the use of pictorial material.

In addition to the previous researchers, Jester and Travers found the audiovisual combination to be superior to a single channel on a reading test only with speeds in excess of 200 words per minute.[11] Travers concluded that there was no advantage from redundant material in two channels unless unusually high speeds were used. The present study was designed in accordance with Travers in that there was complete between-channel redundancy only when spoken and printed words were presented simultaneously.

In reviewing the cue summation theory of learning and related research three possible theoretical positions emerged for what would happen when compressing audio plus video information. These theories are as follows:

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[10]Adrian Van Mondfrans and Robert M. W. Travers, "Learning of Redundant Materials Presented Through Two Sensory Modalities." Perceptual and Motor Skills, XIX(1964), p. 744.

[11]Travers, "The Transmission of Information," p. 375.

(1) A summation of relevant cues from audio and video channels will allow a greater rate of compression without a decrease in comprehension because cue summation predicted that learning increased by a summation of relevant cues from both channels.

(2) The result of compression of audio and video information is very similar to that of audio compression only since the information processing system is a single-channel and at any given time is selective among the different cues. Therefore, if the cues in all channels are related, the receiver is selective as to the cue he attends to in terms of learning the perceived task.

(3) Also, the summation of cues from the audio and video channels, if they are related, causes the threshold at which the comprehension of compressed audiovisual materials to be at a compression rate lower than for audio compressed materials only because the total number of cues available is greater than channel capacity.

The position taken in this study is that the results of audio and video compression of information is very similar to that of audio only compression, since, according to Broadbent[12] and Cherry,[13] the information processing system is a single-channel system and is selective at any given time among the different cues.

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[12]Broadbent, Perception and Communication, p. 297.

[13]Cherry, "Experiments on Recognition of Speech," p. 975.

A study by Foulke, Amster, Nolan and Bixler in which both technical and literary listening selections were used found comprehension to be only slightly affected by using word rates up to 275 words per minute. However, in the range extending from 275 to 375 words per minute, they found an accelerated decrease in comprehension as the word rate increased.[14] In another article Foulke reported that losses in listening comprehension did not reach statistical significance until a word rate of 300 words per minute was passed.[15] Similar findings were reported by Fairbanks, Guttman and Miron[16] in their study of the effects of time compression upon comprehension and also by Foulke and Sticht.[17] Both of the articles revealed that the comprehension of compressed speech is acceptable up to around 250-275 words per minute. Thereafter, there is a rapid decline in comprehensibility.

With the assumption of a single-channel system for compressing information, the prediction here was that the

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[14]Emerson Foulke and others, "The Comprehension of Rapid Speech by the Blind." Exceptional Children, XXIX (1962), p. 134.

[15]Emerson Foulke, "Listening Comprehension as a Function of Word Rate." The Journal of Communication, XVIII (1968), p. 203.

[16]Grant Fairbanks, Newman Guttman, and Murray S. Miron, "Effects of Time Compression upon the Comprehension of Connected Speech." Journal of Speech and Hearing Disorders, XXII(March, 1957), p. 10.

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

audio plus video information such as videotapes resulted in a significant decrease in comprehension at a similar word per minute rate of presentation as that for audio only compression. Therefore, the following hypotheses were formulated.

## Hypotheses

In addition to finding out channel capacity of time compressed videotaped presentations this study was designed to determine if there was a significant difference in post-test scores of subjects taking a pre-test and those not taking a pre-test. The hypotheses considered in this study were as follows:

Hypothesis I---There will be a significant difference in the comprehension scores for pupils viewing a videotaped program at the normal oral reading rate compared to comprehension scores of pupils viewing 20, 40 and 60 per cent time-compressed versions. The major difference will occur at the 60 per cent level.

Hypothesis II--There will be no significant difference in post-test scores of subjects taking a pre-test and those not taking the pre-test.

## Definitions

Specific terms used in this study are defined as follows:

(1) Comprehension score was the score obtained on the comprehension test.

(2) Compressed speech was tape recorded speech which had undergone an increase in the rate of presentation by deleting small portions of the signal and by connecting the remaining sound elements to provide an uninterrupted message without change in pitch.

(3) Normal oral reading rate was an oral word rate of approximately 150 to 175 words per minute as read by a professional reader.

## Organization and Overview

In Chapter I the general frame of reference for the study is given, including the purposes of the study, need for the study, theory, hypotheses, and definitions related to the study. The literature related to the study is reviewed in Chapter II and involves the age level of the pupils, listening comprehension and the various word rates in relation to visual stimuli employed in previous studies. The design of the study, reported in Chapter III, includes population used, design, analysis and stimulus development. In Chapter IV the analysis of the data is the focus, and Chapter V includes the summary and conclusion.

## CHAPTER II

## REVIEW OF RELATED LITERATURE

Until now, few studies have been conducted using compressed speech with accompanying time compressed visuals. Furthermore, almost all of these studies have involved college level students or adults. In this review of literature, research related to audio-only compression has not been reported nor has the general development of the speech compression process been included.

In 1949, Vincent, Ash and Greenhill reported the results of their research which attempted to determine the effects on learning by increasing the concentration of facts in films.[1] Four films on the subject of weather were prepared as follows: a "long-heavy" version of 29 minutes which contained 224 facts, a "long-light" version the same length but with 112 facts, a "short-heavy" version of 14 minutes with 112 facts, and a "short-light" version with 56 facts in 14 minutes.

Conclusions based on the data were that packing more information into a film yields only a slight increase in total measured learning. The "heavy-long" version, for instance,

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[1]W. S. Vincent, P. Ash, and L. P. Greenhill, Relationship of Length and Fact Frequency to Effectiveness of Instructional Motion Pictures, Special Devices Center, Technical Report SDC 269-7-19 (Port Washington, N. Y.: Special Devices Center, 1950), p. 140.

did not result in twice as much learning as the "short-heavy" or the "long-light" versions, nor was there twice as much learning as with the "short-light" film.

Nelson, Moll and Jaspen reported two experiments in which the effectiveness of the aural and visual elements in instructional films was compared to determine their relative contributions to learning.[2] Eight test groups were used with various combinations of aural and visual stimuli. These experiments showed that groups which both saw and heard a film learned more than groups which only saw or heard the film.

The specific conclusions based on the data were that: (1) significant learning accrued from the film as a whole or from either the video or audio alone; (2) neither channel was consistently better than the other, although both channels together were consistently better than either one alone; and, (3) more learning accrued when the two channels were in harmony.

Research on the transmission of information conducted at the University of Utah,[3] was summarized in an article by Travers. Although general in nature, the work contained specific references to compressed presentations involving reading test passages displayed through hearing alone, through

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[2]H. E. Nelson, R. Moll, and N. Jaspen, Comparison of the Audio and Video Elements of Instructional Films, Special Devices Center, Technical Report 269-7-18 (Port Washington, N. Y.: Special Devices Center, 1950).

[3]Travers, "Transmission of Information," p. 373-385.

vision alone, and through both hearing and vision. Travers reported that:

> At the slower speeds of 200 words per minute or less no advantage was achieved through the audio-visual presentation, but at higher speeds two things began to happen. First, many subjects took obvious steps to block one channel by closing the eyes or covering the ears, and second, despite this blocking of one channel, the audiovisual transmission of information turned out to be superior to the single channel. Presumably, subjects tended to block the information channel which was of least value to them.
>
> Two sources of information coming through the same sense modality or through different modalities can be utilized simultaneously if the rate of transmission of information is very low. At higher speeds, where the information from a single source is more than the processing system can handle, switching from source to source may occupy a part of the time available for taking in information. This switching appears to be time out for learning.[4]

In discussing time compression, Travers noted that compression of information by the nervous system involved discarding of less important information and retaining the more important. He further observed that in the experiments reported above, the comprehension of auditory presentation fell off more rapidly than the comprehension of the visual presentation and that the audiovisual presentation began to show an increasing advantage over either of the single channel presentations. Travers further commented that:

> There are several factors involved here. The first factor is undoubtedly the fact that the speeding up of auditory material by time compression results in a loss of intelligibility, but there is no corresponding loss through speeding the presentation of visual material. The second

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[4]Ibid., p. 373.

> is that the eye can scan reading material in such a way that the words or groups of words transmitting the most useful information are more readily received...A third factor is that most people have had some experience in receiving information at high speeds through the visual sense but few have had comparable experience with high speed audio transmission. A fourth factor is that the information needed to identify a word transmitted aurally takes an appreciable time to transmit, but when the same word is transmitted visually the entire information needed to interpret the word arrives at the receptor level at the same instant.[5]

This study described by Travers, however, involved visual augmentation consisting of verbal material and not pictorial information.

In another study, Loper sought to determine the possibility of decreasing the amount of time required to present factual material over a television system while holding the comprehension at acceptable levels.[6] Loper found that when presentation rates of zero, one-third, and one-half were used for a message presented either in an aural or a visually augmented aural form, the only difference between presentation rates was in favor of the visually augmented aural presentation at one-half compression. Furthermore, this difference did not show up on the retention test immediately following the presentation, but on a retention test administered two weeks after the original test. He concluded, therefore, that visual augmentation did not aid comprehension

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[5] Ibid., pp. 382-383.

[6] James L. Loper, "An Experimental Study of Some Effects of Time Compression upon the Comprehension and Retention of a Visually Augmented Televised Speech." Dissertation Abstracts, XXVII(June, 1967), p. 4370-A.

of compressed messages and aided retention of information only at high rates of compression.

The research by Boyle was designed to investigate the effects of variations in visual stimulation on the listening comprehension of compressed speech in fifth-grade pupils. Three variations in visual stimulation were presented to three groups of subjects, each group receiving a different type. The visual treatments were: no visual stimulation, irrelevant and unstructured visual stimulation, and relevant pictorial visual stimulation. The four word rates were 178, 228, 278 and 328 words per minute. Each subgroup received one of the four word rates. Boyle found that the decline in comprehension was due to the increasing word rate only and that there were no differences in groups receiving the same word rate but different visual presentations.[7]

Watts found that the addition of slides to a previously prepared lecture did not augment achievement of college-educated Air Force officers.[8] Watts pointed out that he knew beforehand that the slides did not carry any specific content to strengthen the original stimulus. For this reason, the conclusion that slides themselves do not add to a compressed speech presentation would be incorrect. One important

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[7]Virginia A. Boyle, "Effects of Variations in Visual Stimulation on Listening Comprehension," CRCR Newsletter, III(December, 1969), p. 1.

[8]M. W. Watts, Jr., "Using Compressed Speech to Teach Instructional Techniques to Air Force Officers." Presented to the Second Louisville Conference on Rate and/or Frequency Controlled Speech, (October, 1969).

sidelight of the research was the informal notation that many of his subjects felt more "comfortable" when visuals were added.[9]

In his investigation of slide-audio tape presentation experienced in learning carrels and presented at compressed (250 words per minute) and normal (150 words per minute) rates of speech, Perry reported that:

> At the .05 level it could not be demonstrated that subjects experiencing a compressed speech slide-audio tape presentation achieved higher mean scores on recall or application tests than subjects experiencing a normal speech slide-audio tape presentation.
>
> It was found significant at the .05 level that subjects experiencing a slide-audio tape presentation whether with normal or compressed speech achieved higher mean scores on recall and application tests than subjects who received no presentation.[10]

Anderton sought to determine if a tape-slide instructional program designed to teach recognition of behavioral objectives would be as effective when presented at higher rates of speed. Secondary considerations of the study were to determine if the use of pictorial embellishments (cartoons) contributed to learning, if students learned more when information was presented twice at high speeds, if faster rates of presentation withoug pictorial embellishments were more effective than the original program.

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[9] Ibid.

[10] Thomas K. Perry, "The Effects upon the Learner of a Compressed Slide-Audio Tape Presentation Experienced in a Learning Carrel as Measured by Recall and Application Tests," Unpublished Dissertation, 1970, pp. 65-66.

The results showed that there was no significant difference in learning from a tape-slide instructional program at different rates or from presenting materials twice at high speeds rather than once at the original speed of the recording. Regarding pictorial embellishments, there was no significant difference in learning from a presentation at faster rates, without pictorial embellishments, and the learning resulting from presentation of the original program at the normal rate.[11]

The principal problem in the study by Parker was to ascertain the degree to which college students could recall information presented in an uncompressed version and three differently compressed versions of a 16mm film. Both the audio and visual cues were compressed in varying degrees in the experimental version. In this study the compression was accomplished by eliminating every sixth, eighth and tenth frame of the film. To the extent of his experiment, the audio and video compression appeared to have little or no effect upon information recall of college students participating in the study. Parker further suggested that additional research was needed to determine the effects on learning of compression in various types of media.[12]

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[11]Ray L. Anderton, "The Effect of a Time-Compressed Tape-Slide Instructional Program upon the Learner," Center for Rate Controlled Recordings Newsletter, III(December, 1969), pp. 2-3.

[12]John P. Parker, "The Effect of Varying Degrees of Compression in a 16mm Sound Motion Picture upon Information Recall." Dissertation Abstracts, XXXII(December, 1971), p. 2918-A.

Benz designed a study to test the effect of transmitting compressed speech along with a visual complement on the comprehension of factual material. In his research involving a college level television lecture concerning maps at normal rate and at one-third and one-half aural compression, Benz reported significance was found between the aural-only and aural-visual modes. He also observed that the one-third compressed aural-visual presentation was as effective as the normal rate aural-visual presentation, while the aural-only normal rate was significantly better than the aural-only one-third compressed rate. The visual elements were an aid to learning in this instance.

Benz concluded that the television lecture presentation, which required a visual complement, could be increased in word rate with a reduction in presentation time by one-third without significant loss in comprehension.[13]

In the review of related literature the studies were primarily interested in determining if the addition of visual stimuli increased the comprehension of compressed auditory information. The majority of the studies did indicate that there was at least some increase in learning by the addition of the visuals, but in the light of the major concern of this study, some disagreement might arise. In the studies reviewed in the literature, however, the intention was not to

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[13]Carlton R. Benz, "Effects of Time-Compressed Speech upon the Comprehension of a Visually Oriented Television Lecture." Dissertation Abstracts, XXXII(May, 1972), p. 6579-A.

compare the comprehension scores of subjects receiving an audiovisual presentation at the normal rate with subjects receiving time compressed versions to establish a threshold at which there is a significant difference in the scores. In two of the experiments, however, there was no increase in the learning that could be attributed to the addition of the visuals to the compressed audio information. These findings tended to support the theoretical position of this study that the results of audio and video compression of information are very similar to that of audio-only compression, since the information processing system functions as a single-channel system and was selective at any given time among the different cues.

In two other studies there was no significant difference in the post-test scores when a slide-tape program was compressed to 250 words per minute and when a 16mm film was compressed by the elimination of every sixth, eighth and tenth frame. The word per minute rate in these last studies fell below the generally accepted point of 275-375 words per minute at which comprehension of compressed speech began to show a significant decrease. Since the theoretical position taken in this study is that the results of audio and video compression of information were very similar to that of audio only compression, the 60 per cent compression rate (309 words per minute) was chosen as an upper limit since it did fall within the range at which one expects the comprehension of audio-only materials to decrease significantly.

# CHAPTER III

# DESIGN OF THE STUDY

## Introduction

The description of the population, the nature of the stimulus material and the data collection instruments are described in this chapter. Also the specific procedure, experimental design and method of statistical analysis are presented.

## Population

The subjects for this study were selected from a population comprised of fourth-grade pupils attending two elementary schools in the Bowling Green City School System, a south central Kentucky city of 40,000. Both male and female pupils were involved. The two elementary schools used in the study were randomly selected from six.

The total population of fourth-grade pupils in the two schools was 132. Eighty pupils, randomly selected from the population, were then randomly assigned to one of eight treatment groups. Eight additional pupils were selected by the same sampling procedures to serve as replacements; however, none of these pupils was needed when the data were gathered.

One criterion in the selection of subjects was the existence of an I. Q. score. Additional criteria used in sample selection were the subjects' hearing and seeing abilities. Health records revealed that the subjects selected passed the tests for normal hearing and vision. Some, however, had normal vision only through the use of corrective lenses. Other considerations were the subjects' previous experience with compressed speech and prior knowledge of the subject matter used in the stimulus material. During the meeting with the teachers of the pupils used in the study it was determined that none had to be eliminated as subjects in the study because of prior experience with compressed speech or prior knowledge of the subject matter used in the stimulus material.

## Design and Analysis

The design of the study and treatments are shown in Figure 1. The eighty subjects were assigned to four compression groups and each group was then randomly divided into two sub-groups. One sub-group took the pre-test and the other group did not. For this study the zero compression group was used as the control group.

| | Per Cent of Time Compression | | | |
|---|---|---|---|---|
| | 0 | 20 | 40 | 60 |
| Pre-test | 10 | 10 | 10 | 10 |
| No Pre-test | 10 | 10 | 10 | 10 |

Figure 1. Design of the Study.

The analysis of variance was used in order to investigate the effects of time compression of a visual and aural presentation on comprehension of subject matter by elementary school pupils. This analysis was also used to determine if a significant difference existed between the mean comprehension scores of subjects receiving a pre-test and those not receiving the pre-test. In this study each cell contained ten subjects. This design corresponds to Ferguson's design for one-way analysis of variance.[1]

The level of significance test for each of the null hypotheses for the main effects of Factor A, compression rate, and Factor B, taking of a pre-test, was .05. Because of the relatively small sample size of each cell and the brevity of the treatment, the .05 level for rejecting the null hypothesis was chosen.

The data gathered in the study were transferred to computer punch cards and analyzed at Western Kentucky University's Center for Academic Computing through the IBM 371-65 computer system.

## Stimulus Material

Selection of the stimulus material was based on the following criteria. First, the subject matter should be appropriate for pupils of the fourth grade, and secondly, it should not have been taught prior to the use of the stimulus material.

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[1]George A. Ferguson, Statistics Analysis in Psychology and Education. (New York: McGraw-Hill Book Co., 1971), p. 208.

The material was appropriate for fourth-grade pupils because the subject of simple machines was taught in this school system at the fifth grade level. An instructional 16mm film served as the model for the preparation of the stimulus material in this study. The film, entitled Simple Machines: Inclined Planes, was produced by Coronet Films, Inc.[2] It was intended for use in science in grades three through seven and contained more illustrations appropriate to pupils of this age than did any other film on the subject that was reviewed. The original version of the film was black and white and contained many outdated pictures. The content, however, remained appropriate and useful.

## Audio Development

The person selected to read the script for the audio portion of the stimulus material was given the script one week before the time of the recording session and was asked to become familiar with it. The reader was instructed by the developer to read the script in as normal a manner as possible. The recording was under the supervision of an audio technician to insure the best quality recording possible.

The original tape was recorded at fifteen inches per second. It was sent to the Center for Rate Controlled Speech at the University of Louisville, Louisville, Kentucky, where it was electro-mechanically compressed by 20, 40 and 60

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[2]Coronet Films, Inc. Simple Machines: Inclined Planes. (Chicago: Coronet Films, Inc., 1950), ½ reel.

per cent of its normal playing time. These four tapes served as the audio portion of the videotapes that were produced for the stimulus material.

## Visual Development

After the audio portion was developed, four visual segments were then produced to correspond to the original audio and the three compressed audio tapes. In the visual development one major factor was the necessity of keeping all visuals relative to the audio portion of the tape.

A graphic artist assisted in the preparation of the visuals that explained the principles, concepts and descriptive material within the videotape.

The master image recording at 0 per cent compression was recorded on an Ampex Model VR-1200B quadraplex videotape recorder. The compressed audio was pre-recorded on the videotapes from the compressed audiotapes before video compression was started. The compression of the visual segments corresponding in length to the time compressed audio was accomplished by using two Ampex VR-1200B quadraplex videotape machines with electronic editing. The video editing was scene by scene assemble editing from the original master quadraplex tape to match the length of each individual audio segment. No visual segment was totally deleted in the compression process. The editing was the subjective judgement of the author and the scenes selected best depicted the video appropriate for the audio.

The quadraplex tapes were duplicated to the Sony three-fourths inch U-matic videotape format since this machine was to be the means for delivery of the stimulus material to the subjects. The three-fourths inch cassette format was chosen because of its portability and reliability in image reproduction and the good quality of color reproduction.

The original videotape and the three compressed tapes were recorded and edited in the Western Kentucky University Television Center.

## Instrumentation

Two instruments were employed to collect the data needed in this study. These instruments were the comprehension post-test and the pre-test.

### Comprehension Post-Test

A pilot study was conducted prior to the experiment in order to construct the Experimental Comprehension Test. Since there was no commercially available test of the material presented by the stimulus videotape, a test was developed to determine the pupils' comprehension of the subject matter.

Prior to the test construction a meeting with teachers who taught fourth-grade science in the Bowling Green City School System was held to assess the knowledge of fourth-grade pupils on the subject of the simple machines. From this information the original twenty item multiple-choice test (see Appendix B) was constructed.

According to Chase, in spite of the vigorous attack on the multiple-choice test in recent years, test makers still

see it as the most versatile and effective of the various types of objective test items.[3] Therefore it was decided that a multiple-choice test, if constructed properly, would yield an instrument that was adequate for the study.

The original twenty-item test was administered to thirty fourth-grade pupils from a population that was similar in age, grade and science background to the experimental group. The stimulus at the normal rate was presented to the pupils, and following the presentation, the test was administered as a post-test. Following the giving of the test, the test was subjected to an item analysis to determine the difficulty and discrimination power of each question. According to Nunnally, the questions for the comprehension post-test should have had a difficulty level (percentage of total giving an incorrect response) of 20 to 80 per cent and a discrimination index of 35 per cent (percentage difference between the top 25 per cent and the bottom 25 per cent). The larger the difference, the better the item.[4] (See Appendix C for the results of the analysis for discrimination and difficulty index of each question.)

Since five of the original twenty test items did not meet the discrimination and difficulty criteria for inclusion they were eliminated. Although three of the fifteen items

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[3]Clinton I. Chase, Measurement for Educational Evaluation. (Reading, Massachusetts: Addison-Wesley Publishing Co., 1974), p. 110.

[4]Jum C. Nunnally, Educational Measurement and Evaluation. (New York: McGraw-Hill Book Co., 1964), p. 132.

did not meet the criteria for difficulty, they were used as part of the test in an effort to reduce the possibility of creating frustration for pupils who might otherwise have missed most or all of the questions.

Horrocks and Schoonover commented on content validity: "The content must be relevant to the purpose of the measurement; the items selected must be representative, sufficiently complete, uncontaminated with other content, and at the appropriate level of difficulty."[5] Thorndike and Hagan described content validity in this manner:

> The problem of appraising content validity is closely parallel to the problem of preparing the blueprint for a test..., and then building a test to match the blueprint. A teacher's own test has content validity to the extent that a wise and thoughtful analysis of objectives has been made in the blueprint, and care, skill and ingenuity have been exercised in building the test items to match the blueprint. A standardized test may be shown to have validity for a particular school or a particular curriculum insofar as the content of that test corresponds to and represents the objectives accepted in that school or that curriculum.[6]

In the present study the objective of the comprehension test was to determine the degree to which the pupils participating in the study comprehended the subject matter contained in the videotape, "The Simple Machine: an Inclined Plane."

After viewing the videotape, four fourth-grade teachers and the developer constructed the questions used on the

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[5]John E. Horrocks and Thelma I. Schoonover, Measurement for Teachers. (Columbus, Ohio: Charles E. Merrill Publishing Co., 1968), p. 66

[6]Robert L. Thorndike and Elizabeth Hagan, Measurement and Evaluation in Psychology and Education. (New York: John Wiley and Sons, Inc., 1969), p. 164.

comprehension test. According to the teachers, the difficulty of the test was appropriate for fourth-grade pupils in terms of readability and vocabulary. Their judgment was substantiated by the difficulty index of the item analysis. The data in Appendix C show that none of the final fifteen items was unreasonably difficult.

Consequently, the content validity of the test was deemed satisfactory for the material in this study since the objectives of the test were based upon the content of the videotaped program used as the treatment for subjects in the study and the appropriate difficulty level was present.

Using Hoyt's Estimate of Reliability Formula,[7] a reliability analysis was performed on the comprehension test. The results are reported in Table 1. For the purpose of analysis the subjects' scores on the comprehension test were determined by the number of correct answers.

Table 1. Reliability Analysis of the Comprehension Test.

| Source of Variance | Degrees of Freedom | Sum of Squares | Variance | Reliability |
|---|---|---|---|---|
| Examinees | 79 | 52.50 | .664 | .8375 |
| Items | 14 | 22.68 | 1.620 | |
| Remainder | 1106 | 299.49 | .109 | |
| Total | 1199 | 374.67 | | |

[7] J. P. Guilford, Psychometic Methods. (New York: McGraw-Hill Book Co., 1954), pp. 383-385.

According to Nunnally, reliability coefficients for examinations should be at least as high as .75 and preferably higher than .85. The test was acceptable because the reliability was above the .75 level and was near the .85 level.

Pre-Test

The test used to assess the knowledge of the subject prior to treatment was developed by making an alternative form of the post-test. The stem or options of each question in the post-test was changed to develop the alternate test.

## Procedures

The data were gathered by the experimenter with the cooperation of the teachers and principals of the participating schools.

Prior to gathering the data, the researcher met with the school principal and the fourth-grade science teachers to acquaint the teachers with the nature of the stimulus material and the data collecting instruments.

The subjects participating in the study viewed the videotape in a mobile classroom adjacent to the building in which the subjects were housed. This room was equipped with one teacher's desk, two tables and ten individual armed chairs. A Sony U-matic VP-1200 video cassette machine was used to play the videotapes. In order to insure the optimum viewing conditions, two seventeen-inch Sony Trinitron monitors were used for individuals receiving the treatment. The approximate average viewing distance from the screen was

seven feet and the most extreme viewing angle for any pupil was 45 degrees from the center of the screen.

The subjects received the treatment in accordance with a pre-planned schedule that enabled the data to be collected in one school in one day. The schedules were developed in cooperation with the teachers to accommodate the pupils' class schedules and the treatment they were to receive.

If the subjects were a group to be given the pre-test, they were asked to take a test prior to the television program. (See Appendix D for pre-test and instruction.) The subjects were then asked to listen for a tone on the television. Following the tone the videotape program was presented. After which, the subjects were given the comprehension test. (See Appendix E.) After the instructions were read by the examiner, the subjects were allowed sufficient time to complete the comprehension test. The tests were collected after all pupils had completed the test. This procedure was repeated for each of the groups in accordance with their speech compression rate.

## Statistical Hypotheses

To test the effects of time compression of a visual and aural (television) presentation on comprehension of subject matter by elementary school pupils, the following hypotheses were generated and tested:

Null Hypothesis I--There will be no difference between mean comprehension scores of subjects viewing a videotaped program at the normal oral reading rate and those viewing 20, 40 and 60 per cent time-compressed versions.

Alternate Hypothesis I--There will be a significant difference between mean comprehension scores of subjects viewing a videotaped program at the normal oral reading rate and those viewing 20, 40 and 60 per cent time-compressed versions. The major difference will occur at the 60 per cent level.

Null Hypothesis II--There will be no significant difference in the post-test scores of subjects taking a pre-test and those not taking the pre-test.

Alternate Hypothesis II--There will be a significant difference in the post-test scores of subjects taking a pre-test and those not taking the pre-test.

## Summary

A sample population of eighty fourth-grade pupils was randomly assigned to eight treatment groups. The treatment groups were classified by compression levels of 0, 20, 40 and 60 per cent and pre-test or no pre-test. Each treatment group contained ten subjects. All groups received the same content message at different rates of compression. The information sources were in the form of a three-fourths inch videotape.

A pre-test (See Appendix D) was given to one sub-group. Then, following the presentation each of the subjects was given a comprehension test. The questions with four responses each were duplicated and given to each subject for his completion. These tests were scored and a raw score, the number correct out of fifteen questions, was compiled for each subject in the experiment.

An analysis of variance was used to determine if there was a significant difference in the comprehension scores

for pupils viewing a videotaped program at the normal oral reading rate compared to comprehension scores of pupils viewing 20, 40 and 60 per cent time-compressed versions. The analysis of variance was also used to determine if there was a significant difference in the comprehension scores of pupils taking a pre-test and those not taking the pre-test.

# CHAPTER IV

# ANALYSIS OF RESULTS

## Introduction

The research hypotheses of this study were tested using the analysis of variance of the comprehension test scores. The comprehension test scores were used as the dependent variable. The independent variables were the four levels of compression and the taking or not taking of a pre-test. All the hypotheses were tested at the .05 alpha level with the appropriate degrees of freedom.

## Analysis of Data

The first analysis was to determine the effects of time compression of a visual and aural (videotape) presentation on comprehension of subject matter by elementary school pupils. The second analysis was to determine if there was a significant difference in post-test comprehension scores of pupils taking a pre-test and pupils not taking a pre-test. The total number of items answered correctly out of a possible fifteen was the score used in the analysis. See Table 2 for a summary of the analysis of variance for the comprehension scores.

Table 2. Analysis of Variance for Comprehension Scores.

| Source of Variance | D.f. | Mean Squares | F-value |
|---|---|---|---|
| Word Rate | 3 | 26.2124 | 3.2725* |
| Pre-test/No Pre-test | 1 | 10.5124 | 1.2114 |

*Significant at or above the .05 level

Word Rate

The testable hypotheses for the effect of word compression rate are as follows:

Null Hypothesis I--There will be no difference between mean comprehension scores of subjects viewing a videotaped program at the normal oral reading rate and those viewing 20, 40 and 60 per cent time-compressed versions.

Alternate Hypothesis I--There will be a significant difference between mean comprehension scores of subjects viewing a videotaped program at the normal oral reading rate and those viewing 20, 40 and 60 per cent time-compressed versions.

The analysis of variance of the comprehension test means (see Table 3) yielded and F-value of 3.2725 which was significant at the .05 alpha level. This indicated that there was a significant difference in the comprehension scores of subjects viewing a videotaped program at the normal oral reading rate and those viewing 20, 40 and 60 per cent time-compressed versions. Therefore, the null hypothesis was rejected and the alternate hypothesis accepted.

Table 3. Mean Comprehension Scores for Each Word Rate.

| Word Rate | N | Mean |
|---|---|---|
| 0% Compression (127 wpm) | 20 | 9.3000 |
| 20% Compression (154 wpm) | 20 | 8.8500 |
| 40% Compression (206 wpm) | 20 | 9.3000 |
| 60% Compression (309 wpm) | 20 | 6.9000 |

Analysis of Comprehension between Specific Treatments

In order to determine specifically at what point comprehension changed significantly, a Duncan's Multiple-Range Test[1] was applied to the results of the analysis of variance.

Table 4. Comparison of Comprehension by Treatment Through the Duncan's Multiple-Range Test.

| Groups | | | Difference Between Means | Minimum Range Difference |
|---|---|---|---|---|
| Group 1 | vs | Group 2 | .45 | 1.79 |
| Group 1 | vs | Group 3 | 0 | 1.79 |
| Group 1 | vs | Group 4 | 2.40 | 1.88* |
| Group 3 | vs | Group 2 | .45 | 1.88 |
| Group 2 | vs | Group 4 | 2.55 | 1.79* |
| Group 3 | vs | Group 4 | 2.40 | 1.94* |

*Significant at the .05 level

[1]James L. Bruning and B. L. Kintz, Computational Handbook of Statistics. (Glenview, Illinois: Scott, Foresman and Co., 1968), p. 115.

The mean for each group, the derived standard error of the means and the minimum range differences were used in this calculation of the Duncan's Multiple-Range Test. The test indicated that there was a significant difference at the .05 level in the comprehension scores between the 60 per cent compression group and the 0, 20, and 40 per cent compression groups.

Pre-test

The testable hypotheses for the effect of a pre-test are as follows:

Null Hypothesis II--There will be no significant difference in the post-test scores of subjects taking a pre-test and those not taking the pre-test.

Alternate Hypothesis II--There will be a significant difference in the post-test scores of subjects taking a pre-test and those not taking the pre-test.

The analysis of variance of the comprehension test means (see Table 4) yielded an F-ratio of 1.2113 which was not significant at the .05 alpha level. This indicated that there was no significant difference in the comprehension scores of subjects taking a pre-test and those not taking the pre-test. Therefore, the null hypothesis was retained.

Table 5. Mean Comprehension Scores for Pre-test/No Pre-test Groups.

| Pre-test | N | Mean |
|---|---|---|
| Yes | 40 | 8.2250 |
| No | 40 | 8.9500 |

## Summary

The hypotheses were tested through the analysis of variance. The Duncan's Multiple-Range Test was used to determine between which compression rates there was a significant difference in comprehension scores of subjects. The .05 alpha level of confidence was used in testing the two hypotheses and the Duncan's test for significance. A discussion of the findings and their implications are found in Chapter V.

# CHAPTER V

## SUMMARY AND CONCLUSIONS

The purpose of this study was to investigate the effects of time compression of a videotape presentation on the comprehension of science subject matter by fourth-grade elementary school pupils. The major concern in the study was to determine if the comprehension of pupils receiving compressed videotape information differed significantly compared to pupils receiving the same information by videotape at the normal speaking rate. Another concern was to analyze the post-test scores of pupils taking a pre-test and those not taking the pre-test to determine if there was a significant difference.

The initial research in the area of speech compression was conducted in 1940 by Harry Goldstein at Columbia University, New York.[1] In Goldstein's research, however, no mechanical device was used to increase the rates of speech. Instead, he used human speakers who were trained to read the passages at the desired rates. The majority of the research using compressed speech has been conducted since Grant

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[1]Harry Goldstein, Reading and Listening Comprehension at Various Controlled Rates. Teachers College Contributions to Education #821, Board of Publications. (New York: Teachers College, Columbia University, 1940).

Fairbanks, W. L. Everitt and R. P. Jaeger introduced the mechanical sampling method of compressing speech. They demonstrated this method at the 1953 National Convention of the Institute of Radio Engineers in New York City.[2] Research by Foulke, Amster, Nolan and Bixler;[3] Fairbanks, Guttman and Miron;[4] Foulke and Sticht;[5] and Foulke[6] has shown that the comprehension of compressed messages does not vary significantly until the word rate approachs or exceeds the 275 word per minute level.

In the review of related literature the studies using audio compression with accompanying visuals were primarily interested in determining if the addition of visual stimuli increased the comprehension of compressed auditory information. These studies did show that the combination of audio and visuals in presentations was superior to visual only or audio only at high rates of speed. The intention was not to compare the comprehension scores of subjects receiving an audiovisual presentation at the normal rate with subjects receiving time-compressed versions to establish a threshold at which there was a significant difference in the scores.

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[2]Fairbanks and others, "Method for Time or Frequency Compression."

[3]Foulke and others, "Comprehension of Rapid Speech by the Blind."

[4]Fairbanks and others, "Effects of Time Compression."

[5]Foulke and Sticht, "Listening Rate Preferences."

[6]Foulke, "Listening Comprehension as a Function of Word Rate."

In order to test the comprehension of a videotaped passage by elementary pupils, a sample population of eighty elementary pupils was randomly assigned to the eight treatment groups. The subjects were grouped by the four levels of word rate, 0, 20, 40 and 60 per cent compression, and the taking or not taking of a pre-test. Each of the ten subjects within four groups took a pre-test, watched the videotaped program of the appropriate per cent of compression and was given the comprehension test following the videotape. The other four groups did not take the pre-test but watched the videotaped program of the appropriate per cent of compression and were given the comprehension test following the videotape.

The videotape, "The Inclined Plane: A Simple Machine," served as the stimulus material for the study. The audio for the videotape was originally recorded at 127 words per minute. In addition to the normal or 0 per cent compression word rate, the audio was compressed to 154, 206 and 309 words per minute. The video presented was relative to the audio, and it was also compressed by video editing the various segments to correspond to the audio. However, no video segments were totally eliminated.

The analysis of variance was employed in order to determine the effect of a time-compressed videotaped presentation on the comprehension of subject matter of elementary pupils and to determine if there was a significant difference in post-test scores of pupils taking and not taking a pre-test. The Duncan Multiple-Range Test was used to determine between

which compression rates there was a significant difference in comprehension scores of subjects. The .05 level of confidence was used to test the two major hypotheses for significance.

## Findings and Conclusions

The analysis of the data concerning the comprehension scores of pupils viewing a videotaped program supported the following findings and conclusions:

Finding 1. A significant difference was found in the pupils' scores on the comprehension test when comparing the 0, 20, 40 and 60 per cent compression rates. The significance was when the 60 per cent (309 words per minute) compression rate was compared to the other three (0, 20 and 40 per cent compression) rates of presentation.

Conclusion 1. The results of videotape compression was similar to audio only compression, and it may be concluded that a compression rate of 40 per cent or a word per minute rate of less than 275 may be used without any significant difference in mean post-test comprehension scores.

Finding 2. No significant difference was found in the post-test scores of subjects taking a pre-test and those not taking a pre-test.

Conclusion 2. The administering of a pre-test to fourth-grade pupils did not sensitize pupils to subject matter of a compressed videotape presentation and did not invalidate or significantly affect the post-test scores.

## Discussion of Results

The data analysis indicated that the administering of a pre-test made no significant difference in the mean post-test scores of subjects when used in conjunction with a compressed videotaped presentation as the stimulus material.

No significant difference was found when the mean post-test scores of pupils viewing the 0, 20 and 40 per cent compressed videotapes were analyzed. A significant difference was found when the 60 per cent compression rate was compared to the 0, 20 and 40 per cent compression rates. This finding is consistent with the theoretical position taken in this paper in that the results of audio and video compression of information was very similar to that of audio only compression since the information processing system was a single-channel system and was selective at any given time among the different cues.

Other areas of research that might be considered in future studies similar to this one would be in the areas of subliminal and statistoscopic vision.

## Implications for Education

The following implications, drawn from this study, are worth considering:

1. In information transmission systems which are extremely expensive or in situations where time limitations are great, a compression of up to 40 per cent of televised instructional presentations can effectively be used with science materials for fourth-grade pupils.

2. Teachers may use a pre-test to assess the comprehension of science material of fourth-grade pupils before viewing a videotape without significantly affecting the post-test scores.

3. It is obvious from previous research and from the findings of this study that more appropriate applications could be made of videotape and audiotape compression to save learning time.

## Suggestions for Further Research

Following are suggestions for possible further study of the use of compressed videotapes:

1. The present study might be replicated with different subject matter and at different grade levels. Although the results of this study are quite conclusive for the population that was involved, replication would likely serve to substantiate the findings and broaden their generalizability.

2. Additional research might be conducted using compression of videotaped stimulus material that relies less on audio information and more on video information. This would provide some basis for deciding whether the compression of video cues of highly visual presentations can be successfully accomplished while maintaining comprehension at an acceptable level.

3. Further study might be done to investigate the use of compressed videotapes in combination with normal classroom instructional activities. The present study did not use any classroom activity to prepare the students for

the viewing of the videotape presentation nor was there any follow-up activity.

4. A further suggestion is that this study might be replicated using a larger experimental population. Since this study was restricted to a small sample, a larger sample might increase the statistical accuracy of group measurements.

5. Further research might be done with a greater compression of images in order to study the interaction of audio and video compression where extreme video compression is used.

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# APPENDIX A

## STIMULUS MATERIAL SCRIPT

STIMULUS MATERIAL SCRIPT

THE INCLINED PLANE: A SIMPLE MACHINE

All around us are machines that help us do work. It is easy to recognize a bicycle, a machine that carries people, but it is a simple machine which helps a bicycle go from the street to the sidewalk. The ramp slopes and any slope is an inclined plane. Scientists call an inclined plane a simple machine because it helps us do work. In the case of the bicycle, the slope helps to raise the bicycle to the height of the curb. If the bicycle had to be raised that height without the simple machine of the slope, this work would be much harder.

It takes a force of ten pounds to lift a ten-pound weight straight up. If, instead of lifting the weight straight up, we use an inclined plane, it takes less force. With this inclined plane it only takes nine pounds of force to lift the

ten-pound weight. The inclined plane made the work a little easier.

We repeat this demonstration, but with a flatter slope. Using the flatter slope, the force needed to move the weight is cut to about five pounds. But to raise the weight the same height as before, we have to move it further. Each time the slope is flattened, it is necessary to pull for a longer distance, but less force is required.

Inclined planes, trading distance for force, can make work easier. On this basis, do you understand why a road builder makes a highway wind back and forth along a mountainside? You have to travel farther to go up the mountain, but if the road were built straight up the side of the mountain, few cars would have the power to climb it.

Steps are a kind of inclined plane. To use them you travel a greater distance, but it is much easier than if you had to climb straight up without the inclined plane.

A circular stairway is a kind of inclined plane known as a "screw". If we were to unwrap the threads of a screw, we would find an ordinary inclined plane that trades distance for force.

There are inclined planes in the model screws we see. The threads on one of the model screws has a steeper slope than those on the other. Which takes more force to turn? Which travels farther around to go the same idstance? Let us unwind the thread which represents the ridges that spiral around a screw. The one with the steeper slope requires four revolutions; the one with the flatter slope requires six revolutions.

Another form of an inclined plane that helps us in our work is the wedge; it is a simple machine that helps spread things apart. When a man splits a piece of wood the wedge multiplies the force of his hammer and separates the wood. The axe is another wedge, as is the knife.

Remember that in the inclined plane we trade distance for force.

# APPENDIX B

## PILOT STUDY COMPREHENSION TEST

PILOT STUDY COMPREHENSION TEST

Instructions to Subjects

Please be seated wherever you choose and make yourself comfortable. If you do not have a pencil or pen hold up your hand.

You are about to see a short television program. Do not attempt to take any notes, just relax and watch and listen to the program. If the person talking appears to be speaking more rapidly than normal this is the way it is supposed to be and nothing is wrong.

It will now be necessary for you to take a test. You may guess if you are not sure about an answer. Be sure to fill in the upper right corner with your name, the name of your homeroom teacher and this number _____.

Thank you very much for your time and cooperation. This section is dismissed and we will return to your room.

PILOT STUDY COMPREHENSION TEST

1. Remember in the inclined plane we trade

   a. distance for force
   b. force for distance
   c. height for force
   d. distance for height

2. Which simple machine helps to spread things apart?

   a. wheel
   b. wedge
   c. hammer
   d. screw

3. A circular stairway is a special kind of inclined plane. Which of these best describes the circular stairway?

   a. road
   b. slope
   c. screw
   d. wedge

4. Why would a road builder build a road around a hill instead of straight up the hill?

   a. easier to see where you are going
   b. requires more force to travel up
   c. cheaper to build
   d. requires less force to travel up

5. To gain the advantage of having to use less force, we applied the force over _____.

   a. less distance
   b. less height
   c. greater distance
   d. greater height

6. What happens to the force required to move a weight up a slope when the slope is flattened?

   a. increased
   b. decreased
   c. unchanged
   d. none of these

7. If you raise an object that weighs three pounds without the use of a simple machine how many pounds of force would be needed?

   a. 1
   b. 2
   c. 3
   d. 6

8. If you were going to load an object that you could not lift into a truck, which length of ramp would make the loading easier?

   a. 13 feet
   b. 16 feet
   c. 19 feet
   d. 25 feet

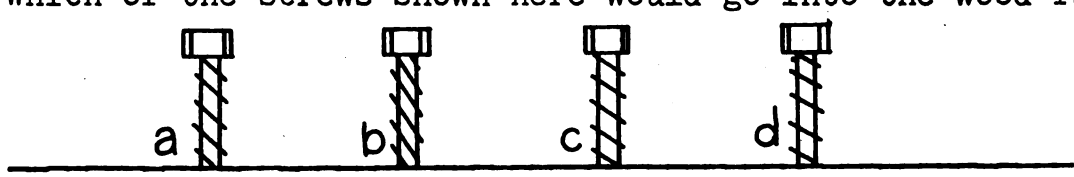
9. Which of the following is <u>not</u> a form of an inclined plane?

   a. wedge
   b. screw
   c. slide
   d. pliers

10. The inclined plane helps us to make work _____.

    a. better
    b. harder
    c. longer
    d. easier

11. Which of the screws shown here would go into the wood faster?




12. Which of the following would <u>not</u> be an example of an inclined plane?

    a. hammer
    b. knife
    c. chisel
    d. axe

13. The closer together the threads are on a screw the _____ it is to turn.

    a. harder
    b. easier
    c. faster
    d. slower

14. What advantage is there to a long thin wedge over a short flat wedge?

    a. harder to drive into the wood
    b. easier to drive into the wood
    c. splits the wood faster
    d. splits a larger log

15. How does increasing the number of times a path winds around a hill affect your climbing? It makes it _____.

    a. harder
    b. shorter
    c. prettier
    d. easier

16. Why is a slope a simple machine? It helps us _____.

    a. turn a wheel
    b. ride a bicycle
    c. open a door
    d. do work

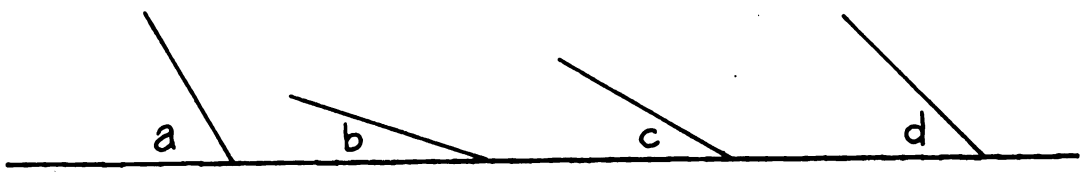
17. What is the name of a special case of the inclined plane that helps us travel from one floor of a building to another?

    a. slope
    b. elevator
    c. stairs
    d. wedge

18. What is the name of the simple machine that helps the bicycle go from the street to the sidewalk?

    a. screw
    b. wheel
    c. inclined plane
    d. wedge

19. Which of these inclined planes should an object move down the fastest?




20. The _____is an inclined plane turned around a center shaft.

    a. wheel
    b. door knob
    c. screw
    d. wedge

# APPENDIX C

## PILOT STUDY COMPREHENSION TEST
## ITEM DIFFICULTY AND DISCRIMINATION INDEX

PILOT STUDY COMPREHENSION TEST
ITEM DIFFICULTY AND DISCRIMINATION INDEX

| Item | Difficulty Index | Discrimination Index |
|---|---|---|
| 1* | .83 | 0 |
| 2 | .17 | .43 |
| 3 | .43 | .43 |
| 4* | .83 | .14 |
| 5 | .70 | .71 |
| 6 | .60 | .57 |
| 7 | .60 | .43 |
| 8 | .77 | .57 |
| 9 | .53 | .57 |
| 10* | .17 | .29 |
| 11 | .70 | .43 |
| 12 | .63 | .86 |
| 13* | .83 | 0 |
| 14 | .67 | .57 |
| 15 | .53 | .57 |
| 16 | .53 | .43 |
| 17 | .50 | .43 |
| 18 | .17 | .43 |
| 19 | .17 | .71 |
| 20* | .87 | .14 |

*These items were judged not acceptable because, according to Nunnally, only items having a difficulty index of 20 to 80 per cent and discrimination index of 35 per cent or above are acceptable test items.

# APPENDIX D

# PRE-TEST AND INSTRUCTIONS

PRE-TEST AND INSTRUCTIONS

Instructions to Subjects

Please be seated wherever you choose and make yourself comfortable. I would like to ask you to take a short test before we see the television program. Simply do the best you can on the test without asking any questions. You will not be penalized for guessing so if you are not sure feel free to guess. If you do not have a pencil or pen please hold up your hand.

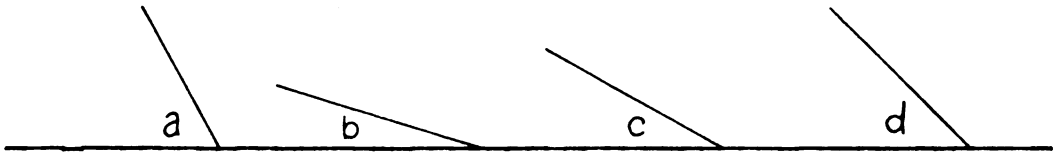
In the upper right-hand corner of the test please write your name, your homeroom teacher's name and this number _____.

PRE-TEST

1. Which simple machine helps to spread things apart?

   a. axe
   b. hammer
   c. wheel
   d. screwdriver

2. Which of these inclined planes should an object move down the slowest?




3. What is the name of the simple machine that helps the bicycle go from the street to the sidewalk?

   a. screw
   b. wheel
   c. slope
   d. axle

4. A stairway is a special kind of inclined plane. Which of these best describes the stairway?

   a. road
   b. slope
   c. screw
   d. wedge

5. Why is an axe a simple machine? It helps us _____.

   a. turn a wheel
   b. ride a bicycle
   c. open a door
   d. do work

6. Which of the following is a form of an inclined plane?

   a. wheel
   b. hammer
   c. slide
   d. pliers

7. How does decreasing the number of times a path winds around a hill affect your climbing? It makes it _____.

   a. harder
   b. shorter
   c. prettier
   d. easier

8. If you raise an object that weighs six pounds without the use of a simple machine how many pounds of force would be needed?

   a. 1
   b. 2
   c. 3
   d. 6

9. Which of the following would <u>not</u> be an example of an inclined plane?

   a. hammer
   b. knife
   c. chisel
   d. axe

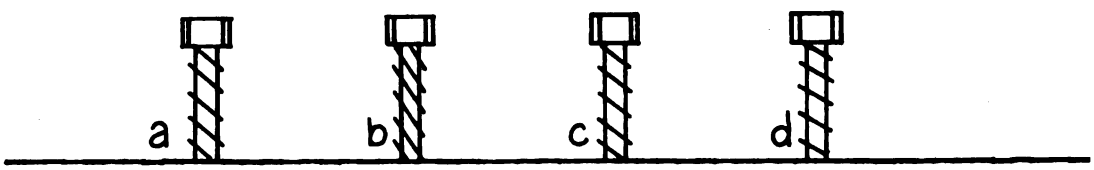
10. What is the name of a special case of the inclined plane that helps a car travel from one floor of a parking building to another?

    a. slope
    b. elevator
    c. stairs
    d. wedge

11. To gain the advantage of having to use less force, we applied the force over _____.

    a. less distance
    b. less height
    c. greater distance
    d. greater height

12. Which of the screws shown here would go into the wood slower?



13. What happens to the force required to move a weight up a slope when the slope is raised?

    a. increased
    b. decreased
    c. unchanged
    d. none of these

14. What disadvantage is there to a short flat wedge over a long thin wedge?

    a. harder to drive into the wood
    b. easier to drive into the wood
    c. splits the wood faster
    d. splits a larger log

15. If you were going to load an object that you could not lift into a truck, which length of ramp would make the loading harder?

    a. 13 feet
    b. 16 feet
    c. 19 feet
    d. 25 feet

# APPENDIX E

## COMPREHENSION TEST AND INSTRUCTIONS

COMPREHENSION TEST AND INSTRUCTIONS

Instructions to Subjects

You are about to see a short television program. Do not attempt to take any notes, just relax and watch and listen to the program. If the person talking appears to be speaking more rapidly than normal this is the way it is supposed to be and nothing is wrong.

It will now be necessary for you to take a test. You may guess if you are not sure about an answer. Be sure to fill in the upper right corner with your name, the name of your homeroom teacher and this number _____.

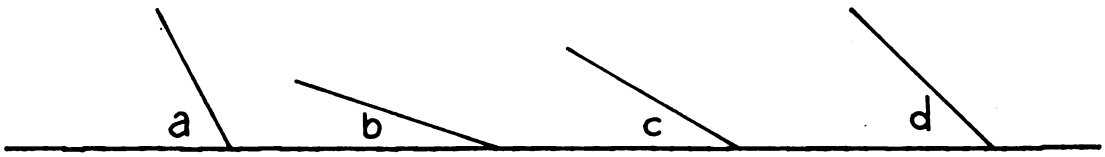
Thank you very much for your time and cooperation. This section is dismissed and we will return to your room.

COMPREHENSION TEST

1. Which simple machine helps to spread things apart?

   a. wheel
   b. wedge
   c. hammer
   d. screw

2. Which of these inclined planes should an object move down the fastest?




3. What is the name of the simple machine that helps the bicycle go from the street to the sidewalk?

   a. screw
   b. wheel
   c. inclined plane
   d. wedge

4. A circular stairway is a special kind of inclined plane. Which of these best describes the circular stairway?

   a. road
   b. slope
   c. screw
   d. wedge

5. Why is a slope a simple machine? It helps us _____.

   a. turn a wheel
   b. ride a bicycle
   c. open a door
   d. do work

6. Which of the following is <u>not</u> a form of an inclined plane?

   a. wedge
   b. screw
   c. slide
   d. pliers

7. How does increasing the number of times a path winds around a hill affect your climbing? It makes it _____.

   a. harder
   b. shorter
   c. prettier
   d. easier

8. If you raise an object that weighs three pounds without the use of a simple machine how many pounds of force would be needed?

   a. 1
   b. 2
   c. 3
   d. 6

9. Which of the following would be an example of an inclined plane?

   a. hammer
   b. knife
   c. wheel
   d. road

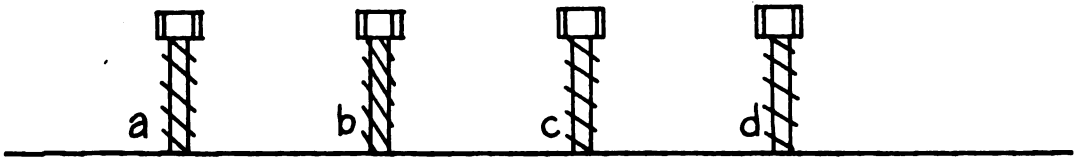
10. What is the name of a special case of the inclined plane that helps us travel from one floor of a building to another?

    a. slope
    b. elevator
    c. stairs
    d. wedge

11. To gain the advantage of having to use less force, we applied the force over _____.

    a. less distance
    b. less height
    c. greater distance
    d. greater height

12. Which of the screws shown here would go into the wood faster?



13. What happens to the force required to move a weight up a slope when the slope is flattened?

    a. increased
    b. decreased
    c. unchanged
    d. none of these

14. What advantage is there to a long thin wedge over a short flat wedge?

    a. harder to drive into the wood
    b. easier to drive into the wood
    c. splits the wood faster
    d. splits a larger log

15. If you were going to load an object that you could not lift into a truck, which length of ramp would make the loading easier?

    a. 13 feet
    b. 16 feet
    c. 19 feet
    d. 25 feet