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AUTHOR Sticht, Thomas G.
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ABSTRACT

Two experiments were performed to determine whether using the time saved by the time compression process to repeat or extend information presented by audio tapes would increase the amount learned by listening to rapid speech. Neither repeating nor extending information improved learning over that obtained by listening to uncompressed information for an equal amount of time. This was true for high and low mental aptitude subjects. The implication that more information can be learned in a unit of time with moderate compression remains to be substantiated. (Two figures and eight references are included.) (Author/LY)

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Studies on the Efficiency of Learning by Listening to Time-Compressed Speech

by

Thomas G. Sticht

Presentation at
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Prefatory Note

The research reported in this paper was conducted under Work Unit REALISTIC, Determination of Reading, Listening, and Arithmetic Skills Required for Major Military Occupational Specialties. It was performed by the Human Resources Research Organization, Division No. 3, at Monterey, California. This paper presents two studies concerning the use of the time saved by the time-compression of listening materials either to repeat or to extend the materials.

STUDIES ON THE EFFICIENCY OF LEARNING BY LISTENING TO TIME-COMPRESSED SPEECH

Thomas G. Sticht

One of the intriguing aspects of the use of time-compressed speech is that more information can be presented in a given amount of time. For instance, if a message is time-compressed by 50%, it is possible to present the compressed version two times in the same amount of time required to present the uncompressed version once. An alternative is that extra information may be presented in the time saved by the compression process.

Both of these possibilities were obvious to Fairbanks, Guttman, and Miron (1, 2) in their work which introduced the automated time-compression process to the experimental study of learning by listening. In one of their studies they compared the comprehension of material compressed by 50%, 282 words per minute (wpm), but presented twice, with the comprehension of the identical, uncompressed material requiring the same amount of time for presentation. They found a slight increase in comprehension with the repeated, time-compressed message over that obtained with the single presentation of the uncompressed message. Their work also indicated that the double presentation appeared slightly more successful with men of moderate, rather than high, mental aptitude.

From the work of Fairbanks and his associates, it appeared that the repetition procedure might prove even more successful with very low aptitude men. We were also interested in determining whether the comprehension of repeated time-compressed messages might be different for different combinations of compression. For instance, a message compressed by 40% and repeated at a compression ratio of 60% might produce a higher level of comprehension than if the reverse sequence was used, that is, if the 60% compressed version was presented before the 40% compressed version. This might be so because more information could be stored from a less compressed, and hence more slowly presented message, to facilitate the comprehension of a more rapidly presented message. To check these ideas, an experiment was performed in which the comprehension of repeated time-compressed messages, presented in several repetition sequences, was compared with the comprehension of messages presented one time in either compressed or uncompressed versions.

Comprehension of Repeated Time-Compressed Messages[1]

For the HumRRO research, a selection on the use of Carbon 14 for dating relics, taken from Form 1A of the Sequential Tests of Educational

[1]A more detailed account of this study appears in the *Journal of Experimental Education*, vol. 37, no. 4, 1969, pp. 60-62.

Progress (3), was used. The tape-recorded listening selection was compressed by an Eltro Information Rate Changer[1] to produce compression ratios of 0, 36, 46, 53, and 59%. In wpm rates, these compression ratios correspond to normal (175 wpm), 275, 325, 375, and 425 wpm. A 20-item "fill-in-the-blank" test was prepared to evaluate listening comprehension.

These listening selections were grouped to form four pairs of repeated messages. One tape presented the passage compressed by 36% and repeated at 59%. The remaining tapes were paired to produce compressed message sequences of 59% followed by 36%, 46% followed by 53%, and 53% followed by 46%. When paired in this way, the combinations of 36% and 59% required 105% of the time required to listen once to the uncompressed message, and the combination of 46% and 53% required 101% of the normal listening time.

Subjects of high and low mental aptitude were selected from Army inductees who scored high or low on the Armed Forces Qualification Test (AFQT). In terms of intelligence, these groups represent men having IQs of around 120 plus, and 90 or below. Individual subjects listened to the tapes in a sound-deadened room. They listened to both levels of compression of the repeated message before taking a 20-item "fill-in-the-blank" comprehension test, presented aurally.

The results of the experiment are summarized in Figure 1. This figure compares the comprehension of the repeated messages with the comprehension of the same listening selection when presented one time at compression ratios of 0%, 36%, and 59%. These data were obtained from subjects tested in previous research (Sticht, 4) who were matched on AFQT with the men in the research described in this paper.

As Figure 1 indicates, both high and low aptitude men showed improved comprehension with the repeated selections. However, in no case did the double presentation improve comprehension over that obtained with a single presentation of the uncompressed selection. The only suggestion that performance may have improved over that for a single presentation is with the lower mental aptitude group with the 59%—36% sequence. However, the difference was not statistically significant (Fischer exact probability test).

As shown in Figure 1, in both double presentations at 53% and 46% compression, comprehension was better than with a single presentation at either of these compression ratios. Many studies (Foulke and Sticht, 5) have reported a notable decrease in comprehension with single presentations of messages at word rates of 325 or 375 wpm. The results herein indicate that, for both ability groups, some savings occurred from listening first at either 375 or 325 wpm before listening to a repetition of the message at these word rates (in this regard, see Jester and Travers, 6). But apparently the savings was

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[1]Citation of trade names or products in this paper is for purposes of research documentation and does not constitute HumRRO or official Department of the Army endorsement or approval.

not sufficient to raise the performance level above that for the single presentation of the uncompressed passage.

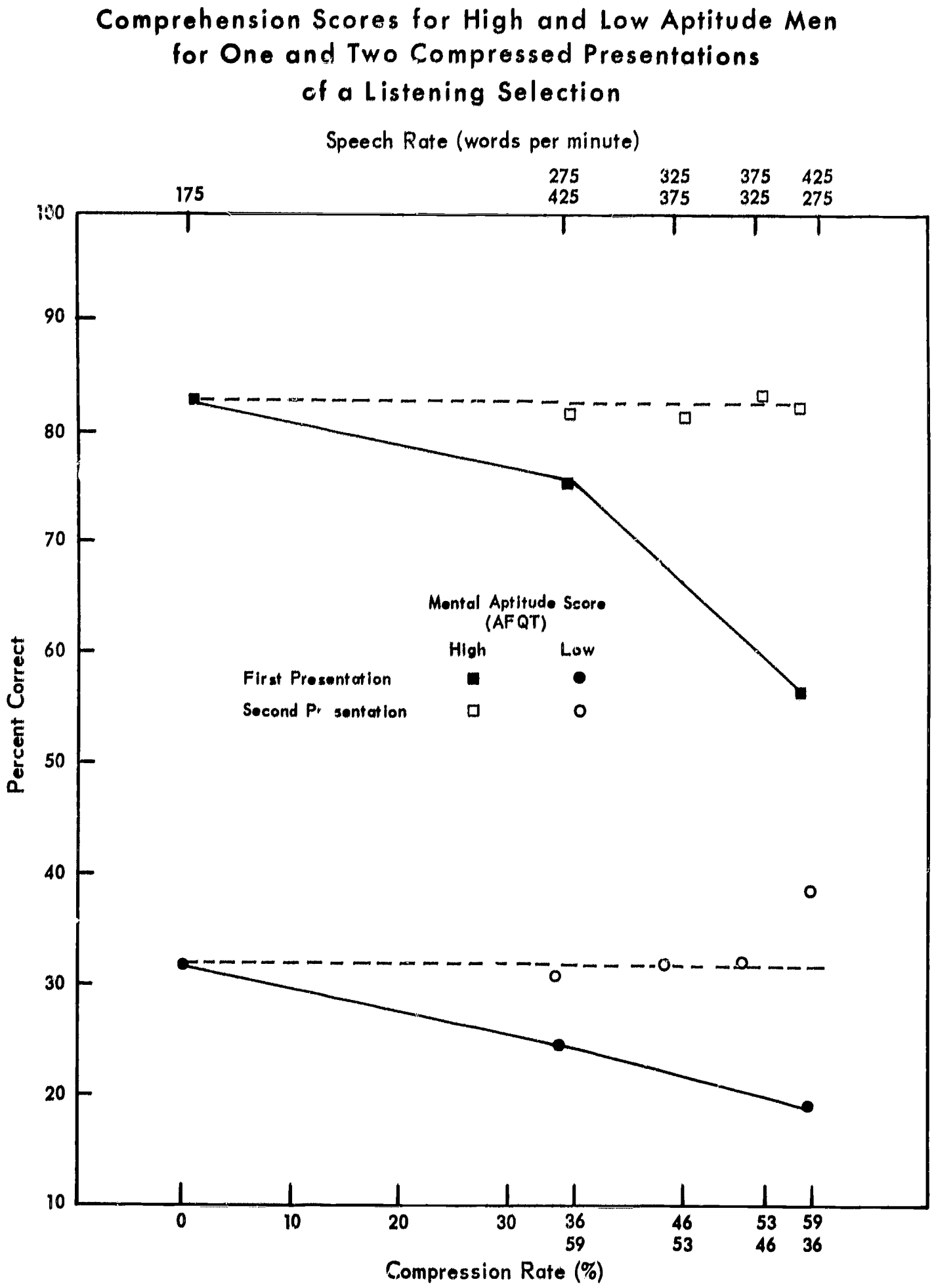

Figure 1

As mentioned earlier, Fairbanks, Guttman, and Miron (1) obtained results similar to those of the present research. A double presentation of materials compressed by 50% (282 wpm) resulted in a very slight improvement in comprehension over that for a single presentation of the uncompressed message. Their results, the work of Friedman, Graae, and Orr (7). Hopkins (8), and the present results seem to indicate that using the extra time resulting from the time-compression of materials to simply repeat information is not likely to improve learning over what could be obtained by listening once to the uncompressed message presented within the "normal" range of speech rate. Furthermore, the work of Fairbanks and associates suggests that listening twice to the *uncompressed* message is not likely to produce very drastic improvements in comprehension—if any at all. Possibly the effectiveness of repeated time-compressed messages may be increased for subjects who are trained in listening to time-compressed speech, but there is no firm data to suggest this (7).

On Learning More Per Unit of Time by Means of Time-Compressed Speech

A second possibility that has been mentioned for improving the efficiency of learning by listening is to use the time saved by the compression of material to present additional information. Fairbanks, Guttman, and Miron (2) used the time saved resulting from 30% (201 wpm) compression of a message to emphasize certain portions of the message. As they state, this amounts to trading temporal redundancy for verbal redundancy. Their results indicate that the reinforcing of certain parts of the selection did, indeed, increase the comprehension of the emphasized materials. However, this increase appeared to occur at the expense of the remaining, unemphasized content, for the comprehension of this material showed a highly significant decline. Thus, the overall comprehension score for the reinforced, compressed material was less than the overall score for the uncompressed material.

Fairbanks and his associates suggested that emphasizing certain parts of the message may have led the subjects to assume that verbal redundancy meant "important to learn" and hence such emphasis may have selectively focused attention upon certain parts of the message, while diminishing attention to the remainder of the material. This suggested that if the time saved by the compression process was used to present additional, *new* information, perhaps an overall increase in the amount learned in a given unit of time might occur.

To evaluate this proposition, research was performed in which independent groups (N = 15 per group) of high (AFQT $\geq$ 80) and low (AFQT $\leq$30) aptitude men listened to a recorded message presented under five different conditions. Under one condition, the men listened to the message presented at a normal, uncompressed speech rate of 178 wpm. The time required to listen to the uncompressed message was 6'4". By means of the time sampling compression method, two additional versions of the message were presented. One was compressed by 36%, which produced a speech rate of 278 wpm and reduced the listening time from 6'4" to 3'53".

The third version of the message was produced by compressing the message by 53%. This resulted in a speech rate of 378 wpm, and reduced the listening time from 6'4" to 2'52". Thus, three versions of a message were available having speech rates of 178, 278, and 378 wpm and for which the time needed to listen to the message decreased from 6'4" in the case of normal speech to 2'52" using speech of 378 wpm. These tapes were used to assess the effects of increasing the speech rate on the comprehension of a recorded message.

Two additional groups of high and low aptitude men listened to the test message at 278 (N = 14) or 378 wpm and then listened to additional information until their total listening time was 6'4", that is, the same amount of time as required to listen to the normal, uncompressed message. These groups thus listened to what the previous three groups had heard, plus additional information. For all conditions, subjects were assigned to the various treatment groups in an unsystematic manner, as they became available, until all treatment cells were filled.

The message used in this study was the "Roland" selection from the standardized listening passages prepared by Clark and Woodcock (1967). Subjects listened to this selection in an open classroom. They were seated in a semicircle around a tape recorder adjusted to a "comfortable" listening level determined by the group. Subjects listened first to the recorded instructions on the standardized listening tapes; then they listened to the "Roland" selection. Immediately after the presentation of the listening selection, Form A of the comprehension tests was administered both by reading and listening. This test contains 28 four-alternative multiple-choice questions. In the HumRRO research, the 6'4" of listening time presented at a normal (178 wpm) speech rate provided answers relevant to only the first 14 of the 28 test items. This was true also for the two compressed versions in which the listening times were 3'53" and 2'52". For the compressed versions in which the listening time was held constant at 6'4", information relevant to both the first and second halves of the comprehension test was presented. In this case, more relevant test information was presented in 6'4" with the speech rate at 378 wpm than at 278 wpm. Of primary interest was whether or not holding the listening time of the compressed message equal to that of the uncompressed message would result in an overall increase in scores on the total 28-item test.

The results of the study are summarized in Figure 2. In this figure, the unfilled symbols designate the conditions for which the listening time was constant at 6'4". The filled symbols indicate those conditions for which listening time was reduced. The square symbols are for the high aptitude subjects and the round symbols are for those of low aptitude. The abscissa indicates the rate of speech at which the message was presented, and the ordinate is the percent correct on the 28-item comprehension test.

The data indicate that, under those conditions in which the speech rate was increased and the listening time was reduced, comprehension decreased for both high and low aptitude subjects. This is the typical finding regarding the relationship between speech compression and comprehension (5).

Listening Comprehension Scores Under Two Differing Conditions

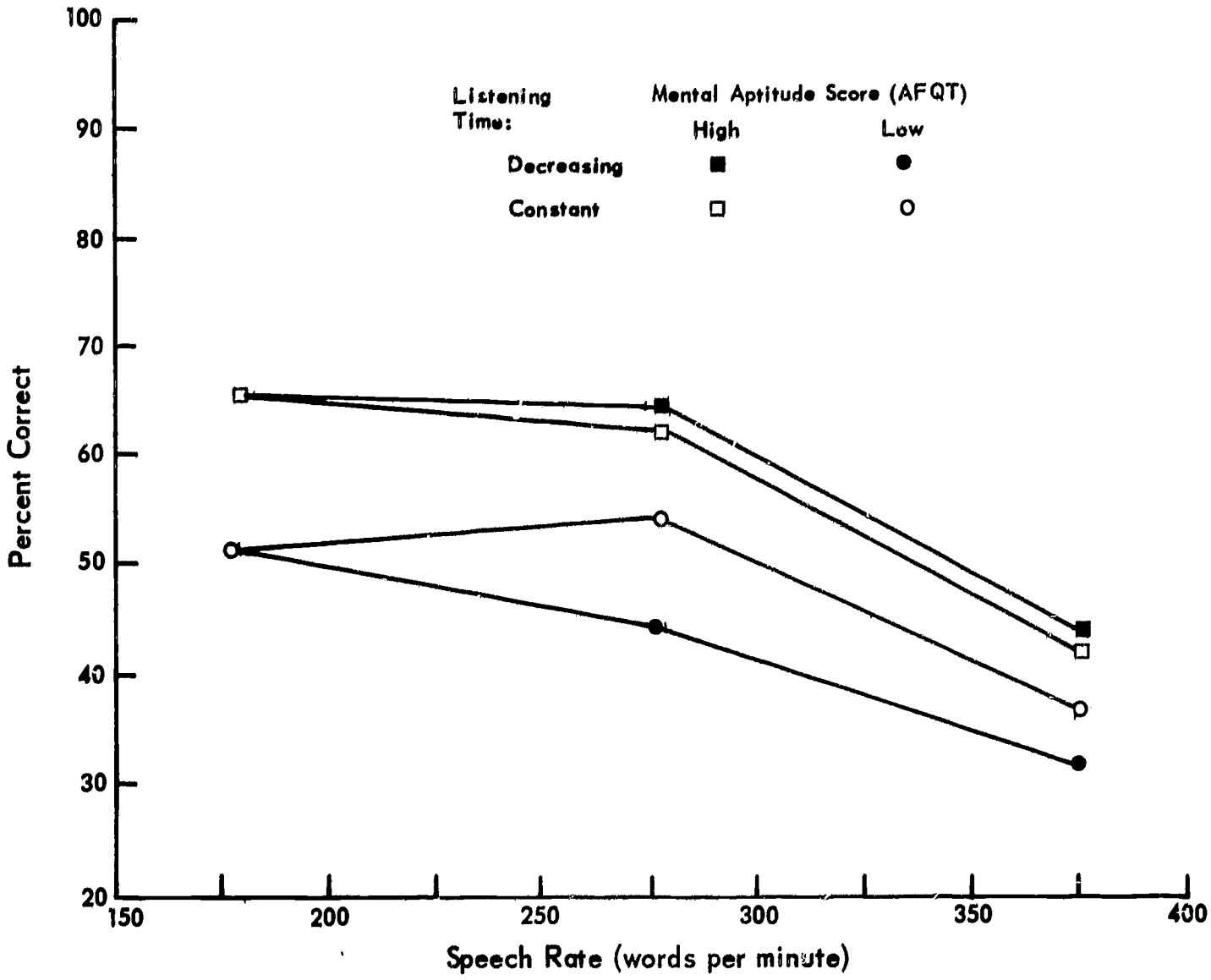

Figure 2

The data of primary interest are given by the unfilled symbols. In this case the listening time was constant at 6'4", while the speech rate was increased from 178 to 278 to 378 wpm. Thus more information was presented with the faster rates of speech. The data of Figure 2 indicate that, for higher aptitude men, there was no increase in comprehension scores when more information relevant to the test was presented at accelerated speech rates. For lower aptitude men there is a suggestion that listening to additional information at accelerated speech rates may have improved comprehension over that obtained by listening to less information at the same accelerated speech rates. However, the differences indicated in Figure 2 are not statistically significant.

These data indicate that listening to additional information in the time saved by the time-compression of speech may not lead to increased learning. In the present study this was true even for material compressed only 36% and presented at 278 wpm, and even though this compression resulted in a higher "listening efficiency" score, that is,

more was learned per time spent listening, than obtained with the normal (178 wpm) rate of speech. This was true for both aptitude groups.

As mentioned earlier, Fairbanks, Guttman, and Miron (2) attempted to increase learning by using the extra time resulting from 30% compression to emphasize certain content in a recorded message. They found that, whereas the learning of the emphasized materials was, indeed, improved, the learning of the unemphasized materials declined, and the total comprehension score stayed about the same as that obtained by listening to the message presented at a normal rate of speech and without added emphasis. Fairbanks, *et al.*, suggested that emphasizing certain content might have caused the subjects to consider it as more important than the remaining content, and hence they may have ignored the unemphasized materials. They also mentioned the possibility that the response to the emphasized version of the message may have actively inhibited the response to the unemphasized content.

The results described in this paper are essentially the same as those found by Fairbanks and colleagues. But in this case the possibility of selectively focusing attention through emphasis of materials was avoided; and hence does not explain the failure to find improved learning with extended listening. However, the notion of inhibition may be related to the HumRRO findings. An analysis of the responses of high aptitude subjects to the first and second halves of the 28-item test indicated that, with the materials presented at 278 wpm, the scores on the first half of the test decreased slightly when the message was 6'4" in duration as opposed to when the message length was only 3'53" in duration. Thus there is the possibility that retroactive inhibition may have occurred such that listening to additional material may have interfered with the retention of previously presented material. However, the evidence for this is very slight. Also this interpretation is not confirmed by the data for the low aptitude men who, in fact, showed a slight increase in performance for both halves of the test when listening time at 278 wpm was extended from 3'53" to 6'4".

Comments on the Efficiency of Learning by Listening to Time-Compressed Speech

To recapitulate briefly, in several research studies attempts have been made to demonstrate that the time saved by time-compression might be used to increase learning over that which could be obtained by listening once to the uncompressed materials. These studies have used the time saved by the compression process to repeat or review messages (1, 7, 8; and the work described herein), to selectively elaborate parts of messages (2) or to present additional, new, but related information (the research described in this paper). To date, none of these techniques has been found to significantly increase the amount of learning over that obtained from a single presentation of the same, or unelaborated, or less extensive material presented in an uncompressed format with speech rates between 140-178 wpm.

On the basis of these limited data it appears that the technique of trading time for information has not resulted in more information being

processed by the listener for short-term retention. Most significantly, this has been true for materials compressed to speech rates of 275-300 wpm for which listening "efficiency," that is, the amount learned per unit of listening time, has actually been higher than obtained with "normal" materials. Thus, the implication that, because of improved listening efficiency more information can be learned in a unit of time with moderate compression, has yet to be substantiated.

I would like to mention, however, that there are several features of these various research efforts that limit conclusions to be drawn from them. For one thing, nearly all of this research has involved listeners untrained in listening to compressed speech. Second, in all of the studies materials used were within a given subject matter area. Possibly, the probability of interference factors might be reduced if a different type of content was presented in the time saved by the compression process. Third, these studies have presented the additional information in a single sitting and immediately tested for learning. Perhaps some spacing of the presentation of new compressed information might increase learning over that obtained by continuously listening for the same amount of time to uncompressed materials (but see Friedman, Graae, and Orr, 7, for preliminary, negative findings using long-term intervals between repetitions of materials).

As a final comment upon the efficiency of learning from moderately time-compressed speech, it should be pointed out that the experiments reported in this paper have all been concerned with using the time saved by the time-compression process for increasing the learning of a given group of subjects. An alternative would be to use this time-savings for other purposes, such as instructing additional students. Thus the efficiency of time-compressed listening does not rest solely on demonstrating an increase in the amount of learning per group per unit of time, but also by the demonstration that more groups per unit of time can be instructed with moderate compression. This is *fait accompli* in many studies, including those conducted by HumRRO, which demonstrate that much learning can occur with materials that have been compressed by 30 to 40%. Clearly this time savings can be used to instruct additional listeners.

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13. ABSTRACT

Two experiments were performed to determine whether using the time saved by the time-compression process to repeat or extend information presented by audio tapes would increase the amount learned by listening to rapid speech. Neither repeating nor extending information improved learning over that obtained by listening to uncompressed information for an equal amount of time. This was true for high and low mental aptitude subjects. The implication that more information can be learned in a unit of time with moderate compression remains to be substantiated.

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