THE EFFECT OF ADDED PAUSE TIME UPON THE COMPREHENSIBILITY OF COMPRESSED SPEECH

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ABSTRACT

THE EFFECT OF ADDED PAUSE TIME
UPON THE COMPREHENSIBILITY
OF COMPRESSED SPEECH

By

Frank Rocco

At present, the medium used most by blind children as a means of information gathering is braille. Recently the talking book record and tape recorded materials have come into use as a supplementary system to braille. The blind high school student reads braille at a rate of approximately 90 words per minute. Record or tape recorded materials, when recorded by professional readers, are presented at an average rate of approximately 175 wpm. In contrast, a sighted high school reader has an average silent reading rate of 251 wpm. In addition, the sighted reader has the capability of visual scanning and overviewing, as well as the ability to quickly and easily reverse course in order to review or retrace the sequence of events. The printed page by virtue of its format permits the sighted reader visually based organizational cues by use of varied spacing, bold type and center and side headings. It is obvious that the blind child is at a significant educational disadvantage because of the slow rate at which he must listen or read.

One method of more favorably equating this disparity in rate of information acquisition is that of presenting

recorded material at a word rate in excess of 175 wpm. It is possible to raise the wpm rate of recorded material employing speech compression technology to any level desired without alteration in pitch of the original presentation. However, comprehensibility of this compressed speech begins to decline at approximately 275 wpm. Although this rate (275 wpm) is slightly higher than the average silent reading rate quoted earlier for sighted readers, the oral method of presentation does not compensate for the visual advantages listed for sighted readers. It is advantageous therefore to attempt to raise the wpm rate of compressed speech to speeds beyond 275 wpm without loss in comprehension so that the blind listener might be permitted two "readings" in the time originally required for one, or one "reading" for previewing content and a second or third for mastery.

An experiment was conducted to determine if it is the lack of information processing time in compressed passages of connected discourse that causes loss in comprehension at word rates greater than 275 wpm. It was assumed that S requires time to make the associations which make full comprehension possible and that this time is greatly reduced by the process of compression.

A 1,319 word fictional story was tape recorded and compressed, using a sampling method with discard intervals of 20 milliseconds, to word rates of 250, 300, and 350 wpm.

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Pause times of 1, 2, and 3 seconds duration were added at 30 fixed intervals (common to all tapes) within the story. This resulted in four tapes at each of the three compression rates previously listed, one with no pause time added, one with 1 second pauses added, etc. In all, 12 tapes were obtained in this manner.

Three hundred and forty-eight college students were randomly assigned to the 12 treatment conditions and asked to complete a 38 item mulitple-choice examination in order that comprehension scores might be obtained for each treatment. The test results were submitted to an analysis of variance to determine if pause addition was beneficial to comprehension. It was hypothesized that (a) the main effect for pause time will be statistically significant, greater comprehension being associated with the presence and the magnitude of pause time and, (b) the interaction effect of pause time and compression rate will be statistically significant, greater comprehension being associated with longer pause times at higher rates of compression.

Results of the analysis of variance showed a significant main effect for compression. Comprehension scores of the 250 and 350 wpm rates of compression were found to be significantly different. The 300 and 350 wpm rate scores were also significantly different. This was in keeping with previous literature on the subject. No significant difference

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was found for either the main effect of pause addition of the interaction term (compression x pause addition). It was concluded therefore, that under the conditions of the present study, there appears to be no beneficial effect for compression attributable to the addition of pause times of the frequency and duration used.

An investigation was undertaken to determine if this unexpected negative finding could in part be attributed to any of the following variables: complexity of the stimulus passage, test ceiling, validity of the measure of comprehension, reliability of the test, appropriateness of the compression rates selected for testing, S's motivation, placement of pauses within the test selection, and sex make-up of the treatment groups. While these variables may have had an effect under different conditions there was no internal evidence indicating that these variables could be held responsible for the negative findings of this research.

THE EFFECT OF ADDED PAUSE TIME UPON THE COMPREHENSIBILITY OF COMPRESSED SPEECH

By

Frank Rocco

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DEDICATION

This dissertation is affectionately dedicated to my father Antonio Rocco and to the memory of my dear mother Anna Rosa Rocco who together embarked upon the great journey to America in order that their children might have a better life.

ACKNOWLEDGEMENTS

The research reported herein represents a cooperative effort on the part of many individuals who contributed considerable time and energy toward its completion.

Special appreciation is extended to Dr. James E. Keller who as Guidance Committee Chairman advised and directed the study from conception to completion. More than this, however, Dr. Keller provided a model of humanity that refreshed this observer and committed him anew to his task.

Grateful appreciation is also extended to Dr. Donald Freeman who provided subjects for the study as well as counsel concerning design and statistical analysis.

Gratitude is due the many individuals who provided direct assistance in the study. Among those who gave unselfishly of their time special mention is given the following: Mrs. Becky Briggs for scheduling and rescheduling of the language laboratory testing site; Mrs. Linda Nutting for serving as girl Friday throughout the testing phase of the research; Mrs. Kathy Dickerman for the many hours of proofreading the copy; Dr. Andrew Porter and Dr. Rosanne Bulgarella for statistical counsel; Dr. Richard DeMott for design counsel and for serving as test proctor; Steven Miller for serving

as test proctor and general assistant; Carl Oldsen for providing resource information for the review of literature; Dr. Emerson Foulke for technical counsel and materials development; Joseph Levine and John Shultz for technical counsel regarding pause addition to tapes; Mrs. Brenda Pecor for typing the test booklet and thesis proposal; George Churchhill for counsel and assistance regarding test booklet duplication; Dennis Allen, Mike Maurer, Harold Van Morgan and Mike Brooks for serving as laboratory technicians.

To Sam Beavers, Matt Klein, Ross Dailey, Miss Barbara Nicholas, Mrs. Lani Ford, John Hoogstra and Mrs. Terry Wood grateful appreciation is expressed for their invaluable assistance in "encouraging" subjects to participate in the study. Appreciation is also extended to the more than 400 Education 200 students who volunteered to be subjects for this study. Without their cooperation there would have been no study.

Finally, I wish to express my heartfelt thanks to a very wise and beautiful woman, my wife Joyce. She unselfishly served in every aspect of the research as pretest subject, scorer, editor and typist. Her constant assistance and gentle encouragement made completion of this research a reality. Her concern for the quality of life of the people about her has made my tenure as a doctoral candidate thoroughly enjoyable.

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CHAPTER I

INTRODUCTION AND REVIEW OF THE LITERATURE

Statement of the Problem

The blind child has long been at a disadvantage when compared with his normally sighted counterpart with respect to the acquisition speed of printed material. Harris (1947) reports the median silent visual reading rate for sighted high school students at 251 words per minute (wpm). For blind high school students the mean braille reading rate is 90 wpm (Bixler, Foulke, Amster, Nolan, 1961). Recently two methods have come under experimentation that show some promise of enabling the blind to cover material at rates comparable to print readers.

One has been the introduction of telegraphic braille materials by Martin and Alonso (1967). In this method the traditional or non-telegraphic presentation of braille material is reduced to its kernel or significant elements by eliminating extraneous content (unnecessary for comprehension) and restructuring the remaining material in the manner commonly found in telegrams. This method is yet experimental and requires that each passage be

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The second method, also still only in the experimental stage, is that of time compression of recorded speech. This is a listening rather than reading method and has particular applicability to talking books and other recordings for the blind. Interest in time compressed speech began with a study by Miller and Licklider (1950) who conducted research on the comprehensibility of prerecorded words (not connected discourse). A manual switching arrangement made the systematic off-on interruption of the speech signal of each word possible. The investigators found that word intelligibility did not decrease until 50 percent of the speech signal was discarded.

Garvey (1953) surmised from this research that the time gap caused by the interruption of the speech signal could be eliminated thereby providing the same comprehensibility of signal in less time without distortion in pitch. He constructed such a tape (of connected discourse) by manually discarding portions of the speech signal and splicing the remaining tape together. This resulted in time-compressed speech.

Since Garvey's pioneering research electromechanical equipment has been developed (Fairbanks, Everitt, & Jaeger, 1954) that compresses tapes to any desired number of words

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The use of such a process with the blind to shorten listening time for recorded materials was first recognized by Foulke, Amster, Nolan, & Bixler (1962). Shortly thereafter, an effort (Orr & Friedman, 1967, 1968; Orr, Friedman & Williams, 1965) was made to extend the application to education in general and to the broad area of human information processing.

The normal oral reading rate of professional readers is approximately 175 wpm. The work of Foulke, et al., (1962) has established that in the range from 275 to 325 wpm significant loss in comprehension of recorded time-compressed speech occurs. Listening rates of approximately 250 wpm would permit comparable rates of information intake between the sighted reader and the blind listener. Yet, significant disadvantages still present themselves. The advantages of previewing, scanning, overviewing or rapid review do not lend themselves well to touch perception in braille and are not possible with recorded materials using present technology. However, if more rapid presentations of compressed speech without loss of comprehension were possible the blind listener might be permitted a second "reading" or time for note taking, etc., in the same space of time that one "reading" originally required.

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whether the decline in comprehensibility for faster rates of compressed speech is in part attributable to the diminished amount of time available to the listener for processing the information he is receiving. According to Foulke and Stricht (1967b, p. 19)

> The perception of speech entails the registration, encoding and storage of speech information, and these operations require time. When the word rate is too high, words cannot be processed as fast as they are received with the result that some of the words and their associated meanings are lost.

It may be useful to conceive of at least two factors in the comprehension of connected discourse: the intelligibility of individual words, and the meaningfulness of groups of words; that is, of phrases, sentences, and larger units in a passage. The serious loss in comprehension at compression rates exceeding approximately 275 wpm may be due, not so much to the loss in intelligibility of individual words, but to the failure of the listener to relate the larger semantic units of the material.

It is perhaps of relevance in this connection that in the electromechanical devices used for compressing speech, the normal pause times between phrases and sentences are also reduced. In addition, such "semantic processing" time is further reduced by the time eliminated by the speeding up of the words. It may be that by the reintroduction of some of the lost natural "pause" time in the form of

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arbitrary pause units, comprehension can be improved at the higher compression rates. The insertion of pause times of presumably effective length would undo only a small part of the gain achieved by time compression.

The resolution of this problem is of practical importance to work with the blind as the disparity in rate of reading between braille and print readers places the blind child at an educational disadvantage particularly in an integrated classroom setting. If in fact, a major portion of the loss of comprehension reported in studies of rapid speech is attributable to the limiting of natural pause time resulting from compression of recorded connected discourse, it may be possible to artificially replace pauses (i.e., add time) at strategic intervals thereby reclaiming the lost comprehension without significantly increasing the time required for compressed presentation.

Many areas of inquiry based on this assumption suggest themselves; however, the most basic of these deals with the establishment of a cause and effect relationship between pause addition and the comprehension of rapid speech.

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Review of the Literature[1]

Speech Compression Methods

An obvious way to produce rapid speech is to speak faster (Calearo & Lazzaroni, 1957; Enc & Stoluran, 1960; Fergen, 1955; Harwood, 1955; Nelson, 1948). This method is less than satisfactory since it "introduces undesired changes in vocal inflection and fluctuations in rate, and (has) a relatively low upper limit ..." (Foulke & Stricht, 1967b, p. 3.)

Another method which requires little in the way of special equipment is the "speed changing" procedure in which the playback speed is greater than the original recording speed. However, a rise in the pitch (frequency) is introduced which is directly proportional to the increase in speed. Intelligibility falls off rapidly; for example, at 33% compression[2] obtained by speed changing, there is a 40%

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[1]For an exhaustive review of the literature the reader is directed to Foulke's (1967) invaluable volume on which the writer relied heavily in the formulation of this review.

[2]Studies of compressed speech usually report either a compression ratio or a word per minute (wpm) rate. Compression ratio refers to the savings in time of the original recording; thus, a 30% ratio would indicate that 30% of the original recording time was saved. Because the ratio is dependent not only on compression procedures, but also on original wpm rate, Foulke (1967b, p. 6) advocates reporting the final wpm rate rather than a ratio. Miron and Brown (1968) believe that syllables per minute would be an even more accurate indication of rate.

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loss of intelligibility (Foulke, 1968, p. 6). Changing the rate of speech by the speed changing method has been the subject of several pieces of research (Barabasz, 1968; Foulke, 1966a; Garvey, 1953; McLain, 1962).

The sampling technique is probably the most widely advocated method for producing rapid speech as it is free from distortion found in the "speed changing method." The sampling method reduces the original recording time by removing tiny (20-100 milliseconds) bits of words and/or pauses between words. If a computer is used, both the interval removed and the frequency of these removals can be varied within a single selection, over a wide range, thus insuring that important components are not sampled out. However, the computer technique is enormously expensive, involving the use of both a digital and an analog computer (Scott, 1965).

Feasibility of the sampling method was determined by Miller and Licklider (1950) when they demonstrated speech redundancy by removing parts of the speech signal. Their experiment illustrated that monosyllabic words did not drop below 90% of intelligibility until 50% of the speech signal was removed.

Recognizing the significance of this finding, Garvey (1953) removed the segments of interrupted speech signal,

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spliced the tape together again and the result was time-compressed intelligible speech.

An electromechanical device, the Tempo-Regulator manufactured by Telefonbau und Normalzeit, Frankfurt-am-Main, Germany, is commonly used in the sampling method. Although the equipment is quite expensive, it is less expensive than the process using computers. The device makes use of recording heads mounted on a cylinder, which rotates as the tape passes over it. Consequently, the recording heads make contact with the tape only at preselected intervals and for preselected durations. Once selected, the sampling frequency and intervals remain constant, resulting in random deletions. Because the sampling technique does not change the frequency of the playback speed, there is no distortion in pitch. Detailed explanation of a similar device is found in Fairbanks, Everitt, and Jaeger (1954).

One other method, according to Foulke (1968), is that of "harmonic compression." The speech signal is fed through a filter, which reduces it to half its original frequency. The signal can then be played back at twice its original rate, without a change in pitch and without any loss of original signal content. The device is apparently under construction, as no studies have been reported using the technique.

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Intelligibility of Time-Compressed Speech

Intelligibility, one method of evaluating time-compressed speech, may be defined as the recognition of short, discrete passages (usually isolated words). A number of tests have been devised to test intelligibility, the most widely used is the "articulation test" (Foulke, 1967, p. 7) in which the listener is asked to write down the words or phrases he hears as they are presented.

Other intelligibility measures are more psychologically oriented. Foulke and Stricht, (1967b, p. 7-8) report two such measures: one, disjunctive reaction time in which reduced intelligibility resulted in increased reaction time required on the part of the listener for making correct identification (Foulke, 1965); and two, threshold intensity in which the relationship between compression and the minimum threshold intensity needed for comprehension is explored (Calearo & Lazzaroni, 1957). More specifically, the investigators established a minimum intensity required for words to be intelligible when recorded at various levels of compression. Changes in threshold intensity, "that intensity at which some percent of a list of words (e.g., 50%) are correctly identified," (Foulke & Stricht, 1967b, p. 7) would indicate an alteration of intelligibility.

A number of studies (Garvey, 1953; Kurtzrock, 1957) have demonstrated that there is little intelligibility loss

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even at high word rates (when the sampling technique has been used). Unfortunately, there appears to be little or no correlation between intelligibility of single words and comprehension of compressed connected discourse other than the obvious statement that some minimum intelligibility level would be required for any comprehension to occur.

To explore the relation between word intelligibility and comprehension of larger units, Foulke (1966b) deliberately introduced degrees of distortion (by using a combination of speed changing and sampling techniques), and found no significant relationships between the amount of distortion introduced and the actual comprehension. In another study which explored the distortion of word intelligibility by speeding the rate of playback presentation, Foulke (1966a) found no significant differences in comprehension between material presented by sampling technique and the same material presented by the speed changing technique (which is accomplished by changing the rate of playback speed of a recording). In both studies, it was found that the only variable which exerted influence on comprehension was the wpm rate.

Comprehension of Time-Compressed Speech

The measurement of comprehension is usually accomplished by a short-answer or multiple-choice objective

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test. Selection of listening passages and construction of tests must consider a number of factors such as: reading and interest levels; contamination (where variations in previous knowledge account for differences in "comprehension" scores); validity and reliability. Most standardized reading tests are unquestionably contaminated or are of doubtful reliability when used as tests of listening. One of the often used published tests is the listening sub-test of the Sequential Tests of Educational Progress (STEP). Many researchers, however, have developed their own tests (Foulke, 1964; Foulke, et al., 1962; McLain, 1962).

Rate.--Perhaps the most widely quoted study in regard to rate and comprehension is Foulke's (1966b) rate study using 360 college students. A selection was presented at 12 rates, in increments of 25 wpm from 125 to 400 wpm. The results indicate that the relationship between rate and comprehension is not a linear one; specifically, comprehension was reasonably good until 250 wpm, where it began to fall off rapidly. At 275 wpm the comprehension loss was significant. These findings are in accord with other studies (Bixler, et al., 1961; Fairbanks, Guttman, & Miron, 1957a) which demonstrate good comprehension up to about 275-300 wpm, at which point comprehensibility begins to decline rapidly. The wpm rate at which there is no loss

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in comprehension varies from S to S as a function of variables relating to the listener and to the type of material used (i.e., literary or scientific).

Listener Variables

Sex.--No sex differences in comprehension for compression rates up to 475 wpm have been found (Foulke & Stricht, 1967b; Orr, et al., 1965).

Age and Educational Experience.--Fergen (1954) and Wood (1965) have found a positive relationship between school grade and comprehension of compressed speech. Woodcock and Clark (1968) also found a relationship between listener age and comprehension in elementary school children. Their data suggest it may not be advantageous to introduce accelerated speech in elementary grades.

Foulke and Stricht (1967b, p. 15) note that while high school and college students have been used in comprehension studies, the relationships between age and other variables and comprehension have not been explored. They further suggest that studies of intelligibility (Calearo & Lazzaroni, 1957) with aged Ss lead one to suspect that comprehension is affected by changes in the central nervous system which accompany old age.

Intelligence.--Foulke and Stricht (1967b, p. 15-16) state that there is not sufficient evidence in regard to

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children's I.Q. and listening comprehension to suggest a relationship. However, studies with adults (Fairbanks, et al., 1957a, 1957b; Nelson, 1948) have demonstrated a positive correlation between intelligence and ability to comprehend time-compressed speech.

Stricht (1968) found a highly significant relationship between mental aptitude (as measured by the Armed Forces Qualification Test) and the ability to comprehend compressed speech although he did not find an interaction between rate and intelligence. That is, aptitude did not appear to play a greater role in comprehension of compressed speech than it did in comprehension of normal speech.

Visual Status.--Because the blind use their hearing far more than do the sighted, one might expect that their listening comprehension would be superior to that of the sighted. In addition to this "use hypothesis," it might also be assumed that lack of visual distractions should serve to increase listening attention and comprehension (Foulke & Stricht, 1967b, p. 16). Foulke (1964) found evidence that blind Ss were superior in listening comprehension.

However, conflicting evidence has been reported, both in regard to comprehension of compressed speech (Bellamy, 1966) and in comprehension of speech presented at normal rates (Hartlage, 1963). Bellamy, in a study

utilizing blind and sighted Ss who were exposed to a passage of compressed material on which they were tested using a multiple-choice examination, found no difference in the comprehension abilities of the blind and sighted. Hartlage's study was similar to Bellamy's except that he used only uncompressed material. "It was concluded that with the age, sex and intelligence variables controlled, no differences in listening comprehension existed between the blind and sighted groups." (Hartlage, 1963 p. 4)

Present Reading Rate.—Orr, et al., (1965) tested the hypothesis that fast readers would be able to comprehend time-compressed speech better than slow readers and found a significant positive correlation between reading rate and comprehension of compressed speech. Both experiments also determined that training in use of compressed speech improved reading rate. On the other hand, Nelson (1948) found no correlation between reading rate and comprehension of accelerated speech.

"Cognitive Style" or Ability Patterns.—Two studies have attempted to discover individual differences in comprehension of compressed speech as a function of Ss' characteristic cognitive approaches or abilities. Friedman and Orr (in Foulke, 1967, p. 73-74) noted that better listeners tended to hear phrases or sentences rather than individual

words. A battery of aptitude and information tests showed a surprising inverse relationship between specific memory skills and listening ability, "suggesting that excessive attention to detail is probably antithetical to good listening in these conditions" (p. 74).

Friedman and Johnson (1968) ran a factor analysis on a battery of 10 reading and listening tests to discover which (if any) could be used as predictors of success in comprehending compressed speech. The Best Trend Name Test, which required Ss to infer a class relationship in a set of objects, showed increasing correlation with comprehension as wpm increased. The authors concluded that this test defined an ability important to comprehension of compressed speech which is the ability to make "rapid comparison of alternative responses to find one which is most similar to a stimulus" (p. 213). This ability could account for differences between individuals in comprehending compressed speech.

Stimulus Variables

The first class of stimulus variables has to do with the technical aspect of producing the auditory signal. This class would include the method of compression, frequency and intervals of sampling, and final wpm rate-- all of which have been discussed in previous sections. It would also

include such considerations as signal/noise ratio. Miron and Brown (1968) write of the high level of background noise in comparison with the signal strength in the Fairbanks device. This is technically referred to as the S/N (signal/noise) ratio. It should be noted that factors such as this are seldom totally accounted for in studies on compressed speech, and many studies (especially the early ones) used recordings which were poor in quality.

A second set of variables deals with the message itself--its content and readability. In regard to readability, most studies at least consider the relationship to comprehension with phrases like "the material was judged suitable for the grade levels tested." Many studies use either the Flesch (1948) or the Dale-Chall (1948) formulas for estimating the difficulty of reading passages. However, Miron and Brown (1968) observed that readability levels can be measured throughout any message and can be seen to vary. Hence, a total readability index may not reflect the actual readability of individual portions of a selection. Another speculation would be that readability levels of test passages might best be kept well below Ss' ceiling reading level in order to control for variance attributable to complexity of the material.

Bixler, et al., (1961) clearly demonstrated that the content of a selection affects comprehension, both at

normal and at accelerated rates. The study compared comprehension of a literary selection and a scientific selection, presented at several wpm rates. Comprehension of literary material was found to be higher throughout, and there was a significant interaction with respect to comprehension between complexity of material and compression rate.

Improving Listening Comprehension Through Training

From the preceding discussion, it will be noted that comprehension declines sharply with only moderate acceleration in word rate after attaining about 275 wpm, and that informational or explanatory type reading seems to be more seriously affected than literary material. Several studies have attempted to reduce this comprehension loss through training of listening skills. Foulke (1964) tested several training procedures for increasing comprehension of time-compressed speech. He compared training using a gradual increase in rate with training using a constant high rate; he also tested whether frequent question-and-answer periods could enhance comprehension. No evidence was found to support the superiority of one training method over the other or to support the superiority in comprehension of trained Ss over naive Ss. In fact, no evidence was found for a "practice effect" commonly noticed among naive listeners upon their first exposure to compressed speech. There are,

however, serious limitations to Foulke's study. He used very small groups (7-11 members). In addition, he noted that the selection on which Ss were trained may have been too short to accomplish its purpose, and he acknowledged that motivation had not been considered.

In a recent study Friedman and Orr (in Foulke, 1967, p. 69-75) report results that appear optimistic with regard to training. These researchers used college students as paid Ss, and further motivated them through bonuses for increased comprehension scores. This procedure resulted in significant gains for the experimental group. One group obtained almost 80% comprehension (based on comprehension at normal rate) of material presented at 425 wpm.

Results of an unpublished study by Nolan and Morris (1968) show that the deleterious effects of compression on comprehension may appear at wpm rates as low as 225 wpm when control Ss at 175 wpm are highly motivated. Blind Ss were rewarded with a box of candy for doing well. The findings of the study indicate that high S motivation produces better comprehension for 175 and 225 wpm rates, having a particularly beneficial effect upon the comprehension of uncompressed material (175 wpm).

One may conclude then, that training for improving the comprehensibility of rapid speech is feasible. The studies just reviewed suggest that simple exposure to accelerated speech is not sufficient for improvement however, and

that motivation must be considered an important aspect of the training program.

Retention

Foulke (1966c) apparently believed that retention of the material in a passage of compressed speech may vary as a function of compression rate. Perhaps comprehension as measured by a test immediately following presentation of the material may be a better indicator of retention over long time intervals for some compression rates than for others. To examine the effect compression had on the retention of rapid speech Foulke (1966c) compared retention among four experimental wpm rates (175, 225, 275, and 325 wpm) at intervals of 0 days (immediate recall), 7 days and 30 days. Foulke found that lower retention over time was a function of lower immediate recall (comprehension) and concluded that retention of accelerated material is not a special case. That is, retention is dependent upon original comprehension and therefore only indirectly effected over time by compression rate.

Other studies add support to this conclusion. Barabasz (1968) studied retention among college students and found no interaction between word rates and retention. These studies support the conclusion of McGoech and Irion (1952) that retention is generally a function of initial

learning and as such can be fostered by improving the learning aspects of S's first encounter with the subject matter.

Summary

The sampling method appears best for the comprehension of pre-recorded speech as no distortion in pitch of original recording results in playback at faster wpm rates.

Comprehension of compressed speech begins to decline sharply at approximately 275 wpm. This decline is due in part to both listener and stimulus related variables. Listener related variables which correlate with comprehension are: age and educational experience, reading ability, "cognitive listening style" and intelligence of the listener. Sex and visual status of the listener are not shown to be clearly related to comprehension. Stimulus related variables to be considered in comprehension are: rate of presentation (compression), method of compression, readability level of the passage used in compression and type of material used (i.e., scientific or literary style).

Improvement of comprehension through training of Ss' listening skills appears feasible. Retention of compressed material would be helped by such training as good retention over time appears to be a function of good initial comprehension.

CHAPTER II

METHODOLOGY

Hypotheses

The basic aim of this research was to determine whether the introduction of pauses in compressed connected discourse would reduce the loss in comprehension that usually occurs at high compression rates. It was hypothesized that this would occur. It also seemed reasonable to assume that long pauses, as opposed to short ones, would be more helpful to Ss exposed to high compression rates than to those exposed to lower compression rates. Pause times of 0, 1, 2, and 3 seconds were used at compression rates of 250, 300, and 350 wpm. Thus, it was assumed that at the slower rate of 250 wpm a 1 second pause would facilitate comprehension as effectively as a 3 second pause, whereas at 350 wpm a 3 second pause would be more helpful to a listener than a 1 second pause.

An analysis of variance (ANOVA) design was utilized. In terms of this design the following hypotheses were tested.

Hypothesis I.—The main effect for pause time will be statistically significant, greater comprehension being associated with the presence and the magnitude of pause time.

Hypothesis II.—The interaction effect of pause time and compression rate will be statistically significant, greater comprehension being associated with longer pause times at higher rates of compression.

Common sense would suggest, perhaps, that the greater the pause time, within reasonable limits, the better the comprehension. However, exploratory pre-testing suggested that the length of the pauses would not be a crucial variable; that comprehension would vary only according to the presence or absence of some pause time. In pre-testing, the 3 second interval seemed to be perceived by Ss as a long delay, particularly at high compression rates. It seemed plausible to speculate that relatively long pauses might encourage irrelevant ideation which would represent a distraction from the task at hand. The ANOVA design permitted exploration of whether or not these assumptions may be tenable.

Design

A two-way fixed effect ANOVA design utilizing compression rates of 250, 300, and 350 wpm and pause time

additions of 0, 1, 2, and 3 seconds were used to test the hypotheses. Ss were randomly assigned to the 12 treatments represented in Table 1.

TABLE 1

DESIGN OF THE STUDY

Compression Rate	Pause Times			
	0 sec.	1 sec.	2 sec.	3 sec.
250 wpm	N=29	29	29	29
300 wpm	29	29	29	29
350 wpm	29	29	29	29

Total N=348

The compression rates were chosen to span those rates where, according to past research, comprehension drops off most rapidly as a function of increased rate. Selection of these rates would serve to maximize the possibility of observing an interaction effect.

The selection of pause time intervals of 1, 2, and 3 seconds duration was somewhat arbitrary as no evidence could be found in the literature as to optimal pause length for listening behavior. Some attempt at reducing the arbitrary nature of this decision was made, however.

Preliminary exploratory testing showed that pauses greater than 3 seconds in duration, when added to recorded material compressed at a rate of 350 wpm were perceived as being too long a delay in material presentation. Pause intervals of less than 1 second duration, on the other hand, were difficult to perceive at the slowest rate used (250 wpm).

Subjects

Three hundred and forty-eight students enrolled in Education 200, The Individual and the School, spring quarter, 1969, at Michigan State University were used as Ss. Ss were drawn from 14 discussion sections of the course and were given credit toward their final grade for participation. Participation was somewhat voluntary in that Ss could choose from a number of alternatives (i.e., one page book or article critique, 10 minute class presentation, etc.) all yielding the same point-credit value toward the final grade.

The decision to use sighted rather than blind Ss was based upon several considerations. First, the evidence found in the literature (Bellamy, 1966; Foulke, 1964; Hartlage, 1963) does not clearly establish a listening superiority for either group. Secondly, a hypothesis concerned with the nature of listening with respect to compressed speech was being investigated. Results of a

study of this type while having application to work with the blind are not specific to blindness. The third consideration was one of the availability of Ss. Three hundred and forty-eight Ss were required to complete the study. The problems concerned with locating, transporting and testing of blind Ss in this large a number were considered too great a burden upon the time and funds available for completion of this research.

Ss were randomly assigned to treatments in order of their arrival at the testing site. Some attempt was made however to balance the number of male and female Ss assigned to each treatment. This was thought desirable as the number of males and females volunteering to be Ss for the study (141 males and 207 females) was somewhat disproportionate. Although no listening differences among sexes were reported in the previous chapter it was thought that the nature of the test passage used (i.e., action oriented story about warring tribes) might hold more appeal for boys than for girls. It seemed prudent therefore, to have an equal or near equal representation of males within each treatment group. For a detailed explanation of how this was accomplished, consult the Procedure section of this chapter.

Group characteristics of Ss by treatment condition are summarized in Table 2. For a listing of individual Ss by treatment condition see Appendix A.

TABLE 2

SEX, MEAN AGE AND GRADE OF PARTICIPATING SUBJECTS BY TREATMENT

Treatment		X Age*	X Grade**	Sex	
wpm	Pause			M	F
250	0	20	3	10	19
250	1	20	3	13	16
250	2	20	3	13	16
250	3	21	3	13	16
300	0	20	2	6	23
300	1	20	3	12	17
300	2	20	3	13	16
300	3	20	3	12	17
350	0	20	3	13	16
350	1	20	3	13	16
350	2	20	3	13	16
350	3	20	3	10	19

*All means rounded to nearest year.

**3 signifies college junior, 2 signifies college sophomore.

Materials

A fictional story about warring tribes in Africa was adapted with permission of the authors (Martin &

Alonso, 1967) to serve as the test selection. The passage contained 1,319 words and had a readability level as measured by the Dale-Chall Readability Formula (1948) of from 7th to 8th grade (Martin & Alonso, 1967). Some modification of the story was required as several of the important names used in the original version were considered to be inappropriate as names of African localities, the specified setting of the story. (i.e., King Lester of Yam was modified to King Matumba of Rozique and King Koko of Mambo was modified to King Koko of Kuwari.) The story remained essentially the same however, with respect to sequence of events, outcomes, etc. The complete text is found in Appendix B.

Using services provided by the Center for Rate Controlled Recordings in Louisville, Kentucky, the story was recorded on tape at 7 1/2 ips by a female professional reader at a rate of 156 wpm. The story was then compressed employing the sampling method on The Tempo Regulator utilizing a discard interval of 20 milliseconds to rates of 250, 300, and 350 wpm respectively. Directions for testing were also recorded on each tape by the same professional reader at a rate of 156 wpm. Directions were given first at this rate. In order to permit Ss to experience rapid speech prior to the actual test passage, the directions were repeated at the same compression rate

assigned to the story. (i.e., If the test passage was to be compressed at the 300 wpm rate, the directions were repeated at the 300 wpm rate.) It was hoped that this exposure to compressed material previously heard at the rate of 156 wpm would have a positive motivating effect upon Ss as they would in all likelihood find it highly comprehensible, thereby establishing the set that the remaining materials would be easily understood. Directions for testing are presented in Appendix B.

Pause times of 1, 2, and 3 seconds' duration were added at previously determined fixed intervals (common to all tapes) within the story by a manual cut and splice procedure. This process required a tape recorder that had been modified to permit the tape to remain engaged to the playback head when the recorder was in the stop mode. The playback head cover was removed to permit exposure of the tape path and playback head. This was necessary since finding the exact point at which pause time was to be added required a manual movement of the tape back and forth over the playback head until no sound was audible. At that precise point the tape was appropriately marked using a grease pencil, removed from the machine, cut, and the appropriate amount of clean tape was then added by splicing (7 1/2 inches of clean tape constitutes one second in time at the recording speed of 7 1/2 ips). Once returned to the

machine the splice was tested for accuracy of placement. Thirty cuts were made for each of the nine tapes assigned to the processing time treatments (See Table 1).

As no guidelines could be found in the literature governing pause time interval placement, a formula for placement of pauses had to be devised. Too frequent a placement of pauses might render them useless in integrating several different ideas that are best heard uninterrupted. On the other hand, a long interval between pauses might span many different ideas making integration of them difficult. By an inspection of the test story to observe the rapidity of the introduction of new ideas, it was finally decided that 30 pauses would represent a reasonable number. This meant that there would be approximately 44 words between each pause.

The actual location of a pause was determined by use of the following rules. If the 44 word unit terminated in the middle or first half of a sentence, (determined by total word count of the sentence in question) the pause time was placed at the end of the preceeding sentence. If the count terminated in the second half of the sentence the pause was added to the end of that sentence. Thirty pause points were thus located.

Pauses were placed between sentences in part to facilitate their placement since pause boundaries between

words are extremely difficult to locate using the manual method described earlier, and in part, because the end of a sentence would appear to be a logical place to provide extra time for information processing. Pause time placement points are presented in Appendix B.

The final taped materials consisted of 12 tapes, each tape containing the uncompressed directions for testing, immediately followed by the same directions compressed to the wpm rate assigned to that treatment condition, followed, after a 30 second pause, by the compressed test selection containing no pauses or 30 pauses varying in length according to the treatment condition (Refer to Table 1). Pause time was not added to the compressed directions for any of the 12 treatment conditions.

The total time required to present the instructions and test selections is recorded in Table 3.

The 38 item, four-alternative multiple-choice test was used to derive a comprehension score for each S. The comprehension score was determined as being the total number of correct answers each S obtained on the test. The test was based on the important events, setting and people in the story and was designed by its authors (Martin & Alonso, 1967) to be an index of the comprehension and retention of factual type material.

TABLE 3

TIME REQUIRED TO PRESENT AUDIO TESTING MATERIALS

Treatment		Time Required*		
Compression Rate	Pause Time Interval in Seconds	Uncompressed Directions	Compressed Directions	Test Selection
250 wpm	0	1 m 21 s	34 s	5 m 13 s
250 wpm	1	1 m 21 s	34 s	5 m 43 s
250 wpm	2	1 m 21 s	34 s	6 m 13 s
250 wpm	3	1 m 21 s	34 s	6 m 43 s
300 wpm	0	1 m 21 s	29 s	4 m 25 s
300 wpm	1	1 m 21 s	29 s	4 m 55 s
300 wpm	2	1 m 21 s	29 s	5 m 25 s
300 wpm	3	1 m 21 s	29 s	5 m 55 s
350 wpm	0	1 m 21 s	24 s	3 m 43 s
350 wpm	1	1 m 21 s	24 s	4 m 13 s
350 wpm	2	1 m 21 s	24 s	4 m 43 s
350 wpm	3	1 m 21 s	24 s	5 m 13 s

*Times are rounded out to nearest second.

To determine if high comprehension scores could be obtained on the basis of chance alone, E pretested the test instrument on five Ss instructing them to try answering the questions without benefit of having heard or read the test passage. Scores obtained in this manner ranged from 17 to 23 points. It appeared that, to a limited degree, Ss were able to reconstruct some of the story utilizing information unwittingly supplied by the test items. A major clue seemed to be provided by the order of the items which paralleled the order of events in the story. To remedy this situation the following changes were made. First, the alternatives to many of the questions were rewritten in such a manner as to suggest several possible story lines, thus making detection of the true story line more difficult. Second, the test items in the final printed test booklets were ordered according to a table of random numbers. This randomization further confused the story line.

Five new pretest Ss were then given the revised test without benefit of having heard or read the story. Their scores ranged from a low of 10 points to a high of 14 points, an appreciable reduction from the earlier pretest results. The comprehension scores of five additional Ss pretesting the instrument after having read the test selection ranged from 32 to 35 points. The selection was read rather than listened to since the finished compressed materials were not available from the Center for

Rate Controlled Recordings until four days prior to the beginning of the experiment. All but four of the pretest Ss were test-wise graduate teaching assistants in educational psychology. These pretesting results suggest that the final form of the test was a valid measure of Ss' knowledge of those elements in the contents of the passage that had been selected for inclusion in the test. The test instrument is presented in Appendix C.

The reliabilities of the test for each treatment were determined using the Kuder Richardson formula 20. These reliabilities are reported in Table 4. The adequacies of these reliabilities are discussed in Chapter III.

TABLE 4

COMPREHENSION TEST RELIABILITY DATA BY TREATMENT CONDITIONS*

Pause Time in Seconds	Compression Rate		
	250 wpm	300 wpm	350 wpm
0	.65	.49	.75
1	.74	.61	.78
2	.83	.81	.81
3	.37	.70	.74
Across Treatment Reliability		.75	

*Kuder Richardson Formula 20

Procedure

The Wells Hall Language Laboratory at Michigan State University which seats a maximum of 236 persons in individual booths was used as the testing site.

A short example of compressed speech was used by E in classes from which the sample was drawn to motivate potential Ss to participate in the study. Ss who volunteered were required to sign up for one of five testing dates which were chosen primarily on the basis of the availability of the language laboratory. The dates chosen were Thursday, April 24, at 4:10 P.M., Friday, April 25, at 8:00 A.M., 3:00 P.M., and 4:10 P.M., and Monday, April 28, at 12:40 P.M. In order to control for time factor variables with respect to different testing dates and times, all 12 treatments of the study were administered simultaneously at each testing date, Ss being assigned randomly to treatment conditions in order of their arrival at the test site.

This control was made possible by playing the 12 treatment tapes on 12 master machines which were programmed to play through a maximum of 19 booths each. A master chart of tape-booth combinations permitted the ordering of test booklets by treatment and booth numbers in consecutive sets of treatments one through 12 to insure that each treatment received the same or nearly the same number of

Ss for that test period. (i.e., First arriving S to treatment one, next to treatment two, etc., through 12, then repeat.)

It was reasoned that testing in the morning might be a different situation than testing in the afternoon with respect to Ss' alertness, motivation, etc. The day of testing might also influence listening ability. It was therefore necessary to control for the variable effect of testing time upon listening ability by having each test period equally represented across all treatment conditions.

Because some Ss "dropped out" of the experiment or rescheduled their testing date to better suit their needs, the total number of Ss being tested at any one time was not always a multiple of 12. This meant that some treatments contained one S more than others. The extra S was removed by randomly selecting out one S from that treatment. The process was not totally random however, as only females were chosen at random. This modification was necessary because the already disproportionate male-female ratio (See Table 2) would have been further increased had males been randomly removed from treatments containing unequal numbers of Ss at any given test date. Table 5 contains the breakdown of Ss by test dates.

As Ss arrived at the laboratory they were given

TABLE 5

SAMPLE DISTRIBUTION BY TESTING DATES*

Treatment		Thurs. Ap. 24	Fri. Ap. 25			Mon. Ap. 28	Total
wpm	Pause Time	4:10 PM	8:00 AM	3:00 PM	4:10 PM	12:40 PM	
250	0	13	3	3	5	5	29
250	1	13	3	3	5	5	29
250	2	13	3	3	5	5	29
250	3	13	3	3	5	5	29
300	0	13	3	3	5	5	29
300	1	13	3	3	5	5	29
300	2	13	3	3	5	5	29
300	3	13	3	3	5	5	29
350	0	13	3	3	5	5	29
350	1	13	3	3	5	5	29
350	2	13	3	3	5	5	29
350	3	13	3	3	5	5	29
Totals		156	36	36	60	60	348

*Unequal cells were randomly reduced to equal numbers shown above.

a test booklet which had a booth number assignment and corresponding number recorded on the front cover. An answer sheet which had been previously coded to match the test booklet booth-treatment numbers was placed in the test booklet with one edge protruding from the cover. A scoring pencil was also provided. Ss were directed to proceed to the proper booth and complete the information called for on the cover of the booklet. They were further instructed not to open the booklet until directed to do so. Proctors were stationed throughout the laboratory to insure correct seating and following of directions. After having been seated on the basis of the chance order of their arrival Ss were next informed via the public address system to slip out the answer sheet from the test booklet by pulling on the exposed corner and complete the information requested. Ss were next requested to compare the coding on the answer sheet with that of the test booklet and report any discrepencies. They were next requested to compare the booth number assignment on the test booklet with that of the booth number in which they were seated and report any discrepencies. Finally, Ss were familiarized with the operation of the volume adjustment knob in each booth and cautioned not to touch any other equipment as each booth had been previously cued for the test. Ss were requested to put on

their earphones and adjust the volume rate while E counted. Any problems were registered by a raised hand and immediately remedied.

At this point all 12 master machines were placed in operation and Ss heard the instructions at normal and compressed speeds. The 30 second pause between the directions and the test selection permitted a time boundary in which to stop the machines as the three compression rates required slightly different amounts of time for completion. E asked for any equipment problems to be made known. There were none. Ss were informed that they would be completing the listening selection at different intervals and therefore need not be concerned if others had finished before they had. The test selection was then played. At the completion of the selection, Ss were informed by recorded message to begin the test. The last item in the test booklet was followed by this printed instruction, "Please place your answer sheet in your test booklet and return it to the proctor. This will be your record of attendance. THANK YOU FOR YOUR COOPERATION." The proctors checked to see that all test items and all information requested were completed. Ss were then free to leave. In all cases the total time was less than 50 minutes.

CHAPTER III

FINDINGS AND DISCUSSION

Findings Regarding the Major Hypotheses

It was hypothesized (a) that the addition of pause time to a passage of compressed speech would result in improved comprehension scores, and (b) that comprehension scores would be a joint function of compression rate and length of pause time, the higher the compression rate the longer the pause time required for maximal comprehension.

In the analysis of variance design utilized, the first hypothesis was tested by the main effect for pause time, the second by the interaction of pause time and compression rate. In Table 6 are presented the means and standard deviations for the 12 treatment conditions. It is apparent from inspection of the means that, within each wpm compression rate, the effect of added pause time is negligible. While the trend of the means for the compression rate of 300 wpm is in the predicted direction, the opposite is true for the 350 wpm rate. If the trends are accepted as depicting the true state of affairs, it could be concluded that at the highest compression rate pauses

have, not an enhancing, but a deleterious effect on performance.

TABLE 6

MEANS AND STANDARD DEVIATIONS FOR COMPREHENSION SCORES BY TREATMENT CONDITIONS

Compression Rate	Pause Time							
	0 seconds		1 second		2 seconds		3 seconds	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
250 wpm	32.41	3.34	30.31	4.35	31.28	5.01	32.79	2.44
300 wpm	29.03	3.26	31.28	3.35	30.03	5.05	32.03	3.66
350 wpm	29.83	4.49	27.90	4.95	27.83	5.43	28.86	4.61

However, the results of the analysis of variance presented in Table 7 indicate that these relationships are not significant. The F ratios for both the main effect of pause time and the interaction term (compression rate x pause time) are not statistically significant. Thus, neither of the hypotheses is supported; under the conditions of this experiment the addition of pauses failed to significantly improve comprehension of compressed materials.

In the remainder of this chapter various explanations for these negative findings will be explored.

TABLE 7

ANALYSIS OF VARIANCE OF COMPREHENSION TEST SCORES

Source	SS	df.	MS	F
Compression Rate (C)	570.764	2	285.3822	15.7688*
Pause Time T (P)	126.023	3	42.0077	2.3211
Interaction PxC	215.236	6	35.8726	1.9821
Within (error)	6080.897	336	18.0979	
Total	6992.920	347	20.1525	

*P<.01

Discussion

Relationship to Previous Studies Relating Compression Rate to Comprehension

One check on the adequacy of the experimental procedures used in this study is to compare the findings on loss of comprehension as a function of increasing compression rate with the findings of previous research.

The research findings reviewed in Chapter I (Bixler, et al., 1961; Fairbanks, et al., 1957a; Foulke, 1966b; Foulke, et al., 1962) indicate that when one systematically increases the wpm rate of recorded material from the average oral reading base rate of 175 wpm, the first significant

loss of comprehension is found to occur at approximately 275 wpm ± 25 wpm. A range rather than an exact wpm rate is stated since the exact compression rate at which the loss occurs is dependent upon the type of material used (i.e., scientific or literary style), Ss with whom it is used (i.e., elementary school, senior high, etc.), and the particular research quoted.

This issue is of particular relevance because neither the passage used nor, consequently, the test employed in this study had been used in compressed speech research. If, in this study, the usual decrement in comprehension with increasing compresssion rate did not appear some doubt would be cast on the adequacy of the experimental conditions.

A test for the significance of the effect of compression rate on comprehension is provided by the analysis of variance data. In Table 7 it is apparent that this relationship is significant. The F ratio for the main effect of compression is significant at the .01 level. Thus, this study replicates previous findings indicating that comprehension is significantly reduced at wpm rates in the range from 250 to 350.

The significant main effect for compression was subjected to Tukey's Test for individual comparisons to determine which of the compression rates (250, 300, and

350 wpm) were significantly different. The results of this test displayed in Table 8 show that the comprehension scores derived from the 250 and 350 wpm rates were significantly different from one another as were the scores derived from the 300 and 350 wpm rates. In each case the difference favored greater comprehension of the material at the slower rate.

TABLE 8

TUKEY'S METHOD FOR MULTIPLE COMPARISONS PAIR WISE CONTRASTS BETWEEN ROW MEANS *

	250 wpm	300 wpm	350 wpm
250 wpm	___	1.1	3.1**
300 wpm		___	2.0**
350 wpm			___

*For compression rates of 250, 300, and 350 wpm comparisons of means of 31.7, 30.6, and 28.6, respectively.

**P<.05

While it has been demonstrated that there was a significant loss in comprehension at higher compression rates, it is also apparent from inspection of mean comprehension scores in Table 6, that these differences were not

large. For the usual condition in compressed speech research, without pauses (the first mean column in Table 6), the mean differences between scores at the lowest and highest rates is only 2.58 items on the test. It is apparent that this small difference reduces, although certainly does not eliminate, the possibility of interaction effects appearing between compression rate and pause time. Perhaps adding higher compression rates to the experimental design to produce more dramatic losses under the standard no-pause condition would permit pause time to become a significant variable. This question will be reconsidered in the discussions of other factors in following sections.

Test Ceiling

Another plausible explanation for the failure of pause time to improve comprehension would be that the test ceiling was too low. Were the comprehension scores of the non-pause aided treatments at high compression rates of such magnitude that it would be difficult to get significant improvement by using pauses? It can be seen in Table 9 that the distributions of scores are not truncated by the test ceiling. That is, almost all Ss in all of the groups could have secured higher scores. There was the possibility that the mean scores could have improved if pauses had

TABLE 9

COMPREHENSION TEST SCORE FREQUENCY DISTRIBUTION

Raw Score	250 wpm				300 wpm				350 wpm				Total
	Pause Time				Pause Time				Pause Time				
	0*	1	2	3	0	1	2	3	0	1	2	3	
38		1		1				1					3
37	3	1	1	1		2	2	2	1			1	14
36	2	1	2	2		1	2	1	1				12
35	3	2	5	1	1	3	2	3	3	1			24
34	3	1	4	7		2	4	4	3	1	3	3	35
33	7	1	1	5	4	2	1	4	1	3	3	3	35
32	2	5	5	4	2	4	2	3		3	3	2	35
31	3	1	2	3	3	2	2	3	3	3	2	3	30
30		6	3	1	4	5	1	2	4	2	3	4	35
29	1	4		3	3	2	1	2	3	2	3	1	25
28	2	1		1	3	3	3	1	5	2	2	1	24
27		1	2		3	1	2			1	1	1	12
26	2		2		2		2	1	1	2	1	4	17
25	1	2			1	1	2			3	1	1	12
24			1		2	1		1	1	2		2	10
23							1	1	1		1	2	6
22										1	1		2
21					1					1	2		4
20		1					1		1	1			4
19		1							1				2
18							1				1		2
17											1		1
16													0
15											1	1	2
14													0
13										1			1
12			1										1

*N=29 for each treatment condition.

aided comprehension. Thus, this aspect of the test instrument's function cannot be held responsible for the negative findings.

Complexity of the Stimulus Passage

Reference has already been made to the fact that the test instrument and the test story produced the same compression-comprehension loss relationship as that generally found throughout the literature. This would suggest perhaps that the test materials were as appropriate or as inappropriate a measure of comprehensibility as materials and test instruments generally in use for this purpose. However, it might have been advantageous to use technical, scientific material instead of fictional material as the test base in order to decrease the number of high comprehension scores found in the 350 wpm rate, no-pause group. Perhaps with such technical material the value of pauses with respect to comprehension would increase since full comprehension of such material might require a greater amount of, or more complex, associative activity than that required by story material.

Complexity of material is certainly a variable influencing comprehension of compressed speech (Bixler, et al., 1961). But, if one wishes to explore the relationship of pause addition to compression rate with respect to

comprehension the complexity of recorded material used must be such that if heard it can be understood. It was this rationale that led to the use of a fictional passage of sufficiently low complexity (7th to 8th grade reading level) as to be easily understood by college Ss as long as the material was clearly heard.

Thus, while it seemed appropriate to use fictional material for this study, this fact may be of relevance for interpretation of the results. It may well be that pauses would prove highly useful in material requiring more complex information processing activity.

Validity of the Measure of Comprehension

The test instrument used to measure comprehension should, also, accurately measure S's comprehension under normal conditions. That is, if S has heard and understood the story he should be able to correctly identify the appropriate answers to questions based on that story. Inability to answer questions correctly should be, in the main, a function of the rate of compression. Retention plays a role in S's ability to correctly identify answers to questions but this role is a minimal one since only short-term memory is required and the nature of a multiple-choice examination is such that it can aid in the recall

of material under immediate recall conditions.

As was mentioned in Chapter II, to determine if high scores could be gotten on the basis of chance alone, E pretested the final test instrument with five Ss instructing them to try answering the questions without benefit of having heard or read the test passage. The scores derived in this manner ranged from 10 to 14 points. The maximum score obtainable is 38 points. The comprehension scores of five additional Ss pretesting the instrument with benefit of having read the test selection ranged from 32 to 35 points. (See Chapter II for details of how determination of final test form was made.)

These data seem to support the notion that under conditions of no compression (i.e., average oral reading rate of approximately 175 wpm) the probability of Ss answering all or nearly all of the test items correctly is excellent. Thus it seems reasonable to assume that the test was a reasonably valid measure of comprehension and does not bear responsibility for the negative findings.

The Reliability of the Test

It is appropriate at this point to discuss the significance of the modest reliability (.75 for the total sample as measured by the Kuder-Richardson Formula 20)

reported for the test scores.

It will be noted in Table 4 that the majority of the reliability coefficients were close to this figure. Several were quite low: for example, the 250 wpm, 3 second pause treatment condition had the lowest reliability (.37). It is generally accepted that for comparison of experimental group means, reliabilities of the order of .75 are satisfactory. The few low reliabilities are not satisfactory, and their existence suggests the presence of random error in these scores. Low reliabilities in these few groups work against the finding of statistically significant differences between groups.

However, it is doubtful if the test reliability can be held accountable for the negative findings, because of the generally satisfactory reliabilities; the failure of the majority of treatment conditions with adequate reliabilities to generate statistically significant differences relating to pause time variations and the pause time compression rate interaction; and, finally, because of the fact that the test reliability was sufficient to produce, as predicted, the significant compression rate result.

The Appropriateness of the Compression Rates

As explained in Chapter II, the compression rates selected were chosen because previous research suggested

that in the range from 250 to 350, comprehension drops sharply. Rates of 375 and 400 were rejected because in listening to other material at these rates, E felt that intelligibility was so severly reduced that the motivation of the experimental Ss might be seriously disturbed. However, E was not able to listen to the experimental passage at 400 wpm leaving open the possibility that, because of superior recording equipment, or reader clarity, this passage might have been more intelligible at higher speeds. The smallness of the loss in comprehension for the 350 wpm, no-pause treatment was disappointing. However, there is some internal evidence suggesting that extending the range to 400 wpm would not have changed the general nature of the finding. It is apparent in the distributions of 350 wpm in Table 9 that, at this highest compression rate, the introduction of pauses had little beneficial effect. What trend there was in comprehension scores would suggest, instead, that in some way the pauses became a negative factor as compression rate increased. While these trends cannot be regarded as significant, it is at least apparent that there is no trend suggesting that pause times are increasingly helpful as compression rates increase, and, hence no reason to believe that adding a 400 wpm rate would have strengthened the study.

Role of Subject Motivation

Another question worthy of some consideration deals with the role played by motivation in the comprehension of rapid speech. Was it possible that a lack of motivation on the part of Ss assigned to the pause-added treatments was responsible for the lack of significantly better comprehension score gains attributable to pause addition?

Results of an unpublished study by Nolan and Morris (1968) show that the deleterious effects of compression on comprehension may appear at wpm rates as low as 225 when control Ss at 175 wpm are highly motivated. Failure in past research to find differences in comprehension between normal speaking rates and a rate of 225 wpm is explained by Nolan and Morris as due to needlessly low scores for both groups, the effect of which would be to decrease differences between groups. Conversely, they argue that high motivation should increase the differences between groups exposed to different compression rates.

If this effect applies also to the higher compression rates used in this study, then it could be argued that optimum motivation should have created the best conditions for demonstrating differences between the sub-groups used in this study.

Research by Friedman and Orr (in Foulke, 1967, p. 69-75,) reviewed earlier in this text, also reported a significant

gain in comprehension attributable to high S motivation. This fact may account for the relatively small losses in comprehension at the higher compression rates in this study, a factor which, as suggested earlier might work against the appearance of significant group differences. This would be a plausible explanation if, in fact, motivation was high for Ss used.

It was the opinion of this investigator and his co-workers that Ss manifested evidence of high motivation prior, during and after testing. Several weeks previous to testing, a short example of compressed speech had been used in classes from which the sample was drawn to motivate potential Ss toward participation in the study. All the classes (14) appeared very interested in the project as evidenced by the manner of questions asked which were directed at exploring the methods and uses of compression. Ss' behavior immediately prior to testing was characterized by extreme inquisitiveness and general insistence on being informed of group and individual results after completion of the experiment.

Attention to directions during testing was extremely conscientious as evidenced by every S's completion of all test items. Indeed, Ss were so interested in their test results that many requested feedback on particular answers as they were returning their completed test booklets. It

was observed that a good many requests for immediate feedback centered upon one particular item dealing with the number of humans and animals that changed possession as a result of a battle between tribes spoken of in the fictional narration. It was discovered that none of the four alternatives assigned to the item was completely accurate. The item was subsequently removed from consideration during the scoring operation.

For several weeks after the experiment the graduate assistant instructors in charge of portions of the sample frequently inquired as to when results would be known as many of their students who served as Ss had requested their performance scores.

It would appear from this evidence that a condition of high motivation on the part of Ss existed during the testing phase of the experiment. One can conclude that the benefits for comprehension attributed to motivation by Nolan in all probability had a positive influence upon the measures of comprehension obtained in this research and that pause-added treatments were not excepted from this benefit.

Thus, the factor of high S motivation may have, by minimizing the magnitude of differences in comprehension for different compression rates, reduced the chance of demonstrating the value of adding pause times.

Training for Listening

Another factor to be considered in the discussion of why the addition of pauses to compressed speech did not result in a significant gain in comprehension scores is the training for listening factor.

In the study by Nolan and Morris (1968) reference was made to the fact that training in the art of listening to compressed speech has not been given enough consideration in studies aimed at determining or improving the comprehensibility of rapid speech. The question then is, was the fact that Ss were not exposed to training in listening techniques responsible for the negative results of this research?

In considering this question, two things must be kept in mind. One is that the absence of training for listening was standard across all groups used in the research. The possibility that some Ss may have been trained in listening techniques prior to participation in the research, at best a highly improbable possibility, was controlled for by random assignment of Ss to treatments. The exposure to compressed speech which all Ss experienced in the form of repeated directions prior to the presentation of the test selection (See Chapter II) cannot be construed as training (Foulke, 1964). A second consideration to be kept in mind is that the benefits of training and the methods best employed in training for better listening are at this time inconclusive (Foulke, 1964; Friedman & Orr in Foulke, 1967,

p. 69-75).

Training of a sort not previously investigated might have been helpful, however. That is, it might have been beneficial to train Ss in the productive use (with respect to comprehension) of the time breaks created by the addition of pauses to compressed material. This training might have insured some uniformity in the use made of pauses by Ss.

The Uses and Placement of Pauses

It becomes appropriate at this point to discuss the intended use of pause time as conceived by E and to speculate as to the uses made of such time by Ss. Addition of pause time was intended by E to be a period during which Ss' cognitive processes would be permitted time to make meaningful, by whatever process the mind requires, the information heard at a faster than normal rate.

The uses made of pause time by Ss may have been entirely different, however. Rather than having been utilized for information processing, the pause time may have been a period which permitted anxiety about the testing situation to develop or as a period during which irrelevant ideation could have intruded. Indeed, as no specific task was formally required of Ss by E during pause time an infinite range of possible uses may have been made of such

time by Ss.

It is conceivable, therefore, that some type of training or instruction in the use of pause time may have resulted in better gains in comprehension scores for the pause added treatments of this research.

A question which appears to be an adjunct to this discussion of pauses and their use is whether the placement of pauses within the compressed material was a factor contributing to the negative results of the research.

A post hoc investigation of the placement of pauses within the story was made by the writer to determine if proximity of pauses to information required by a particular test item had any effect upon the frequency of correct or incorrect responses recorded for that item across pause-time treatment conditions thereby increasing or decreasing comprehension scores. This investigation had to be abandoned when it became apparent that isolation of specific content required to answer a particular test item could not always be made, since events transpiring early in the story were necessary, in some cases, to the understanding and recall of subsequent events. A categorization of pause placement (e.g., immediate pause, near pause, etc.) for purposes of examining the effect of pauses upon frequency of correct item response seemed impossible.

Research by Friedman and Orr, (in Foulke, 1967, p. 73-74) which indicates that better listeners tend to hear phrases or sentences rather than words, gives rise to an interesting speculation with regard to the number of pauses used in this research. It is conceivable that the number of pauses used (30 pauses in a 1,319 word passage) might have fostered interruption of the comprehension of larger units of information and directed the listener's attention to specific phrases and words that were in immediate proximity to the pauses. This interruption might have been greatest at the fastest compression rate tested (350 wpm) as the pause time additions of 1, 2, and 3 seconds would psychologically appear as longer periods of time at this speed encouraging greater interruption of developing thoughts.

The Sex Make-up of the Sub-groups

As discussed in Chapter II, some attempt was made to keep the groups roughly even in sex. An analysis of mean scores for each treatment by sex was made by E to determine if any trend could be identified relating mean scores to sex. No such trend was found to occur. This is consistent with the literature on this subject reviewed in Chapter I.

The 300 wpm, 0 pause treatment was the only subgroup with a highly disproportionate number of males to females (see Table 2). The mean number of correct answers for males across all treatments was 30.78 as compared with 29.64 for females. This being the case, the inclusion of a greater number of females in this no-pause treatment should have helped lower the mean score making pauses more helpful to comprehension. Instead of minimizing the effect of pause addition across the 300 wpm treatments, the number of females in the group served to maximize this effect making a significant main effect for pause addition more likely. Therefore, sex differences cannot be held responsible for the negative findings of this research.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Summary

At present, the medium used most by blind children as a means of information gathering is braille. Recently the talking book record and tape recorded materials have come into use as a supplementary system to braille. The blind high school student reads braille at a rate of approximately 90 words per minute. Record or tape recorded materials, when recorded by professional readers, are presented at an average rate of approximately 175 wpm. In contrast, a sighted high school reader has an average silent reading rate of 251 wpm. In addition, the sighted reader has the capability of visual scanning and overviewing, as well as the ability to quickly and easily reverse course in order to review or retrace the sequence of events. The printed page by virtue of its format permits the sighted reader visually based organizational cues by use of varied spacing, bold type and center and side headings. It is obvious that the blind child is at a significant educational disadvantage because of the slow rate at which he must listen or

read.

One method of more favorably equating this disparity in rate of information acquisition is that of presenting recorded material at a word rate in excess of 175 wpm. It is possible to raise the wpm rate of recorded material employing speech compression technology to any level desired without alteration in pitch of the original presentation. However, comprehensibility of this compressed speech begins to decline at approximately 275 wpm. Although this rate (275 wpm) is slightly higher than the average silent reading rate quoted earlier for sighted readers, the oral method of presentation does not compensate for the visual advantages listed for sighted readers. It is advantageous therefore to attempt to raise the wpm rate of compressed speech to speeds beyond 275 wpm without loss in comprehension so that the blind listener might be permitted two "readings" in the time originally required for one, or one "reading" for previewing content and a second or third for mastery.

An experiment was conducted to determine if it is the lack of information processing time in compressed passages of connected discourse that causes loss in comprehension at word rates greater than 275 wpm. It was assumed that S requires time to make the associations which make full comprehension possible and that this time is greatly

reduced by the process of compression.

A 1,319 word fictional story was tape recorded and compressed, using a sampling method with discard intervals of 20 milliseconds, to word rates of 250, 300, and 350 wpm. Pause times of 1, 2, and 3 seconds duration were added at 30 fixed intervals (common to all tapes) within the story. This resulted in four tapes at each of the three compression rates previously listed, one with no pause time added, one with 1 second pauses added, etc. In all, 12 tapes were obtained in this manner.

Three hundred and forty-eight college students were randomly assigned to the 12 treatment conditions and asked to complete a 38 item multiple-choice examination in order that comprehension scores might be obtained for each treatment. The test results were submitted to an analysis of variance to determine if pause addition was beneficial to comprehension. It was hypothesized that (a) the main effect for pause time will be statistically significant, greater comprehension being associated with the presence and the magnitude of pause time and, (b) the interaction effect of pause time and compression rate will be statistically significant, greater comprehension being associated with longer pause times at higher rates of compression.

Results of the analysis of variance showed a significant main effect for compression. Comprehension scores of

the 250 and 350 wpm rates of compression were found to be significantly different. The 300 and 350 wpm rate scores were also significantly different. This was in keeping with previous literature on the subject. No significant difference was found for either the main effect of pause addition of the interaction term (compression x pause addition). It was concluded therefore, that under the conditions of the present study, there appears to be no beneficial effect for compression attributable to the addition of pause times of the frequency and duration used.

An investigation was undertaken to determine if this unexpected negative finding could in part be attributed to any of the following variables: complexity of the stimulus passage, test ceiling, validity of the measure of comprehension, reliability of the test, appropriateness of the compression rates selected for testing, S's motivation, placement of pauses within the test selection, and sex make-up of the treatment groups. While these variables may have had an effect under different conditions there was no internal evidence indicating that these variables could be held responsible for the negative findings of this research.

Conclusions

Implications for Educational Practice.—It would be

over generalizing to conclude that pause times are of no value as an aid in comprehension of compressed speech.

Conditions within the present study such as the use of fictional rather than scientific material, the lack of training of Ss for listening, the compression rates chosen, and the frequency and placement of pauses within the story all limit the ability to generalize about the role played by pause time with respect to comprehension of rapid speech. It is prudent, therefore, to withhold statements regarding implications for educational practice until more is known about the relationship of added pause time to comprehension of rapid speech.

Implications for Future Research.--The following possibilities for future research are suggested as methods for examining the pause time-comprehension relationship.

First, it would be of interest to determine if pause time under S's control with respect to duration and placement might be of value in comprehension of rapid speech. This could be accomplished by a playback machine that would permit S to introduce pauses as required. For experimental purposes the placement and duration of pauses for a variety of subjects, materials, and wpm rates could be recorded. Such information would provide empirical data for the eventual development of a rationale for the addition of pauses.

A second study might involve the use of pauses with faster wpm rates than were used in the present study. Pause frequency, duration and placement might be altered to determine the effect various pause conbinations had upon comprehension of rapid speech.

A third study of interest with respect to the comprehension of pause added compressed speech would involve holding the pauses and wpm rates constant and varying the task Ss are assigned to perform during pause breaks. Ss might be asked to take brief notes, answer test questions or mentally review the passage during the pause. This would allow E to exercise some control over the use made of pause times by Ss. Pauses of long duration and of infrequent placement would therefore be required for a study of this type.

A fourth suggested research problem might be the determination of what constitutes an adequate training program for improving S's listening skills.

Finally, the area of individual differences in comprehension of compressed speech requires investigation. Table 9 shows extreme individual differences in listening ability. Some Ss did very well at the fastest rates while others did poorly at the slowest rates. Since a passage of very low complexity was used, these differences are of

great interest. Research should seek to explain the ways high achievers achieve and low achievers fail. This will help to discover the important variables that affect listening under compression and non-compression conditions.

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APPENDICES

APPENDIX A 1

CHARACTERISTICS OF SUBJECTS
250 WPM, 0 PAUSE ADDITION

Student Number	Age	Class*	Sex
505920	19	1	M
464794	19	2	M
479172	20	2	F
454297	23	3	F
465711	19	2	M
465046	19	2	F
434039	21	3	F
461240	19	2	F
516442	21	3	M
466982	19	2	F
467212	20	2	M
414451	23	4	M
492884	19	3	F
460268	19	2	F
514546	20	2	F
408624	22	3	F

*1, freshman; 2, sophomore; 3, junior; 4, senior

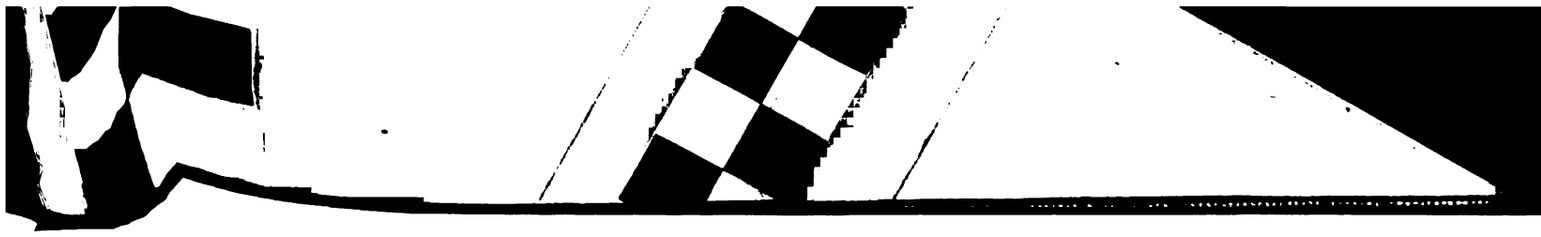
Appendix A 1, Continued

Student Number	Age	Class	Sex
461988	19	2	F
420289	21	4	M
404563	21	4	M
493294	20	3	F
438403	21	3	F
504678	18	2	F
414356	22	4	M
516464	20	3	F
478433	19	2	F
494061	22	2	M
443865	20	3	F
462116	19	2	F
461475	20	3	F

APPENDIX A 2

CHARACTERISTICS OF SUBJECTS
250 WPM, 1 SECOND PAUSE ADDITIONS

Student Number	Age	Class	Sex
440077	20	3	M
469099	20	2	M
477830	19	2	F
435840	20	3	M
485212	19	2	M
486424	21	3	F
516329	20	3	F
470233	21	4	M
493170	19	2	F
466736	20	2	F
493706	20	3	M
401241	21	4	M
485161	18	2	F
428943	20	3	F
464587	19	2	F
479244	19	2	M



Appendix A 2, Continued

Student Number	Age	Class	Sex
465097	20	2	F
469069	20	2	F
494240	20	2	F
493946	20	3	F
464426	20	2	F
411420	21	4	M
492971	19	2	F
469940	20	3	F
461931	20	2	M
387051	22	4	M
462884	19	2	M
444602	20	3	M
479710	19	2	F

APPENDIX A 3

CHARACTERISTICS OF SUBJECTS
250 WPM, 2 SECONDS PAUSE ADDITIONS

Student Number	Age	Class	Sex
493562	19	2	F
439046	21	3	M
480944	20	2	M
469601	22	3	F
436235	20	3	M
463579	19	2	F
492509	20	2	F
468823	20	2	M
465589	19	2	F
461921	20	2	M
460523	20	2	F
479712	20	2	F
462041	19	2	F
465930	19	2	M
492975	20	3	F
461638	19	2	F

Appendix A 3, Continued

Student Number	Age	Class	Sex
408067	22	3	M
413261	21	4	M
403483	21	4	F
414790	22	3	F
414656	21	3	F
435538	21	3	M
439433	20	3	M
413017	22	3	F
469394	21	4	M
435767	20	3	M
404212	21	4	M
469139	19	2	F
465785	19	2	F

APPENDIX A 4

CHARACTERISTICS OF SUBJECTS
250 WPM, 3 SECONDS PAUSE ADDITION

Student Number	Age	Class	Sex
411411	22	3	M
437290	21	4	M
465965	19	2	F
461395	20	2	F
355276	24	3	M
494055	24	3	F
415313	21	4	F
433342	20	2	F
466975	20	2	F
462075	20	2	M
431698	20	3	F
481046	19	2	M
504088	19	1	F
415387	22	4	M
479866	19	2	F
465532	20	3	F

Appendix A 4, Continued

Student Number	Age	Class	Sex
432912	21	4	F
442368	21	3	F
480443	19	2	F
462668	20	2	F
484529	27	3	M
462710	19	2	F
492168	21	2	M
478145	20	2	M
460355	19	3	M
516609	20	3	M
493826	20	2	M
434613	20	3	M
462718	20	2	F

Studen Number
46473
46259
49382
4644
3745
4633
4938
460
489
434
415
46
46
48
46
360

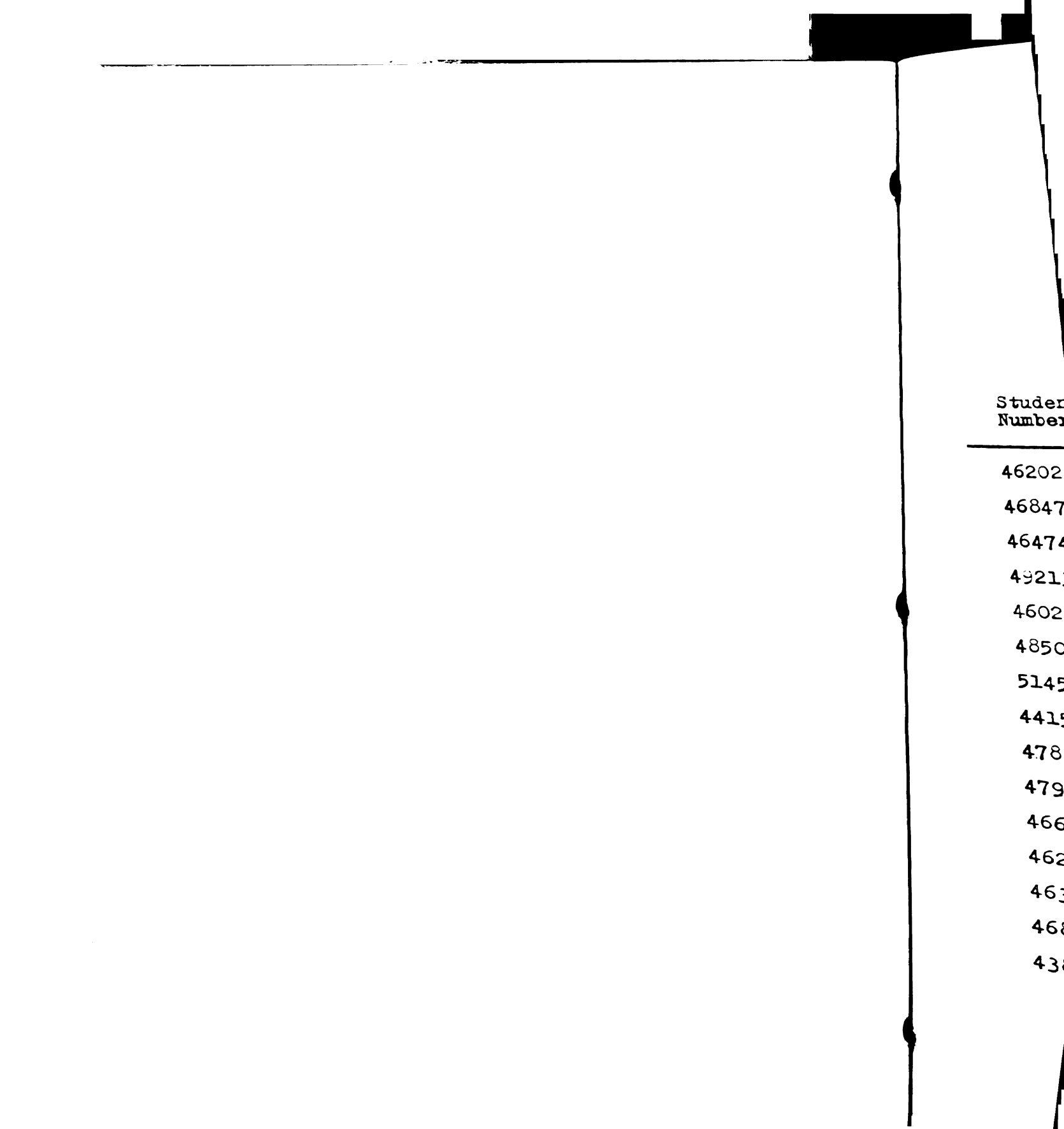
APPENDIX A 5

CHARACTERISTICS OF SUBJECTS
300 WPM, 0 SECONDS PAUSE ADDITION

Student Number	Age	Class	Sex
464734	20	3	F
462599	20	2	F
493811	19	2	M
464431	19	2	F
374543	24	4	M
463348	19	2	F
493832	19	2	F
460401	19	2	M
489213	19	2	F
434035	21	3	F
415857	22	2	F
463037	19	2	F
463018	19	2	F
480444	20	2	F
463137	19	2	F
360448	23	2	M

Appendix A 5, Continued

Student Number	Age	Class	Sex
436999	20	3	F
461641	20	2	F
464191	19	2	F
513022	18	2	F
433613	21	3	M
415923	22	4	F
492508	20	4	F
516533	21	3	F
465053	19	2	F
434776	20	3	F
479810	19	2	M
398756	24	2	F
462488	19	2	F


Studer
Numbe
46202
46847
46474
4921
4602
485C
5145
441
478
479
466
462
46
46
43

APPENDIX A 6

CHARACTERISTICS OF SUBJECTS
300 WPM, 1 SECOND PAUSE ADDITION

Student Number	Age	Class	Sex
462021	20	2	F
468474	20	2	F
464745	19	2	F
492131	21	3	M
460245	20	3	M
485057	19	2	F
514548	20	2	F
441519	21	3	M
478312	20	2	F
479744	20	2	M
466537	19	2	F
462478	19	2	F
463774	20	2	F
468227	19	2	M
438880	21	3	M

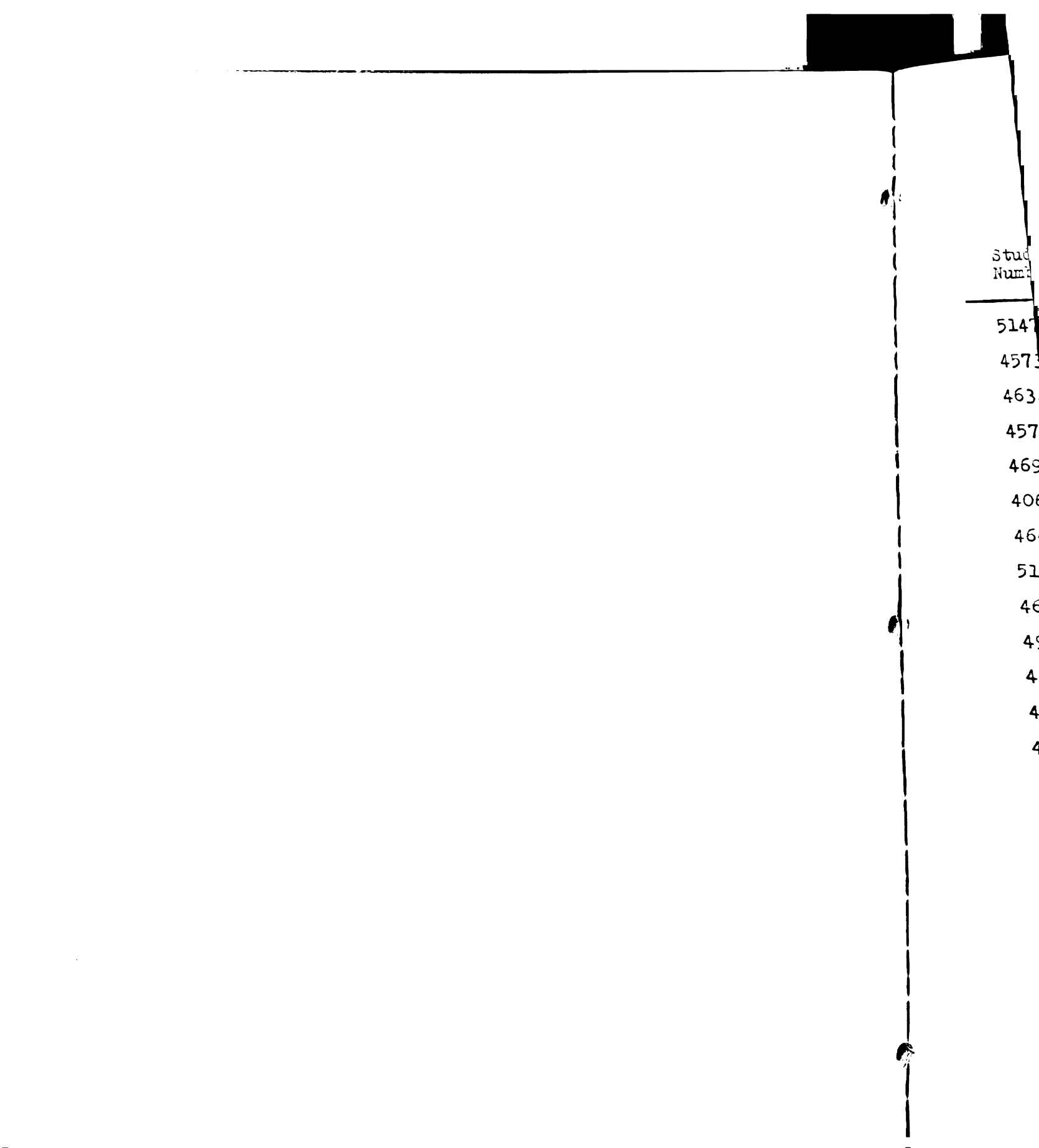
Appendix A 6, Continued

Student Number	Age	Class	Sex
429238	21	4	M
433781	21	3	F
469841	21	4	F
514714	19	2	F
445221	21	3	M
408650	21	3	M
465136	19	3	M
494187	19	2	F
404237	21	4	F
514679	20	3	M
492336	22	4	F
481311	19	2	F
469140	19	2	F
409875	21	3	M

APPENDIX A 7

CHARACTERISTICS OF SUBJECTS
300 WPM, 2 SECONDS PAUSE ADDITION

Student Number	Age	Class	Sex
462436	20	2	M
480591	19	1	F
465089	19	2	F
455726	20	2	F
492529	22	3	M
438020	20	3	F
463156	20	2	F
431617	20	3	F
464674	19	2	M
435525	21	3	F
478019	20	3	M
468037	19	2	F
408330	22	4	M
462399	19	2	M
493657	24	3	M
437134	21	3	F



Stud
Num

5147
457
463
457
469
406
46
51
46
4
4
4

Appendix A 7, Continued

Student Number	Age	Class	Sex
514707	20	3	M
457357	20	3	F
463005	19	2	F
457213	19	1	M
469515	21	4	F
406283	21	4	F
466909	19	2	F
516482	22	4	F
464682	20	2	M
493118	23	2	M
492762	19	2	F
464750	19	3	M
467060	19	2	M

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49
43
51
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41
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4
4
4
4

APPENDIX A 8

CHARACTERISTICS OF SUBJECTS
300 WPM, 3 SECONDS PAUSE ADDITION

Student Number	Age	Classes	Sex
492313	20	3	M
431713	20	3	F
516359	22	3	F
408869	21	4	F
433527	20	3	F
494101	20	3	F
436034	21	3	M
416855	22	4	M
428872	20	3	F
492082	22	3	F
463336	19	2	F
466475	19	2	M
462815	19	2	F
463515	20	2	M
436642	20	3	F
464784	19	2	F

Appendix A 8, Continued

Student Number	Age	Class	Sex
514625	21	3	F
465279	19	2	F
490978	21	3	M
468036	19	2	F
479052	19	2	F
468083	20	2	F
442230	21	3	M
437687	21	3	M
470319	22	4	M
409060	22	4	M
468321	19	2	F
467730	20	2	M
438915	21	3	M

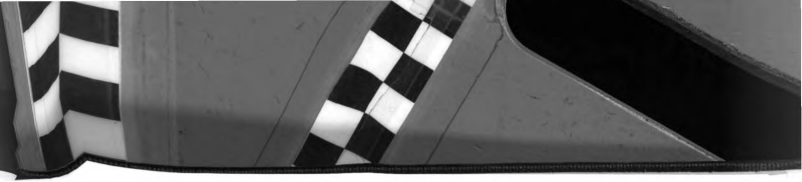
APPENDIX A 9

CHARACTERISTICS OF SUBJECTS
350 WPM, 0 SECONDS PAUSE ADDITION

Student Number	Age	Class	Sex
461274	20	2	F
492527	20	3	M
465978	20	2	F
412530	21	4	M
465755	20	2	F
411499	22	4	M
462919	19	3	F
493324	19	3	F
461361	20	2	F
466050	19	2	M
542164	20	2	F
480671	20	2	F
422822	20	2	F
494170	20	3	F
514366	23	3	M
464516	20	2	M

Appendix A 9, Continued

Student Number	Age	Class	Sex
463482	19	2	F
432574	20	3	M
462073	20	2	M
497374	25	4	F
463006	18	2	F
462620	19	2	F
390026	22	4	M
437838	20	3	F
428447	21	3	M
514446	20	2	M
464685	20	2	M
466718	19	2	F
464881	19	2	M



APPENDIX A 10

CHARACTERISTICS OF SUBJECTS
350 WPM, 1 SECOND PAUSE ADDITION

Student Number	Age	Class	Sex
467974	19	2	M
412001	21	2	M
466202	19	2	F
441046	21	3	M
415473	27	4	M
479293	19	2	F
516370	20	3	F
426038	21	4	M
404350	21	4	F
466139	20	3	M
466793	19	2	M
458133	22	3	M
494536	22	3	F
479954	19	2	F
461077	20	2	F
492887	19	2	F

Appendix A 10, Continued

Student Number	Age	Class	Sex
514350	20	3	F
468081	20	2	F
440662	20	3	M
437473	20	2	F
444064	21	3	M
493287	20	3	M
439647	20	3	F
433702	20	3	M
466262	19	2	F
445200	21	3	F
466957	19	2	F
438183	21	2	M
462608	19	2	F

APPENDIX A 11

CHARACTERISTICS OF SUBJECTS
350 WPM, 2 SECONDS PAUSE ADDITION

Student Number	Age	Class	Sex
463610	19	2	M
467629	20	2	F
463650	19	2	F
493395	21	3	F
465673	19	2	F
468945	20	2	F
466523	19	2	F
465523	20	3	F
480370	19	2	F
479912	20	2	M
402907	21	4	M
464379	19	2	M
480943	19	2	M
492016	20	3	M
516570	20	3	F
408977	21	3	M

Appendix A 11, Continued

Student Number	Age	Class	Sex
514352	21	3	M
457268	19	2	F
406639	21	4	M
406525	22	2	F
432131	21	3	M
465775	19	2	F
483070	19	2	F
492132	20	3	M
431172	21	3	M
468479	19	2	F
467018	20	2	F
409489	22	4	M
463843	19	2	F

APPENDIX A 12

CHARACTERISTICS OF SUBJECTS
350 WPM, 3 SECONDS PAUSE ADDITION

Student Number	Age	Class	Sex
478459	19	2	F
466941	19	2	F
192134	27	4	F
461203	19	2	F
465050	19	2	F
469141	19	2	F
444310	21	4	F
459720	21	3	M
466749	20	2	F
463009	19	2	F
462293	19	2	F
432501	20	3	M
454315	22	3	M
411828	22	4	M
435294	20	3	F

Appendix A 12, Continued

Student Number	Age	Class	Sex
461620	19	3	F
409488	22	4	M
412012	22	4	M
444023	23	3	F
404440	21	4	M
468544	19	2	F
481124	20	2	M
436799	20	3	F
446980	20	3	F
480778	19	2	F
464866	20	2	M
493770	21	3	M
467305	19	2	F
479064	19	2	F

APPENDIX B 1

DIRECTIONS FOR TESTING

Please listen carefully to the following selection. It is important that you pay particular attention to the story as you will be asked to answer questions concerning it.

You will notice that the selection will be played at a more rapid speed than the normal listening rate. You will quickly accomodate to this high speed speech however, as the human ear is rarely pushed to the limits of its listening capacity.

After listening to the selection, please complete the short quiz provided you by the proctors. Be certain to mark one answer for each question leaving no unanswered items; and record all your answers on the answer sheet provided. Do not write on the quiz booklet.

The results of this test will provide listening data that will add measurably to our understanding of the role that can be played by high speed speech in the education of blind students, so please do your very best.

Appendix B 1 Continued

The following rapid speech passage will be a repeat of the directions you have just heard. This is done to provide you with both an opportunity to hear rapid speed speech and to adjust your volume control to a comfortable level before the test selection begins. We will pause before beginning the test selection to correct any equipment problems you may be having and to answer questions.

This is only an example.

APPENDIX B 2

TEST STORY AND PAUSE PLACEMENT POINTS

In the year 1800 on the continent of Africa, two unfriendly nations existed, the nations of Kuwari and Rozique. The Nile River separated these two hostile nations. They often fought wars over business with Rozique being the richer of the two. —[1] Rozique was rich in wood, ivory, leopard skins, cattle and goats. By trading with friendly tribes, Rozique had become very wealthy.

King Koko, the leader of the military minded nation of Kuwari, began to make plans for the defeat of Rozique. — Koko was a military man and most of his subjects were brave, strong, expert warriors; no Kuwari tribesmen were merchants. They liked war so much that they often would fight another tribe's battles for money and glory. They never lost.

Koko was aging, however, and his body ached from numerous war wounds. -- If he defeated Rozique, he would

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[1]Dashes indicate placement at which pauses of 1, 2, and 3 seconds duration were added.

Appendix B 2 Continued

become very rich and would control thousands of people. Koko could then live a life of luxury, enjoying great personal wealth and power; he would in fact be the most powerful tribal ruler on the continent. --

Koko felt the time for war was right as his Kuwari warriors hated King Matumba of Rozique. Matumba was a popular ruler, loved by all his subjects; he was also an excellent hunter and warrior. Koko knew that his warriors would welcome the chance to defeat Matumba. -- Their dislike and jealousy of Matumba plus their greed for the wealth of Rozique was more than enough reason for them to go to war.

However, there was a small band of expert Kuwari warriors who knew about Koko's plans and did not agree with their king. -- These warriors compared Koko to Matumba and decided Matumba was the kind of king they would like to serve and welcomed the chance to be traitors. -- As a result, they were secretly meeting with a small group of Rozique merchants who agreed to pay them wages and supply them with weapons so they might defend Rozique from attack. The merchants also wanted to be trained as warriors. This group came to be known as the Pro-Matumba Union. -- It was a rather odd looking group with a small

Appendix B 2 Continued

number of strong, fierce looking warriors trying to teach weak, fat merchants how to throw spears, shoot arrows and handle the battle axe. The training periods never lasted more than twenty minutes as the merchants would become very tired and in need of rest. -- Nevertheless, these men were serious about becoming warriors and vowed to fight to the last man for their noble ruler Matumba.

Until this time the life for most of the people of Rozique was peaceful and happy. -- Being merchants, Matumba's followers thought little about war. Their business successes made them wealthy and unconcerned.

Thus the stage was set. King Koko prepared his army for war by worshipping the sun-god. A witch doctor, robed in white, looked directly into the sun at high noon and began a ritualistic chant. -- All warriors had to perform the same actions and those who fainted from the heat or could not look directly into the sun were killed. The witch doctor, acting by divine directive, would kill all warriors deemed unworthy by the sun-god. -- This was to spare them death at the hands of the enemy as no unworthy warrior could receive divine assistance in battle and would surely die. Fifty warriors were executed.

Appendix B 2 Continued

For courage the Kuwari warriors painted their faces with the blood of goats. -- Some historians believe that this procedure was of great value as a blood streaked warrior, screaming and charging for the kill doubtless would create terror in the enemy.

Being thus readied for battle, the warriors embarked by canoe across the Nile to Rozique. -- It is interesting to point out that the canoe paddles were also the spears of the warriors. These spears were medium length, well balanced poles with wide iron tips that came to a point. -- Being sharp on both edges and being heavy in weight the weapon was at once a paddle, a spear, a club, an axe and a sword.

The Rozique tribesmen meanwhile prepared for battle by doing native tribal dances that were said to chase away any evil spirits lurking about who might harm King Matumba during battle. -- These dances were religious in nature performed to the unusual sound of musicians blowing ram horns, beating drums and shaking snake rattles.

As the war canoes came near, the lookouts of King Matumba shouted the alarm. -- After a period of confusion, the traitor Kuwari warriors and the Rozique merchants went running to meet the enemy. Matumba entered the battle on a

Appendix B 2 Continued

zebra previously used to haul trade goods. His army wielded sharp-edged heavy pieces of iron that could cut off an enemy's head with a single stroke. --

Matumba's tribesmen were losing the battle. One reason was that the fat Rozique merchants were no match for the tough expert warriors of Kuwari. Matumba's army was also very small; they were outnumbered five to one. -- Their heavy iron pieces were no match for the versatile, effective weapons of King Koko's men.

The battlefield quickly became a mass of men, spears, swords, and blood. Matumba decided that the only way he could win would be to fight Koko in personal combat and kill him. -- Before he could strike, however, Koko sent his spear through Matumba's chest. The spear was thrown with such force that it came out through Matumba's back. Seeing this, the Rozique tribesmen fled in terror; they became helpless cowards without their leader, thereby enabling Koko to easily win the battle. --

Proud of his victory, King Koko's toothless mouth widened into a big grin. He was now master of seven thousand prisoners, two hundred thousand cattle and sheep, and all the business wealth of Rozique. -- Moreover, the original social structure of Kuwari remained the same with the largest number of tribesmen still being expert warriors.

Appendix B 2 Continued

This was necessary because Koko needed a large military force to keep the conquered Rozique inhabitants under control and to protect his new found wealth. --

After its defeat the social structure of Rozique changed; all the people and the traitor Kuwari warriors became slaves. They no longer performed the duties that the trading society they once knew demanded.

However, there was an interesting legend which came out of all this. -- After King Koko killed Matumba, some of Matumba's faithful subjects succeeded in rescuing his dead body and secretly burying it, to prevent the traditional burning of killed enemy leaders that the Kuwari warriors liked to perform. -- These Rozique subjects never revealed their deed but instead claimed that some friendly spirits had taken the seriously wounded Matumba away to safety so he could recover and return to free his people. This became known as the Matumba Legend. It was no comfort to Koko that a rather sizable number of Rozique slaves believed the legend. -- In time, he too began to wonder about it. Koko felt certain he killed Matumba but the dead body was never found.

If Koko had known about the Freedom Group, he would have been less concerned about mere legend. -- The Freedom

Appendix B 2 Continued

Group was made up of some Legend Believers and the traitor Kuwari warriors who fought for Matumba. This group was secretly hiding caches of weapons, kept the Matumba Legend alive, and planned for the overthrow of Koko. They were very active. -- From time to time Koko would find a skull or a dead Kuwari warrior in front of his hut. Shipments to other tribes often never reached their destination. Koko's food often contained poison. In one week alone five food tasters died. -- The constant harrassment left Koko irritable and suspicious and his relationship with his warriors became unfriendly. He was certain they were plotting with the slaves to overthrow him. Koko looked upon the future with uncertainty. -- His victory was not as sweet as he had previously imagined it would be.

APPENDIX C

TEST INSTRUMENT

PLEASE DO NOT OPEN BOOKLET UNTIL REQUESTED TO DO SO

QUIZ BOOKLET

Education 200 Compressed Speech Laboratory

NAME_____AGE_____SEX_____

STUDENT NUMBER_____DATE_____

CLASS (please circle) Freshman Sophomore Junior Senior

DISCUSSION INSTRUCTOR (please circle)

Beavers Dailey Ford Hoogstra

Klein Nicholas Wood

SECTION (please circle)

10:20 AM Tue. & Thurs.	12:40 PM Tue. & Thurs.	8:00 AM Tuesday	8:00 AM Thursday

GENERAL INSTRUCTIONS

1. Select the one best answer to each item. Blacken the number of your choice on the answer sheet.
2. If you wish to change your answer, be sure to carefully erase your original selection.

(Do not write below this line)

Subject number _____ Tape number _____

Condition number _____ Booth number _____

_____ _____

_____ _____

Appendix C Continued

1. Some historians believe that the Kuwari warriors frightened their enemies because of:

   * a) their goat-blood painted faces

   b) their terrible war cries

   c) their hideous war masks

   d) the long period of drum beating before the attack

2. Koko and his followers earned money from other tribes by:

   a) trading with them

   * b) fighting their battles

   c) selling them slaves

   d) protecting their villages

3. Matumba's plan to get rid of Koko was to:

   a) bribe one of Koko's warriors to kill him

   b) bribe one of Koko's servants to poison his food

   * c) fight Koko in personal combat and kill him

   d) say religious prayers for spirits to harm Koko

4. The Kuwari warriors had spears that were also:

   a) canoe paddles

   b) swords

   * c) all of the above

   d) none of the above

---

*Indicates correct answer.

Appendix C Continued

5. Matumba's dead body was buried by:

   a) Koko's warriors

 * b) Matumba's subjects

   c) Matumba's family

   d) Koko's merchants

6. Koko was getting old and tired so he planned:

   a) to have an heir

 * b) to defeat Rozique

   c) to step down in favor of a younger warrior

   d) to sign a treaty with Rozique

7. The proportion of Koko's warriors to Matumba's warriors was:

   a) one to two

 * b) five to one

   c) one to one

   d) one to five

8. The Kuwari witch doctor killed fifty Kuwari warriors because:

 * a) they were unworthy

   b) they were weak

   c) they were cowards

   d) they were traitors

Appendix C Continued

9. The Rozique musicians danced and played music:

   a) to encourage Matumba's warriors in battle

   b) to welcome the coming of the warriors

   * c) to chase away any evil spirits that might harm Matumba during the battle

   d) to show power and to frighten the enemy

10. The Kuwari warriors did not like King Matumba of Rozique because:

   a) Matumba was popular among his subjects

   b) Matumba was an excellent hunter

   c) Matumba was rich

   * d) all of the above

11. At the end of the battle Koko was:

   a) unsatisfied with his victory and his new wealth

   b) unsatisfied with his new found wealth

   c) unsatisfied with his victory, but proud of his new found wealth

   * d) proud of his victory and his new found wealth

12. Koko would become very rich if he:

   a) agreed to a mutual trade pact with Rozique

   * b) defeated Rozique

   c) sold slaves to Rozique

   d) fought a war for Rozique

Appendix C Continued

13. Matumba rode into battle on a:

a) water buffalo

b) war platform carried by his warriors

c) elephant

* d) zebra

14. The attitude of King Koko about the rumor of Matumba's return was that he:

a) felt indifferent since few tribesmen believed it

b) discouraged the rumor to avoid the annoyment of his slaves

* c) felt uneasy about the increasing number of believers of this rumor

d) was unconcerned as he would soon step down as chief

15. The Kuwari warriors were willing to fight Rozique because:

* a) they wanted the wealth of Rozique

b) they wanted the trade routes of Rozique

c) they wanted to live in Rozique

d) they wanted the water supply and the strategic military position of Rozique

16. King Koko of Kuwari was basically a:

* a) military minded man

b) peace loving man

c) generous man

d) businessman

Appendix C Continued

17. The Rozique merchants of the Pro-Matumba Union were learning:

* a) to become warriors

b) to become spies

c) to make weapons

d) all of the above

18. The unusual sounds of the Rozique musicians as the canoes approached were:

* a) ram horns blowing, drums beating, and rattles shaking

b) whistles blowing and drums beating

c) drums beating

d) ram horns blowing

19. The setting of this story is:

a) South America

* b) Africa

c) Australia

d) Samoa

20. Most of Matumba's followers were:

* a) merchants

b) warriors

c) union members

d) musicians and witch doctors

Appendix C Continued

21. After the battle the people of Rozique were:

* a) slaves for their new ruler

b) more prosperous than ever

c) merchant warriors

d) none of the above

22. King Koko's weapons were:

* a) simple and effective

b) good for use only as clubs

c) not as effective as enemy weapons

d) none of the above

23. Among Koko's subjects, there were many:

a) priests

b) merchants

* c) warriors

d) musicians and witch doctors

24. The behavior of the Freedom Group was characterized by:

a) negotiating with other tribes to battle Koko

b) inactivity and lack of leadership

* c) planning the overthrow of Koko

d) helping slaves escape to other countries

Appendix C Continued

25. The Kuwari warriors had an advantage in the war because:

* a) they had a versatile weapon

b) the Rozique citizens were cowards

c) Matumba was not a good warrior

d) all of the above

26. The Pro-Matumba Union consisted of a small group of Rozique merchants and:

a) Matumba's warriors

* b) some traitor Kuwari warriors

c) some Kuwari merchants

d) all of the above

27. A small band of Kuwari warriors decided:

* a) to help Matumba in case of war

b) to kill Matumba

c) to establish a trade agreement with Matumba

d) to work for peace

28. The relationship between Koko and his warriors after Matumba's death was:

a) respect and loyalty

b) friendly

* c) unfriendly

d) open rebellion

Appendix C Continued

29. The two nations in the story often fought wars over:

a) a border dispute

b) political viewpoints

* c) business

d) religion

30. The rumor about Matumba after his death was that:

a) King Koko's witch doctor treated him

* b) he was treated by some friendly spirits and would return

c) he was alive and being treated by a neighboring tribe

d) he was secretly burned by King Koko's warriors

31. The rumor of Matumba's return was kept alive by:

* a) Matumba Legend Believers

b) Koko's witch doctor

c) a neighboring tribe

d) Koko's warriors

32. Matumba's followers upon seeing his death:

a) became more fierce and determined to win

b) became more courageous

* c) became hopeless cowards

d) retreated to plan the revenge of their leader

Appendix C Continued

33. Matumba's weapons were:

a) sharp-pointed heavy daggers

b) sharp-edged light knives

c) sharp-pointed light spears

* d) sharp-edged heavy pieces of iron

34. Who was losing the battle?

* a) King Matumba and his followers

b) Matumba's advanced force of spear carriers

c) King Koko and his followers

d) Koko's warriors who used the swords

35. The Kuwari warriors prepared for war by:

a) dancing and shaking rattles

* b) painting their faces with goat's blood for courage

c) beating drums and singing

d) resting for three days

36. King Matumba's lookouts announced the beginning of the war by:

a) sending mirror signals

* b) shouting the alarm

c) setting a fire

d) waving signal flags

Appendix C Continued

37. Matumba was killed:

a) by Koko's warriors

* b) by Koko's spear

c) by his own followers

d) by evil spirits

38. Matumba's tribesmen differed from King Koko's tribesmen because most were:

a) expert warriors

b) younger than Koko's warriors

c) disloyal warriors

* d) none of the above

Please place your answer sheet in your test booklet and return it to the proctor. This will be your record of attendance.

THANK YOU VERY MUCH FOR YOUR COOPERATION