Technical Report 69-23

Learning by Listening in Relation to Aptitude, Reading, and Rate-Controlled Speech

by

Thomas G. Sticht

HumRRO Division No. 3

December 1969

Prepared for:

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HumRRO

HUMAN RESOURCES RESEARCH ORGANIZATION

DEPARTMENT OF THE ARMY

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1. This report describes a series of studies on listening comprehension for men of high, average, and low aptitudes as part of a research program considering methods for reducing literacy requirements for training and job performance.

2. The research showed that certain materials can be transmitted as effectively by listening as by reading for men of both average and low aptitude, that moderate degrees of time compression in speech in presenting materials may improve listening efficiency, and that speech rate is the primary limiting factor to comprehension under certain conditions. It is suggested that time saved by the use of compressed speech, where appropriate, might be used to enlarge on certain aspects of the material, but that mere repetition of materials may not increase comprehension. Low aptitude men displayed a deficiency in recognizing individually spoken words that may account for some of their reading and listening difficulties.

3. This report should be of interest to those engaged in training research, to linguistics researchers, to groups or individuals engaged in the use of rate-controlled recordings, and to those concerned with instructing people with low literacy capabilities.

FOR THE CHIEF OF RESEARCH AND DEVELOPMENT:

Lynn E. Baker

LYNN E. BAKER
US Army Chief Psychologist
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by

Thomas G. Sticht

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HUMAN RESOURCES RESEARCH ORGANIZATION

Technical Report 69-23
Work Unit REALISTIC

The Human Resources Research Organization (HumRRO) is a nonprofit corporation established in 1969 to conduct research in the field of training and education. It is a continuation of The George Washington University Human Resources Research Office. HumRRO's general purpose is to improve human performance, particularly in organizational settings, through behavioral and social science research, development, and consultation. HumRRO's mission in work performed under contract with the Department of the Army is to conduct research in the fields of training, motivation, and leadership.

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

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FOREWORD

The research reported herein was undertaken by the Human Resources Research Organization as a part of Work Unit REALISTIC, which considers methods for reducing literacy requirements for training or job performance. This report presents six studies that explore the feasibility of substituting learning by listening for learning by reading. This possibility is of special interest for situations wherein the demands for reading exceed personnel reading skill levels. The research was performed and most of the report preparation completed while HumRRO was part of The George Washington University.

The research was conducted at HumRRO Division No. 3, Fort Ord, California, where Dr. Howard H. McFann is Director.

Military support was provided by the U.S. Army Training Center Human Research Unit. Military Chief of the Unit was LTC David S. Marshall.

The research was carried out by Dr. Thomas G. Sticht, with military assistants PFC Richard L. Ferrington, PFC James P. Ford, and SP 5 Alva J. Tucker.

HumRRO research for the Department of the Army is conducted under Contract DAHC 19-70-C-0012. Training, Motivation, and Leadership research is conducted under Army Project 2Q062107A712.

Meredith P. Crawford
President
Human Resources Research Organization

Military Problem

A large number of men currently being inducted into the Army are functionally illiterate. Recent statistics[1] indicate that more than one-fourth of the new standards accessions under Project 100,000 are functionally illiterate, that is, they read at or below the fourth grade level of ability. The Army is faced with the problem of developing means for coping with the literacy deficiencies of the lower mental category accession. Both training and job requirements involving literacy skills will need to be modified to accommodate the functionally illiterate. Research is needed to determine the actual literacy requirements for certain MOSs, and ways to reduce or otherwise modify these requirements to accommodate the marginally literate, low aptitude man.

Research Problem

One method for adapting training or job requirements to accommodate men with deficient reading skills is to remove the reading requirement where feasible. The present research considers the possibility of substituting listening materials for reading materials in some instances, thereby removing one of the obstacles encountered by the marginally literate man.

Approach

The first in a series of studies compared the performance of men having average or low AFQT scores on reading and listening tests of comprehension. The reading and listening tests contained materials of school grades 6.5, 7.5, and 14.5 in difficulty level.

Three studies examined the ability of high and/or low aptitude men to discriminate and comprehend listening materials presented at rates comparable to those used in reading silently. Two additional studies were aimed at determining whether observed limitations in the ability of men of all aptitude levels to comprehend very rapid rates of speech were due primarily to signal distortions resulting from the process used to accelerate the speech, or to the rate of speech per se.

Results

Regarding the comparisons of listening and reading test performance, the results indicated that:

(1) Listening was as effective as reading in transmitting information of all three difficulty levels for both average and low aptitude men.

(2) Reading and listening performance of the average aptitude groups was uniformly 20% higher than that of the low aptitude groups.

(3) Individual differences among both the average and the low aptitude men were such that some did better by listening than by reading, and vice versa.

The results of the studies exploring the use of time-compressed speech to permit listening rates equivalent to silent reading rates indicated that:

(1) For both normal and time-compressed speech, comprehension increased as aptitude increased.

(2) Rate of speech did not, under the conditions of these studies, produce differential effects for high and low aptitude men.

[1]*Summary Statistics on Project One Hundred Thousand* (1).

(3) Men of all aptitude levels got more items correct per minute of listening time when moderate speech compression (36%-275 words per minute) was used, rather than with the normal (175 wpm) rate of speech.

(4) Listening to a compressed selection that was presented twice in the same amount of time required to present the uncompressed message once did not improve the peak comprehension of high or low aptitude men.

(5) Lower aptitude men did not discriminate individually presented words as well as did higher aptitude men.

(6) Both the speech rate and the signal distortion due to the compression process affected the comprehensibility of listening selections, but signal distortion was important only when the materials used were very low in redundancy.

Conclusions

(1) Certain materials may be presented as effectively through listening as through reading for men of both average and low aptitude.

(2) Moderate degrees of speech compression may improve the listening efficiency (amount learned per minute of listening) of men of high, average, and low aptitudes.

(3) The rate of speech is the primary limiting factor in the comprehension of listening selections subjected to more than about 40% compression, when a base speech rate of 175 wpm is used and the material is fairly high in redundancy. For very low-redundancy material, the signal distortion due to the compression process may act to limit comprehension.

(4) Because listening efficiency may improve with the use of time-compressed speech, the time saved might be used to selectively enlarge on certain aspects of the material, but the present results suggest that mere repetition of the materials may not increase peak comprehension.

(5) The low aptitude men display a deficiency in recognizing individually spoken words. This may account, in part, for some of their reading and listening difficulties.

These findings indicate that in some instances listening materials may be as useful as reading materials for training men of all aptitudes.[1]

[1]Additional data, obtained from questionnaires used in REALISTIC research to be reported elsewhere, suggest that about one-fourth of the Army input would prefer to listen rather than to read for information. This suggests that the potential motivational value of listening materials in inducing men to study should be explored.

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INTRODUCTION

Recent reports (1) indicate that many lower mental aptitude men inducted into the armed services read at a sixth grade level of ability or below. Of the new standards accessions under Project 100,000, 27% read at or below the fourth grade level; that is, they are functionally illiterate.

However, the functioning of these lower aptitude men with respect to listening is unexplored. It is possible that replacing requirements for reading with requirements for listening might result in improved training and/or job performance of these men. Such improvement might be expected if listening skills are better than reading skills, or if motivation to study is improved by substituting listening for reading requirements. In either event, the outcome would be consistent with the directives of the Guidance Paper for Project One Hundred Thousand (31 March 1967), prepared by the Office of the Secretary of Defense, Assistant Secretary of Defense (Manpower), with its emphasis on "How to improve our techniques of motivating and training Category IV men by removing the obstacles and conditions which cause them to fail." (p. 7)

The present report describes the results of several studies concerned with listening skills of men of various mental aptitudes, as determined by the Armed Forces Qualification Test (AFQT). In Part I, comparisons of reading and listening skills are presented for men of average and low mental aptitude levels.

In Part II, several studies are reported in which listening ability is evaluated by varying the word rate of recorded listening selections. Recent developments (2) permit the acceleration of recorded listening selections to allow listening rates comparable to silent reading rates, with only slight losses in comprehension. The studies in Part II are concerned with the ability and limitations of men of various aptitudes to learn from accelerated speech. In addition, the separate effects on listening comprehension of speech rate, distortion due to the compression process, and certain linguistic variables have been studied.

Part III presents a summary of Parts I and II, and a discussion of some educational and training implications of these studies.

Part I

READING VERSUS LISTENING

Many studies have indicated that listening may be as effective as or superior to reading for some instructional purposes. Duker, in his annotated bibliography (3) of more than 800 articles on listening, comments on 33 studies that compare reading and listening test performance for children and adults. Of 15 studies using adult subjects (mostly college students), eight reported no differences in reading or listening test scores, six favored listening, and one reported that listening was best with narrative material while reading was best with descriptive material.

Eighteen articles annotated by Duker used children as subjects. The general finding was that in the early grades (first through fourth or fifth) listening was likely to be more effective than reading, while in the higher grades reading became as effective or more effective than listening.

These studies suggest that, in some instances, listening might prove a more effective training technique than reading. The present study compares the relative effectiveness of reading and listening for instructing men of different aptitude levels. The possibility that listening might prove superior to reading in the case of the lower aptitude men was of particular interest.

METHOD

Materials

Two comprehension tests, A and B, were constructed to determine the relative effectiveness of reading as contrasted with listening (see Appendix A). Each test consisted of four selections. Two articles were prepared by the author and two articles were taken from military literature of the kind the men might encounter later on in their military careers.

Grade difficulty level of each article was determined by use of a modified Flesch method (4). For Test A, the average grade levels of the four articles were 6.5, 7.5, 7.5, and 14.5; for Test B, they were 6.5, 7.5, 14.5, and 14.5. The results for the selections having the same grade level of difficulty were combined when computing the subject's scores.

A "fill-in-the-blank" test of comprehension was prepared for each selection included in both tests. All questions were of a factual nature, requiring, for a correct reply, information contained in the selection.

Both Test A and Test B served as reading and as listening tests. Group I read Test A and listened to Test B. Group II read Test B and listened to Test A. The reading scores for both groups were then combined, as were their listening scores. This counterbalancing ensured that possible differences in group reading and listening scores would not be due to test differences.

Subjects

Ninety-six Army inductees received for basic training at Fort Ord, California during the Fall of 1967 served as subjects. The men were divided into two groups, Group I and Group II, in order that the counterbalancing procedure described above might be carried out. The men were assigned to each group to form two mental aptitude categories based on their AFQT scores. The low mental aptitude (LMA) category consisted of those men with AFQT scores of 30 or below (i.e., Category IV personnel). The mean AFQT score for this group was 18.3. The average mental aptitude (AMA) category included men with AFQT score of 31 or above and the mean AFQT score was 63.0. Considering Group I and Group II together, there were 40 LMA men and 56 AMA men. The selection of men for the experiment was unsystematic, except that they were chosen from the daily input to the reception station so as to form the aptitude group described above.

Procedure

Testing was carried out in four experimental sessions, each on a different day, with 25 men tested each day. Four were subsequently dropped because their AFQT scores were not available. On the first day, the men read Test A and listened to Test B. Reading time for each selection was limited to the amount of time required to present the same selection orally, in recorded form. In taking the reading test, the subjects first read a selection, and then turned immediately to the test for that selection. They read the questions and attempted to answer them. There was no time limit for completing the test.

For the listening test, the men listened to tape-recorded selections presented by means of a loudspeaker. The loudness of the recording was adjusted to a "comfortable" listening level, as determined by three staff members. The selections were clearly audible throughout the testing room. Following each selection, the experimenter read aloud the test questions for that selection. Each question was read twice, and was repeated a third time if requested. There was no time limit for completing the test.

The procedure for the second experimental session was the same, except that the men read Test B and listened to Test A. The remaining two experimental sessions repeated the program of the first two sessions, except that the order of administration of the tests was reversed.

In all sessions, the men were instructed that the purpose of the tests was to find out how much they remembered about what they read (or listened to). They were told that there was no time limit for the tests, and that if they didn't know the answer to a question they should guess, as there was no penalty for guessing.

RESULTS AND DISCUSSION

Scores on the subtests of the reading and listening tests were converted to percent-correct scores. The reading scores for Groups I and II were combined, as were their listening test scores, in keeping with the counterbalancing procedure described above.

The mean scores and standard deviations of the reading and listening subtests for both mental aptitude groups are presented in Table 1. It is apparent that there are only slight, inconsistent differences between reading and listening scores within both the LMA and AMA groups, and none of these differences

Table 1

Mean Percent-Correct Scores for Low and Average Mental Aptitude Groups on the Listening and Reading Subtests

Aptitude Group	Average Grade Level of Material					
	6.5		7.5		14.5	
	Listen	Read	Listen	Read	Listen	Read
LMA ($N=40$)						
Mean	52.9	51.7	52.5	43.0	25.5	26.0
SD	20.0	27.4	16.3	19.5	13.4	17.8
AMA ($N=56$)						
Mean	72.3	72.5	69.5	65.2	44.9	48.7
SD	19.9	21.0	15.9	18.5	19.8	20.6

is statistically significant. Although a high mental aptitude group was not separately analyzed, of eight men having AFQT scores of 90 or above four did better on the reading test, and four did better on the listening test, but in no case was the difference of a significant magnitude.

These results indicate that men of low and average aptitudes may obtain information—whether simple, or of a more difficult nature—equally well by reading or listening, when the time available for both activities is equated. This is of special interest with regard to the low aptitude men because it suggests that their comprehension problems in reading situations may be due to general inadequacy in language skills, rather than to difficulties in performing the visual-to-auditory decoding skills demanded in reading.

It should be mentioned, however, that this conclusion applies primarily to the group scores. It was observed that some individuals performed consistently better on the listening than on the reading tests, and vice versa. For an efficient training program, a choice of listening rather than reading materials for instructive purposes should take into account the individual differences in these skills.

Of additional interest in Table 1 are the differences between the LMA and AMA groups, and the effects on reading and listening scores of increasing the difficulty level of the material.

The large differences between mental aptitude groups were not unexpected, since the assignment to groups was based on AFQT scores that are derived from tests requiring verbal and reading skills. It appears that for both reading and listening, mental aptitude is a critical variable in determining test performance.

The reading and listening performance of both groups declined as the difficulty level of the material was increased. This suggests that, as far as group scores are concerned, the modified Flesch formula may be useful for predicting both the readability and the listenability of materials. However, in view of the contradictory evidence concerning the adequacy of readability formulas for predicting listenability (5) and the limited scope of the present study in this area, these results should be regarded with caution.

The conclusion to be drawn from this comparison of reading and listening is that a variety of factual information, ranging from quite simple to very difficult, may be communicated equally well through reading or listening activities of men of average and low aptitudes. Part II of this report explores further the possibility of presenting information by aural means to men of various aptitude levels.

Part II

PRESENTING INFORMATION FOR INSTRUCTION BY LISTENING

The Comprehension of Time-Compressed Speech: Experiment 1

One drawback to listening for instructional purposes is that it is a relatively slow process. In general, listening rate is limited by the speaker's rate of speech. Now, however, a technique has been developed for speeding up the playback time of a recorded message without producing frequency multiplication with its attendant "chipmunk" sound (2). The technique is analogous to the process of clipping out small segments of magnetic tape, and splicing the remainder together. The result is accelerated speech without annoying changes in vocal pitch. (A more detailed description of the compression equipment and process is provided in Appendix B.)

Accelerating the playback time of a recorded message results in the presentation of the message in less than the original recording time. Therefore, accelerated speech is sometimes referred to as time-compressed speech. Previous research (6) has indicated that men of moderate and higher aptitude levels (determined by scores on the Technical Specialist Aptitude Index of the Airman Classification Battery) can grasp technical information without serious losses in comprehension with accelerated speech having word rates up to about 280 words per minute (wpm). This is a listening rate some 66% faster than the professional oral reader's average rate of 175 wpm (2). It is also a listening rate comparable to the average silent reading rate, and thus constitutes a satisfactory rate to be used in a training program that emphasizes listening comprehension.

To evaluate the possibility of using time-compressed speech as a teaching method for men inducted into the Army, data have been obtained in the present study comparing men of low, medium, and high mental aptitudes with respect to their ability to comprehend time-compressed speech.

METHOD

Materials

A selection on the use of Carbon 14 for estimating the age of prehistoric remains, taken from the Sequential Test of Educational Progress, Form 1A, Part I, (7) was used to evaluate a man's ability to comprehend compressed speech. This article was selected because it was believed that its content would be novel to practically all the subjects. The article was available from previous research in six compression ratios, from which three were selected for the present study: 0, 36, and 59%. The zero-compression (normal) version was recorded by a professional reader at a rate of 175 wpm. After 36% compression the word rate was 275 wpm, and after 59% compression the rate was 425 wpm.

A 20-item "fill-in-the-blank" test was prepared to evaluate how well the men comprehended the listening selection presented at either 175 (normal), 275, or 425 wpm. The test questions required the recall of factual information contained in the listening selection (e.g., "What was the number of the special carbon?"). The tests were scored by counting the number of correct responses.

Subjects

Subjects were 135 Army inductees received for basic training at Fort Ord, during the Fall of 1967. Seventy-two of these men also participated in the comparison of reading and listening discussed in Part I.

The 135 men were divided into three mental aptitude categories: Low, Medium, and High, according to their AFQT scores. The range of AFQT scores was: for the Low category, 10-30; for the Medium category, 31-64; and for the High category, 65-100.

The 45 men in each aptitude category were divided into three subgroups: One group listened to the non-compressed material, a second group listened to this material presented at 275 wpm, and the third group listened to it presented at 425 wpm. Since there were three mental aptitude categories and three speech rates, there were nine experimental conditions. Men were assigned to an experimental condition as they became available. The AFQT scores in a given mental category were comparable across the three speech rate conditions.

Procedure

For any one speech rate condition, men of high, medium, and low mental aptitude were tested together in the experimental classroom. The listening selections were presented by means of loudspeakers located in the classroom. The loudness of the selections was adjusted to a "comfortable" listening level (as determined by three staff members) and they were clearly audible throughout the classroom.

All men were instructed that they were going to be tested on how well they could remember the listening selection. Men who listened to the normal (175 wpm) word rate were then presented with the test selection, and immediately thereafter were administered the 20-item test. The test questions were read aloud twice by the experimenter and repeated if requested, with no time limit for answering.

Men who listened to compressed speech were instructed that they would first listen to a brief warm-up passage to permit them to adjust to listening to the rate of speech they would hear. They were told that following the warm-up passage they would listen to the test selection and then would be questioned about the content of the test passage.

RESULTS AND DISCUSSION

The mean comprehension scores and standard deviations were computed for each group (see Table 2). An analysis of variance (8) was performed on these data, the results of which are presented in Table 3. As indicated, both main effects of speech rate and of mental aptitude were significant ($p < .001$), while the interaction of these two factors was not significant.

The mean scores were transformed to percent-correct scores for presentation in Figure 1. It is clear that test performance is better for men whose mental aptitude is higher, regardless of speech rate. This figure suggests an interaction of mental aptitude and speech rate such that increasing the speech

Table 2

Mean Scores Obtained With the Listening Test Presented at Three Word-Per-Minute Rates to High, Medium, and Low Aptitude Groups

Aptitude Group	Speech Rate (wpm)		
	175	275	425
High			
Mean	15.7	14.9	9.4
SD	2.2	2.2	4.2
Medium			
Mean	11.7	10.3	6.4
SD	3.9	1.4	3.1
Low			
Mean	6.8	6.0	3.6
SD	2.0	2.8	1.7

Table 3

Summary of Analysis of Variance of the Compressed Speech Data

Source of Variation	*df*	MS	*F*
Speech Rate (A)	2	308.05	38.89[a]
Mental Aptitude (B)	2	695.21	87.77[a]
Interaction (A x B)	4	13.10	1.65[b]
Within cells	126	7.92	

[a]Statistically significant ($p < .001$).
[b]Not significant.

rate has a greater disrupting effect on test performance with the higher aptitude than with the low aptitude men.

This possibility is shown more clearly in Figure 2, in which speech rate has been plotted on the abscissa, and mental aptitude is the internal parameter. From Figure 2 it can be seen that the differences between the three mental aptitude groups remain fairly constant with the normal and 275-wpm speech rates. However, there seems to be a converging of the three curves with the speed-up of the speech rate to 425 wpm, and these curves would probably converge if much faster rates of speech were used. Under such circumstances all groups would perform at a chance level.

Such a convergence has been found for men of high and moderate aptitudes who were presented messages with speech rates of 500 wpm or greater (6). The lack of such rapid speech rates, and hence a lack of sufficient convergence of group scores, may account for the nonsignificant interaction effect in the analysis of variance of the present data.

For all three aptitude groups, comprehension declines only slightly with an increase in speech rate up to 275 wpm, and then declines more rapidly. These results are consistent with previous observations (2, pp. 19-20). There appears to be some special significance attached to a speech rate around 275 wpm; exceeding this rate accelerates a decline in comprehension.

Comprehension Scores for the Three Message Presentation Rates as a Function of Mental Aptitude

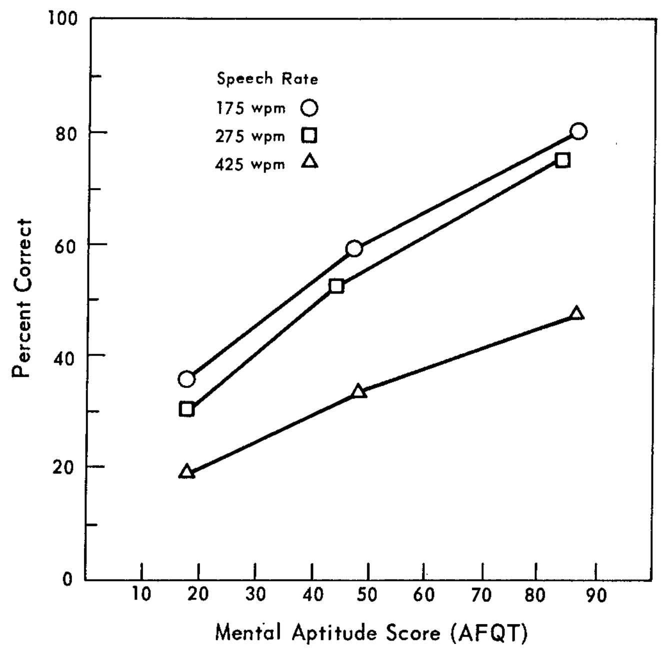

Figure 1

From Figures 1 and 2 it is apparent that for all three mental aptitude levels the time required to present the message can be reduced by time compression as great as 36% (275 wpm) without greatly disturbing performance. In fact, from Figure 1 it can be determined that the performance of the high aptitude men with listening time compressed by 59% (425 wpm) was similar to the performance of the medium and low aptitude men with listening time compressed by 36% and 0% respectively. Assuming that this performance differential might be generalized across a number of other activities, these results suggest that training or education criteria and schedules geared toward the student of average aptitude may be accomplished by high aptitude students in considerably less time.

Comprehension Scores for the Three Aptitude Groups as a Function of Message Presentation Rate

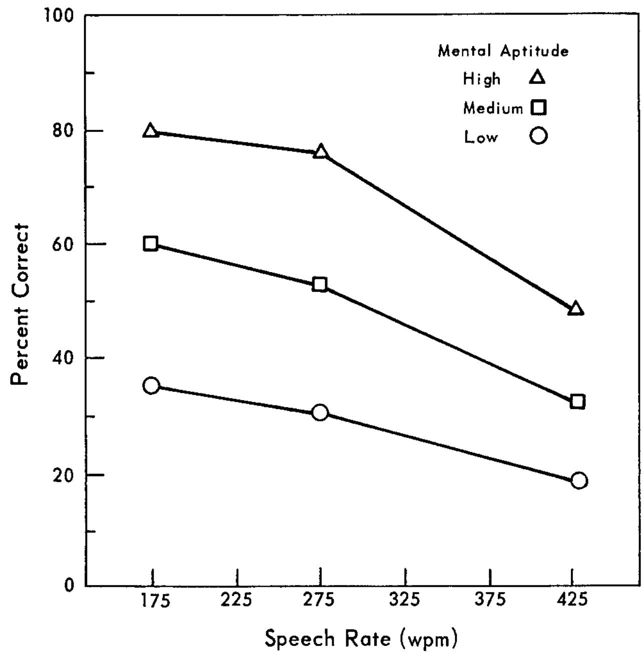

Figure 2

Another way to regard the listening and comprehension relationship is to consider the efficiency of listening time. For the low aptitude men in this study there was a 4% decrease in comprehension when the speech rate was increased to 275 wpm. However, with the 275-wpm rate there is a 36% reduction in the time required to present the message. Thus, for a 36% savings in time, there occurred only a 4% drop in comprehension. This indicates that it was less efficient, in terms of listening time, to use the normal rate of speech.

Listening Efficiency Curves for the Three Aptitude Groups as a Function of Message Presentation Rate

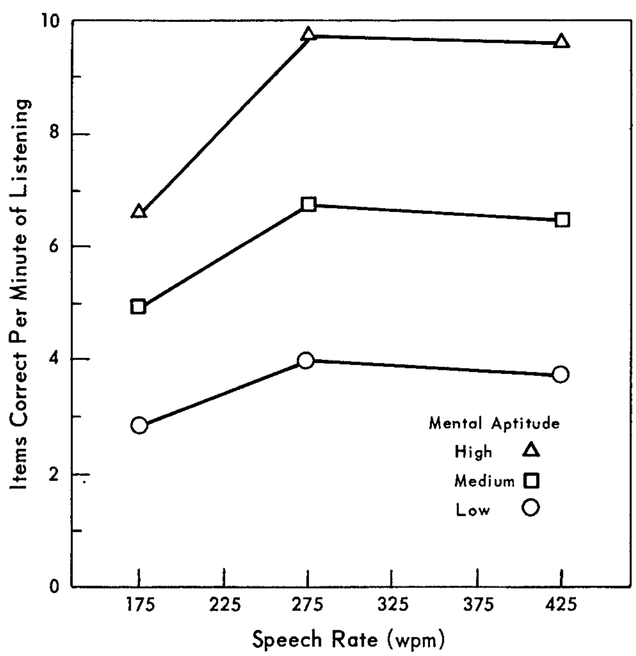

Figure 3

In Figure 3, the data from Figure 1 have been presented in terms of the number of test items correctly answered per minute of listening time. This graph shows that listening efficiency increased for all three aptitude groups with the 275-wpm speech rate, and then declined very slightly with the 425-wpm rate. Thus the decline in comprehension evidenced in Figure 2 with the increase in speech rate to 275 wpm is more than compensated for by the reduction in time required to present the message. Such findings have been previously observed (9), using blind subjects.

The fact that listening efficiency increased for all three mental aptitude groups in the present study has certain implications for education and training. Since the reduction in listening time may exceed the reduction in comprehension, it may be possible to improve comprehension by using the extra time to review, repeat, or extend what was originally presented. Experiment 2 was performed to determine whether, indeed, repetition of compressed messages might improve comprehension.

The Comprehension of Repeated Time-Compressed Recordings: Experiment 2

When recorded speech is time-compressed, the amount of time required to present the speech is reduced. If a message is compressed by 50%, it is possible to present the compressed version twice in the same amount of time required to present the uncompressed version once. Fairbanks et al. (10) compared the comprehension of material compressed by 50%, but presented twice, with the comprehension of the uncompressed material requiring the same amount of time for presentation. They found a slight improvement in comprehension with the repeated, time-compressed message. The double presentation appeared more successful with men of moderate than of high mental aptitude. This suggested that the repetition procedure might prove more successful with the low aptitude men of concern in the present studies. Hence, several repetition procedures were used to determine whether performance of high and low aptitude men could be improved over that for a single presentation of uncompressed material.

METHOD

Materials

The selection on the use of Carbon 14 for dating relics, used in Experiment 1, was used in this study; the listening selection was available in compression ratios of 36, 46, 53, and 59%. The same 20-item "fill-in-the-blank" test used in Experiment 1 was used in the present study.

Subjects

Eighty Army inductees served as subjects. Forty had AFQT scores less than 30 and formed the low mental aptitude (LMA) group. The remaining 40 men had AFQT scores of 87 or above and constituted the high mental aptitude (HMA) group.

Procedure

The 40 men in each aptitude group were subdivided into four groups of 10. Each group of 10 listened to a different pattern of repeated presentations of the listening selection. One subgroup listened to the passage compressed by 36%, and then the passage was repeated with 59% compression. A second subgroup heard the 59% compressed version first, and then the 36% compressed version.

A third subgroup listened to the passage presented at 46% compression, followed by the same passage presented at 53% compression. The fourth subgroup listened to the same versions as the third group, but with the order of compression ratios reversed.

Listening time for the uncompressed message was 2 minutes, 35 seconds. To listen to the message presented once at 36% compression, and then again at 59% compresion, required 5% more time than needed to listen once to the uncompressed message. For listening to both the 46% and 53% compressed versions, the time required was 1% more than that necessary to listen to the uncompressed message.

The recordings were presented to each man individually, in a sound-deadened room, by means of a tape recorder. Subjects listened to both versions of the repeated message before taking the comprehension test. The comprehension score was the percent of items correctly answered on the test.

RESULTS AND DISCUSSION

The results are presented as the outline symbols in Figure 4. In this figure, the bottom scale presents the compression ratios, while the top scale gives the corresponding speech rates in words per minute. In each instance, the upper numerals in the paired values on the scales indicate the compressed version presented first.

For comparative purposes the filled symbols are included in Figure 4, to show how men similar to those of the present study scored on the same listening selection when it was presented only one time, at the compression ratio indicated by the upper numerals on the scales. These data were obtained from the men of Experiment 1 who were matched as nearly as possible to the men of the present study with respect to AFQT score. Ten men were included in each of the mental aptitude subgroups.

The dotted lines in Figure 4 are reference lines showing the comprehension level for the single presentation of the uncompressed passage for the low and high aptitude men. Better performance due to listening to repeated compressed passages (outlined symbols) would be indicated by scores above the reference line.

Comprehension Scores for High and Low Aptitude Men for One and Two Compressed Presentations of a Listening Selection

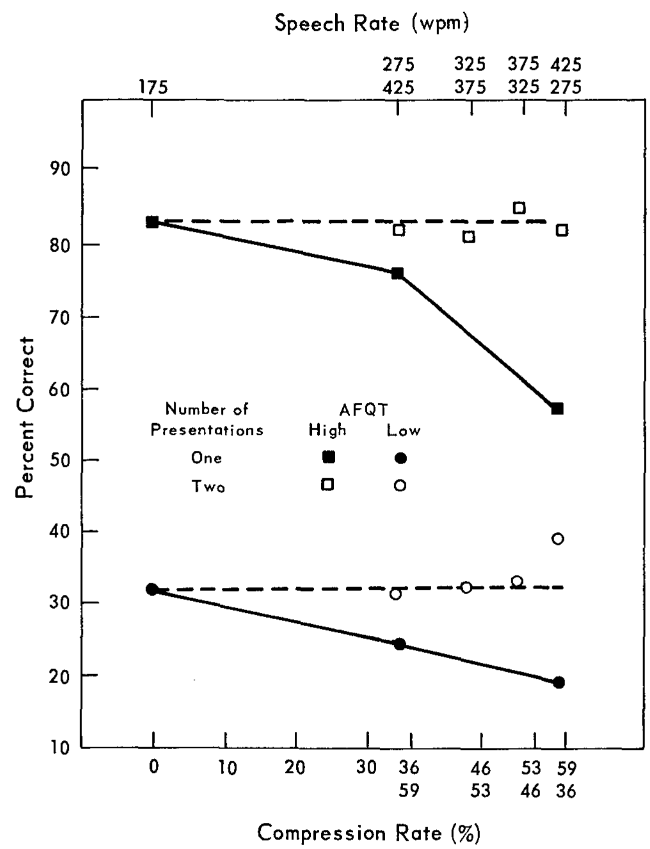

Figure 4

Three aspects of these data are notable:

First, listening to the selection twice, with the various conbinations of compressed material, did not improve performance over that obtained with one presentation of the uncompressed story. This was true for both HMA and LMA groups.

Second, the sequence of presentation did not differentially affect performance. The only suggestion that the sequence of presentation may have improved performance is with the LMA group and the 59%-36% sequence. However, the score for this sequence is not significantly higher than that for the single presentation of uncompressed speech nor the presentation of the 36%-59% sequence (Fisher exact probability test, 11).

Third, repeating the selection with the fast word rates accompanying 46% and 53% compression (325 and 375 wpm) results in better performance than would be estimated for these rates from the curves for the single presentations. The fact that there is a notable decrease in comprehension with single presentations of word rates of 325 or 375 wpm is well documented for a variety of materials (2). The better performance of the HMA and LMA groups in this study indicates some benefit from the second presentation of the listening selection; however, their performance level was not above that for the single presentation of the uncompressed passage.

As mentioned earlier, Fairbanks et al. (10) reported a very slight improvement in comprehension with double presentation of compressed material over that obtained with a single presentation of uncompressed material. This improvement was more marked with men of moderate than of higher aptitudes. The results of the present study, which show no improvement of peak comprehension with repeated presentation of material for either low or high aptitude groups, would appear to confirm the marginality of the findings of Fairbanks et al. It should be noted that in both the Fairbanks study and the present one, technical materials were used as listening selection; possibly results would be different for less difficult technical or literary compressed materials.

The Intelligibility of Normal and Time-Compressed Speech as a Function of Mental Aptitude: Experiment 3

A finding common to the preceding studies of Parts I and II is that the performance of low aptitude men is poorer than that of higher aptitude men on listening tasks involving both normal and compressed speech. Since the low aptitude men also perform poorly on the reading test, it seems likely that, at least in part, some general language deficiency may account for their performance. In the present experiment, the question is raised as to whether such a deficiency might operate at the level of simple recognition of words presented one at a time, in either normal or compressed modes. Any such deficiency in the ability to recognize words might partially account for the poorer performance of the lower aptitude men on the listening tests of the previous studies.

METHOD

Materials

One hundred words from two phonetically balanced word lists (12) were used for obtaining intelligibility scores. The words were obtained from tapes containing the word lists spoken by a professional reader for the American Printing House for the Blind in Louisville, Kentucky. The words were presented at one of four compression ratios—0, 36, 53, or 59%—to which they were assigned randomly, but so that no word occurred twice. There were 26 words presented at 0% and 36% compression, and 24 words presented at 53% and 59% compression. The compressed words were placed onto one tape in a random sequence for presentation to the men, and the time interval between words was never less than eight seconds.

Subjects

The intelligibility tests were administered to 72 of the Army inductees who participated in the reading and listening comprehension comparison described in Part I of this paper. Subjects were divided into three mental aptitude groups—High, Medium, and Low—on the basis of their AFQT scores. The mean AFQT scores for these three groups were, respectively, 79, 38, and 16. There were 24 men in each category.

Procedure

Subjects were administered the intelligibility test following the completion of the listening and reading comprehension tests. They were told that they would hear a list of words presented by means of the loudspeaker, and were instructed to write down each word as they heard it on the answer sheet provided. The intelligibility score was the percent of correctly identified words. Words were scored as correct without regard to spelling mistakes, so long as the word as written was pronounced the same as the word transmitted; thus "dum" was acceptable for "dumb" while "dome" was unacceptable because of the difference in pronunciation.

RESULTS AND DISCUSSION

Means and standard deviations of the percent-correct scores are presented in Table 4, while Table 5 provides the summary of the analysis of variance performed on the data. Both main effects of compression ratio and aptitude level are significant, as is the interaction of these factors ($p < .001$).

In Table 4 it can be seen that intelligibility decreases for all aptitude groups as the amount of compression is increased, which is consistent with previous research (7). The slight reversal in the monotonic decline in intelligibility scores observed with the HMA group may be due to the fact that the tape for the 53% compression condition was slightly noisier than the

Table 4

Mean Percent-Correct Scores for Low, Medium, and High Aptitude Groups for the Four Word Compression Ratios on the Intelligibility Test

Aptitude Group	Percent Compression			
	0	36	53	59
HMA				
Mean	91.6	81.1	67.6	71.2
SD	4.6	5.8	10.0	9.3
MMA				
Mean	88.0	75.3	64.5	61.7
SD	6.3	8.0	11.6	8.5
LMA				
Mean	74.9	71.5	59.8	56.8
SD	16.7	14.6	14.3	13.5

Table 5

Summary of Analysis of Variance of the Intelligibility Test Data

Source of Variation	*df*	MS	*F*
Between Subjects			
Mental Aptitude (B)	2	3,539.26	10.47[a]
Error (b)	69	337.92	
Within Subjects			
Compression Ratio (A)	3	7,724.00	168.56[a]
Interaction (A x B)	6	181.64	3.96[a]
Error (W)	207	45.82	

[a]Statistically significant ($p<.001$).

others. This noise may have attenuated the scores for the HMA group for this condition. Apparently, however, there was little or no attenuation of scores for the other groups.

Of primary interest is the fact that, for even such basic tasks as discriminating simple, very familiar words and writing them down, there is a difference in performance due to aptitude. Previous research (**13**) has indicated that such differences are not likely to occur. However, in those studies men of very low aptitude were not examined, and it is with such men that the effects of aptitude level are notable in the present study.

The question of why the LMA group performed so poorly, relative to the HMA group, is not easily answered. One possibility was that spelling errors may have occurred more often among the LMA group and been counted as wrong because the experimenter did not pronounce the word, as spelled, the same as the subject would. As a test of this notion, spelling tests were administered to a group of LMA and HMA men, using words frequently missed on the intelligibility test. While LMA men made more errors than HMA men on this test, only one word out of 30 was found that might have been scored incorrectly for some LMA men. Spelling errors were, therefore, discounted as a cause of the differences between LMA and HMA groups (Table 4).

Another possible explanation for the differences between intelligibility scores for the LMA group and the other two groups is that the LMA men did not attend as carefully as the others, either because they did not want to, or because they could not. Observation of the group during the test administration failed to reveal any obvious differences in overt behavior that would indicate voluntary inattentiveness. Consideration was therefore given to the possibility that the LMA men, considered as a group, have difficulty in attending due to some factor inherent in the group. The hypothesis was formulated that these men may have difficulty in switching attention from one situation to another, especially when the first is somewhat challenging to them. Thus, in the intelligibility test, it may have been that when LMA men were trying hard to recognize, or spell, one word, a second word appeared that also made demands on them. They may then have fluctuated between these demands, perhaps confusing them, and as a result making incorrect responses to both.

In short, the LMA men may not have the ability to make a quick response, correctly or incorrectly, and then proceed to the next task. It has been reported in other research (**14**) that LMA men take longer to respond to the appearance of a light stimulus than HMA men. It is not unreasonable, therefore, to suggest that there may be some limitations on their ability to respond quickly to a challenging stimulus, and to then direct attention to the next stimulus, as hypothesized in the intelligibility testing situation.

To evaluate this hypothesis, the data for 20 LMA men and 20 HMA men were matched on the basis of total number of errors made on the intelligibility test. It was reasoned that if the foregoing hypothesis were correct, then, disregarding the compression factor, the LMA men should have made more sequential errors than the higher aptitude men because of inability to dismiss a challenging stimulus readily and proceed to deal with the next. The fact that a stimulus was missed was taken to indicate that it was challenging for the subject. It was found that the LMA men made 102 runs of two or more consecutive errors, as compared to 78 such runs for the higher aptitude men. This was true even though high and low aptitude men were matched with respect to the total number of errors made. The difference was significant beyond the .01 level ($p < .01$).[1] While this observation supports the hypothesis that the LMA men may be less capable of switching from one demanding task to the next, a more direct test of the hypothesis would be to present the words at a rate paced by the subject. Under such conditions fewer sequential errors, and perhaps fewer total errors should occur.[2]

A final feature of the data, indicated by the analysis of variance, is the interaction of compression ratio and mental ability. It is suggested by the data in Table 4 that the interaction is probably due to the disproportionately low score of the LMA group at the zero-compression ratio. For the other compression ratios, the scores of the LMA group run parallel to the scores for the other groups. This indicates that compression, per se, does not differentially affect the performance of the three groups. Aptitude is the factor that is of overwhelming importance.

The relatively poor performance of the LMA men on the simple discrimination test with the noncompressed words suggests that at least a part of the reason for their poor performance on the listening (and perhaps reading) tests of Parts I and II may be due to difficulties in discriminating and/or responding to speech sounds. If further research should confirm such a viewpoint, then remedial training in speech discrimination may be recommended as an attempt to improve reading and listening performance of these low aptitude people.

Signal Distortion vs. Speech Rate in the Comprehension of Time-Compressed Speech: Experiment 4

Recorded materials subjected to time compression by the method used in the present series of studies are changed in two ways. First, there is a certain amount of distortion of the speech signal due to the deletion of small segments of the speech waveform. As indicated in Experiment 3, the effects of such distortions of individual words is to render them less intelligible as the amount of deleted material is increased (i.e., as compression is increased). Second, the rate of speech is increased. In Experiment 1 it was found that the comprehension of the listening selection decreased when the speech rate (amount of compression) was increased.

It is not clear what the relative contributions of signal distortion and speech rate may be to the decline in comprehension of materials subjected to high-compression ratios. If this decline is due primarily to the rate of speech, then it is indicative of some limitation in human information-processing skills. On the other hand, if it is due primarily to signal distortion, then the limitation rests more on the compression processing equipment and techniques. These

[1]One-tailed sign test for matched pairs.
[2]This research has yet to be done.

propositions show clearly that interpreting the results of studies using speech compressed by the sampling method of the present series requires a distinct separation of the effects of speech rate and signal degradation or distortion. In general, the effects of speech rate point to human failure, while the effects of signal quality point to instrumentation problems.

The present study was conducted to evaluate the relative effects of signal distortion and speech rate on the comprehension of time-compressed speech. To do this, comprehension test scores were obtained for a listening selection presented first at 0% compression (i.e., normal), and then at 40% compression. The 40% compressed version was then expanded to produce a word rate equal to the normal version. The expansion process preserves the distortions in the compressed tape, and adds further distortion.

It was reasoned that, if speech rate is more important than signal distortion in reducing comprehension, then restoring the speech rate of the compressed story to normal, through the expansion process, should result in comprehension test scores equal to those obtained with the uncompressed selection. If this did occur, the demonstration of the effects of speech rate over those of signal distortion would be even more emphatic, since the compressed/expanded speech would contain much more distortion than speech subjected only to compression.

METHOD

Materials

Three listening selections were prepared, each concerned with some activity related to military service. The first selection was a brief segment from a combat situation, the second provided fire-drill instructions, and the last described the transfer unit of a 2 ½ ton truck. The grade level of difficulty of the selections, as estimated by a modified Flesch formula (4), was 6.5, 7.5, and 14.5 respectively.

The listening selections were prepared in (a) an uncompressed (0% compression) version; (b) a version compressed by 40%; and (c) a version compressed by 40% and then expanded by 40%.[1] With the device used in this study (see Appendix B), this procedure preserves the distortions due to the compression process, but restores the speech rate to that of the uncompressed version.

Comprehension was tested by means of 12 "fill-in-the-blank" questions prepared for each of the three selections, making a total of 36 possible points for the complete listening test.

Subjects

The subjects were 87 Army inductees, all with AFQT scores of 80 or higher. Thirty-three men listened to the 0% compressed version, 29 to the 40% compressed version, and 25 to the 40% compressed/expanded version.

Procedure

The three groups were tested on three different days in an ordinary classroom, seated in a semi-circle about the tape recorder used to present the listening selections. They were told that they were to be tested to determine

[1]Although referred to as 40% expansion with the rate changer, there is actually a 67% increase required in the amount of tape containing the compressed message to restore the message time to normal.

how well they could remember some listening selections, and that following each selection they would be asked some questions and were to write the answers on the answer sheet. Any questions from the men were then answered. Following this, the listening selections and comprehension tests were administered as indicated. The same procedure was followed for the uncompressed, the compressed, and the uncompressed/expanded versions of the listening selections.

RESULTS AND DISCUSSION

The results are summarized in Table 6. As indicated, the compression process produced a significant reduction in the comprehension of the listening selections. This finding is consistent with the results of Experiment 1.

Of particular interest is the fact that the comprehension test scores for the uncompressed and compressed/expanded versions of the listening selections are not significantly different; the compressed and compressed/expanded scores are significantly different ($p < .01$). This indicates that restoring the speech rate of the compressed selections to normal restores the comprehension to normal—despite the fact that the compressed/expanded condition contained signal distortion due to both the compression process and the expansion process.

Table 6

Comprehension Test Scores for Groups Who Listened to Either Uncompressed, Compressed, or Compressed/Expanded Recordings

Listening Selection	AFQT Mean	Items Correct[a]		
		Mean	SD	Percent
Uncompressed	87	25.3	3.7	70.4 A
Compressed (40%)	88	18.1	4.0	50.3 B
Compressed (40%)/ Expanded	88	24.4	4.2	67.9 C

[a]The means for A and B differed significantly ($p < .01$); those for A and C did not.

The present results are consistent with previous research (7) which concluded that rate of speech, and not the reduced intelligibility of the signal, is the greater contributer to the decline in comprehension observed with the higher-compression ratios. Apparently the redundancy of the spoken language is such that considerable signal degradation can occur without seriously interfering with comprehension of the information in the message.

It seems certain, however, that if sufficient signal distortion were introduced, comprehension would decline. Also, it is likely that signal distortion would have a more disrupting effect on low-redundancy material. Experiment 5 explores further the effects of speech rate, signal degradation, and various redundancy factors on listening comprehension.

Interactions of Speech Rate, Signal Distortion, and Certain Linguistic Factors in Listening Comprehension: Experiment 5

In Experiment 4 it was concluded that signal distortion introduced into three listening selections by the time-compression process was not a significant factor in reducing the comprehension of the selections. That conclusion was based on a procedure that involved increasing the signal distortion in a compressed message while restoring the speech rate by the expansion process. Such a procedure is a "brute force" method for demonstrating that speech rate is the more important variable in reducing the comprehension of compressed speech, at least with normal prose material.

A more analytic method for studying the effects of signal distortion and speech rate on listening comprehension is to vary these factors separately, the approach that was used in the present study. Several versions of listening materials were prepared in which the speech rate was varied while the amount of compression of the individual words in the message was either held constant or varied systematically. Thus it was possible to evaluate the separate effects of speech rate or signal distortion on comprehension.

As indicated in Experiment 4, it seems likely that the effects of signal distortion on comprehension are attenuated by the high redundancy of the English language (for a discussion of redundancy and noise and interactions thereof, see Miller, 15, p. 106). In the present study, certain linguistic factors that lead to redundancy (e.g., the sequential constraints imposed by syntactical rules) have been manipulated to determine some interaction effects of these factors and signal distortion on listening comprehension.

METHOD

Materials

To distinguish the effects of word distortion due to the compression process from the effects of word rate, listening selections were presented in which these parameters were varied separately. To accomplish this, the phonetically balanced (PB) word lists presented in Experiment 3 were used, subjected to 0, 36, and 59% compression.

From the recorded lists of PB words, words were selected and arranged into two brief listening selections. One selection was composed of 63 words, the other of 82 words (see Appendix C). To vary the speech rate of the uncompressed stories, the words in the stories were first recorded directly adjacent to one another, with no time interval between them. This process resulted in a word rate of 100 wpm ($\pm$ < 2% variation) for each of the two listening selections. This was the fastest speech rate possible with the 0% compressed words.[1] A second, slower speech rate was obtained by inserting a time interval of 180 milliseconds between words, which produced a speech rate of 75 wpm. Thus, for the two selections made up of uncompressed words, two rates of speech, 75 and 100 wpm, were available.

Listening selections composed of the words compressed by 36% were prepared in the same manner as with the uncompressed words. When recorded with no time interval between words, the speech rate was 155 wpm. By introducing temporal intervals of 222 and 402 milliseconds between words, speech rates of 100 and 75 wpm were obtained. Using similar techniques, the listening selections were recorded with 59% compression. When recorded with no temporal interval between words, the speech rate was 222 wpm. By inserting time intervals of 111, 333, and 513 milliseconds between words, versions of the listening selection having speech rates of 155, 100, and 75 wpm were prepared.

Through the procedures outlined above, nine different versions of the two listening selections were obtained. In two versions, the words were not compressed, and speech rates of 75 and 100 wpm were produced. In three versions,

[1]The limitation in speech rate is discussed further on page 22.

the words were compressed by 36%, and word rates of 155, 100, and 75 wpm were produced. In four versions, the words were compressed by 59%, and rates of speech of 222, 155, 100, and 75 wpm were obtained.

To compare the effects of distortion due to compression, while holding speech rate constant, comprehension was tested on the selections presented at either 75 or 100 wpm, with compression ratios increasing from 0 to 59%. To compare the effects of speech rate, with distortion due to compression either omitted or held constant, changes in comprehension of the passages within a category of percent compression (e.g., the two versions with noncompressed words) were determined.

Because the words used in composing the two listening selections were individually pronounced, the selections contained no inflectional cues of emphasis or meaning. There were also no cues of transition from one phrase or sentence to another. In short, linguistic cues to meaning were restricted, in each selection, primarily to cues from the sequential constraints of the language, and the lexical meaning of the words.

The use of individually spoken PB words makes possible the isolation of compression and rate factors, relatively independent of other linguistic and semantic variables. However, such speech is not "normal". To determine the effects on comprehension of removing inflectional cues, pauses between sentences, and so forth, additional versions of the listening selections were recorded using a natural prose oral reading style in which inflectional and phrasing cues were maintained. In this case, the two listening selections were recorded at an average rate of 158 wpm.

A final listening test was prepared, which consisted of the same PB words used in each of the two selections, but presented in random sequence. This was to determine what effects removal of the sequential constraint from the words in story form might have on the comprehension test. With the random PB words, the sequential constraints of the language were removed, leaving only the lexical meaning of the words.

To test comprehension, the cloze (16) technique was used. Every fourth word was omitted in typed copies of the two listening selections, with a standard-length line inserted in place of the word (see Appendix C).[1] The subjects' task was to fill in the missing words as he read the passage. The test was scored by counting the number of correct words, with only the words actually deleted accepted as correct responses (i.e., no synonyms were accepted).

To find out how well men could perform on the tests without prior exposure to the listening selections, a group of men who had not heard the selections read the tests and attempted to guess the missing words. This procedure provided baseline data to determine improvement due to listening to the stories.

In all there were 12 test conditions, including the baseline tests.[2]

Subjects

One-hundred eighty Army inductees served as subjects, 15 in each of the 12 test conditions. All men had AFQT scores of 80 or above, and there were no significant differences among the mean AFQT scores of the men in the 12 conditions.

[1]If the fourth word was at the beginning of a sentence, the next word was deleted. Articles and conjunctions such as "and" were not omitted; prepositions were not omitted if they were of a routinely evident nature.

[2]These conditions are listed in Table 7.

Procedure

The men in each experimental group were tested together in a classroom. They were informed that they were to listen to two listening selections, and that following each selection they would be tested on how well they remembered what they heard.

Subjects who listened to the stories composed of PB words were told that the selections were prepared in a special way and would not sound like regular speech, so they would have to listen carefully. Following the presentation of each selection, the cloze test for that selection was administered. Subjects were instructed to guess if they did not know the answers.

Subjects who listened to the random words were instructed that they would hear a list of words and would then be administered a test in which they were to use them. They were instructed to listen carefully and to remember as many words as they could. Following the presentation of the PB words used in the first listening selection, the appropriate cloze test was administered. This procedure was then repeated, using those PB words that made up the second listening selection.

The baseline test performance data were obtained in the same classroom as the experimental data and in the manner outlined above.

Presentation of all listening materials was by means of a tape recorder. The loudness was adjusted to a "comfortable" listening level by the experimenter, and all the men indicated they could hear the messages satisfactorily.

RESULTS AND DISCUSSION

The results are summarized in Table 7. In all cases, those groups that listened to the stories on random words performed significantly better (median test, **11**, p. 111) on the cloze test than those who took the test without prior exposure to the missing words in the selections. Thus the listening experiences did improve test performance.

Speech Rate and Signal Distortion

Regarding the speech rate and compression distortion variables, performance was significantly better for the 0% compression - 75 wpm condition than for all other combinations of these variables. There were no significant differences between the scores for any of the remaining speech rate and stimulus compression combinations.

Table 7

Relative Effects of Signal Distortion, Speech Rate, and Linguistic Factors on Comprehension of Listening Selections
($N = 15$ per Test Condition)

Test Condition	Number Correct		Percent Correct
	Mean	SD	
Baseline Test[a]	7.1	2.2	21.4
Random Words	10.9	1.8	33.1[b]
Word Rate of 75 wpm			
0% compression	14.3	5.3	43.4
36% compression	11.1	3.2	33.5[b]
59% compression	10.0	2.5	30.3[b]
Word Rate of 100 wpm			
0% compression	10.1	3.3	30.7[b]
36% compression	10.1	2.4	30.5[b]
59% compression	11.0	3.5	33.3[b]
Word Rate of 155 wpm			
36% compression	10.8	4.7	32.7[b]
59% compression	11.5	2.6	34.7[b]
Word Rate of 222 wpm			
59% compression	10.6	3.2	32.1[b]
Normal Prose (158 wpm)	16.0	3.5	48.4[c]

[a]All test scores were significantly different from the baseline test score.

[b]Scores significantly different from both the 0%-75 wpm and Normal Prose conditions.

[c]Not significantly different from 0%-75 wpm condition.

Holding compression constant, speech rate effects were found only with the 0% compressed selections when the rate was increased from 75 to 100 wpm. This increase produced a significant reduction in test scores. With the individually pronounced PB words it was not possible to produce the very fast word rates that have resulted in large decrements in comprehension in other experiments in this series of studies, and in the work of others (2). The limitation on the rate of speech in the present study was due to the fact that the PB words averaged approximately .6 second in duration when spoken individually. Thus, the fastest word rate possible, with no temporal interval between words, was about 100 wpm. Even when the words were compressed by approximately 59%, and abutted without any interval between them, a top rate of only 222 wpm was obtained. This rate is well within the range which, as indicated by the scores of the higher aptitude men in Experiment 1 (Figure 1), would not be expected to affect comprehension by any significant amount. Quite possibly, faster word rates might reduce comprehension below the levels observed in the present study.

The effects of signal distortion due to compression are indicated by the statistically significant decrease in scores in the 75 wpm condition where the compression was increased from 0% to 36%. The additional compression to 59% produced a slight additional (but not statistically significant) decrease in test performance.

These results contrast with those of Experiment 4, from which it was concluded that signal distortion did not significantly reduce comprehension. At that time it was suggested that signal distortion might be a more potent factor with materials of reduced redundancy. The present study used low redundancy materials. Such aids to efficient message encoding as inflection and phraseology were omitted. In addition, the use of PB words produced many low-probability sequences in the messages.

The results obtained with this low-redundancy material appear to reinforce the suggestion that signal distortion will be a more or less potent factor for listening comprehension depending upon the redundancy of the listening selection.

Further Observations on Linguistic Factors

The material used to study the effects of speech rate and signal distortion in the present study differed from normal connected discourse. In these materials there were no cues to meaning in the form of inflectional cues, phrasing cues, or transitional cues between sentences. There were, however, cues of sequential dependency (albeit reduced, since the men could not be certain at times where contingencies began and ended) and lexical cues.

The importance of these various linguistic factors for comprehension test performance is illustrated in Figure 5. There it is seen that the successive addition of these various cues is associated with improved performance. An additional factor to be considered with the uncompressed, sequenced words and the normal prose passage is the speech rate. For the former the speech rate was 75 wpm, while for the normal prose the speech rate was 158 wpm. A speech rate of 158 wpm falls within a "normal" range of 90-175 wpm, whereas the 75 wpm rate lies outside this range. Hence, the comprehension of the normal prose may have been aided by a more normal time frame, as well as the additional expressional linguistic factors.

It should be mentioned, too, that while the comprehension scores for the sequenced words and normal prose are not significantly different, it is the general trend shown in Figure 5 that is of concern. Because of the differences in

Improvement in Listening Comprehension With Increased Cues to Meaning

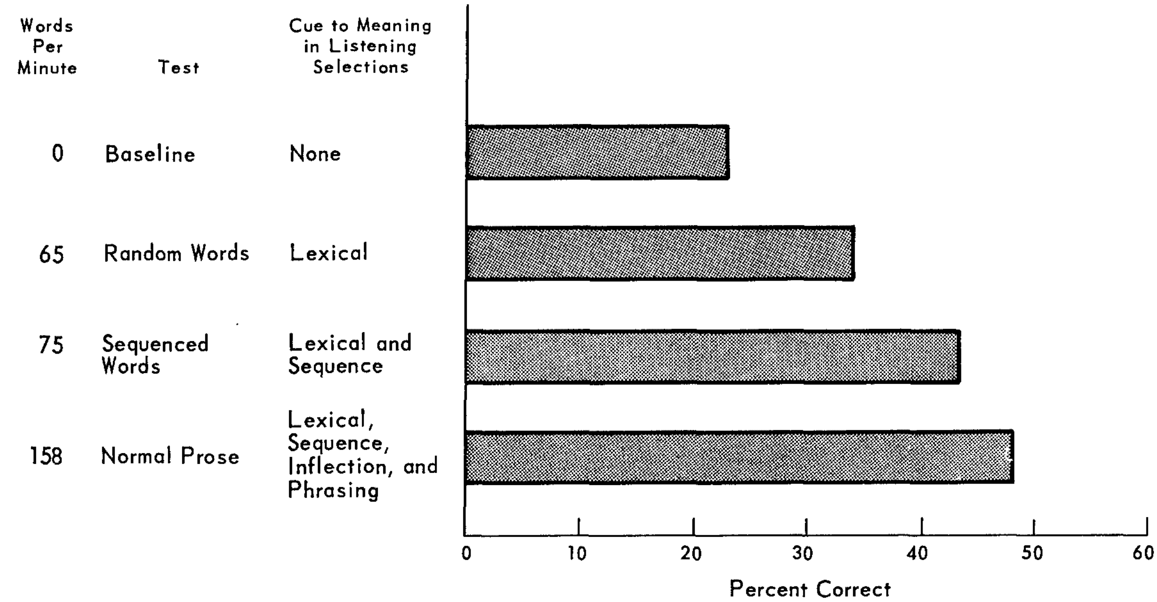

Figure 5

word rate of the three listening conditions, Figure 5 should be considered simply as a qualitative indication of the importance of the various linguistic factors. A more rigorous demonstration would require that word rates be similar.

Performance, Perception, and Storage/Retrieval Processes

In the present study, equal performance was obtained with the randomly presented words and the compressed words presented in story form at 75 wpm. The latter performance was significantly below that obtained with the uncompressed stories presented at 75 wpm. A question of interest is whether the reduction in comprehension indexed with the compressed stories was due to misperception, as commonly found with individually presented words in intelligibility tests, or to storage/retrieval problems (with the posibility of nonperception included as a storage problem).

The answer to this question is suggested by a comparison of the error responses obtained with the uncompressed, randomly presented words, and the compressed stories presented at 75 wpm. Unpublished observations of the error responses in intelligibility tests using compressed PB words indicate that these errors practically always involve a phonemic substitution in the word such that it rhymes with the target word (e.g., such as substituting lay for way).

Thus, if misperceptions were the primary cause for the decrease in performance observed with the compressed materials in the 75 wpm condition of the present study, it seems likely that a large number of the error responses would rhyme with the correct response. If misperception were not the primary factor operating to reduce the comprehension of these compressed materials, then the error responses should equal the heterogeneity of error responses obtained with the uncompressed, randomly presented words, and would not necessarily rhyme with the target word.

An analysis of error responses, as just suggested, showed that the error responses obtained with the compressed materials were as heterogeneous as those obtained with the randomly presented words. This suggests that storage/ retrieval problems, and not misperception, were apt to be instrumental in reducing performance with the compressed materials.

The present data shed no light on the nature of the storage/retrieval factors that may have reduced performance with the compressed materials. However, the data are relevant to previous research concerned with speech rate, word duration, and storage/retrieval problems. Arronson (17) conducted studies in which the duration of spoken digits was varied, while the interdigit interval was varied to maintain a presentation rate of three-per-second. Seven-digit sequences were presented to subjects who attempted to memorize each sequence and recall it a few seconds after the presentation. She found that recall accuracy was higher for the briefer stimulus durations with the larger interdigit intervals between them. For a fixed presentation rate, subjects produced fewer errors when the ratio of speech to silent time between digits was decreased. Arronson suggested that the silent time between stimuli may be used for perceptual processing, and hence may be more important than the stimulus duration, at least within some finite limit of the latter.

In the present study the duration of spoken words was varied while the interword interval was changed to keep the presentation rate constant. This was similar to Arronson's procedure with digits. However, in the present study recall did not improve when word duration was decreased and the time between words was increased. In fact, the opposite occurred, as indicated by the data in Table 7 obtained with the 75 wpm speech rate and 0, 36, and 59% compression ratios. This indicates that Arronson's hypothesis must be restricted to the materials and procedures of her experiments. At least it is not confirmed by the present study, whose procedures more nearly approximate the usual listening comprehension test situation.

Summary of Experiment 5

This experiment was designed to determine the relative effects of speech rate and signal distortion due to the time-compression process on listening comprehension. In addition, linguistic factors, including sequencing of random words into story form, and inflection and phraseology, were qualitatively considered for their effects on listening comprehension.

The results indicate that both speech rate and signal distortion may affect listening comprehension. The latter effects became noticeable with the low-redundancy material used in Experiment 5, while they were not apparent with the more redundant material of Experiment 4. The effects of signal distortion in the present study did not appear to result from misperception of the distorted words. Sequencing (syntax) and inflectional and phraseology factors tended to improve listening comprehension.

Part III

DISCUSSION

One of the concerns of Work Unit REALISTIC is to explore methods for reducing training and job requirements for reading, so as to improve the utilization of many lower aptitude men who are deficient in reading skills. The experiments reported herein represent an approach to reducing the need for reading skills that involves the possibility of substituting listening for reading. Studies using time-compressed speech have been included because such speech makes possible listening rates that compare favorably with silent reading rates. Hence it is possible that the substitution of listening for reading requirements may not necessarily mean that more time will be needed to transfer information.

Reading vs. Listening

In research initiated to determine the relative effectiveness of reading and listening as means for instructing men of different mental aptitude levels, the results indicated that: (a) With average and low aptitude groups, listening was as effective as reading in promoting the recall of factual information from simple and complex passages; (b) reading and listening performance of the average aptitude group surpassed that of the low aptitude group; and (c) some individuals in both aptitude groups did better by reading than by listening, and vice versa.

Comprehension of Time-Compressed Speech

Listening performance on comprehension and intelligibility tests using normal and time-compressed speech was evaluated in five experiments as a function of mental aptitude, repetition of listening passages, speech rate, signal distortion due to the compression process, and certain linguistic factors (e.g., sequential constraint of the language, inflection, and phraseology).

Briefly summarized, the results of these studies using time-compressed speech indicate that:

(1) The higher the aptitude level, the better the comprehension of normal and time-compressed speech.

(2) Under the conditions of Experiment 1, no differential effects of speech rate were found for low or high aptitude men.

(3) In terms of listening efficiency (i.e., the amount of comprehension per unit of time spent listening) all men performed more efficiently with the speech rate of 275 wpm than with the noncompressed rate of 175 wpm.

(4) Listening to a compressed selection twice did not improve comprehension over that obtained by listening once, in the same amount of time, to the selection presented in uncompressed form.

(5) Lower aptitude men did not discriminate individually presented normal or time-compressed words as well as did the higher aptitude men.

(6) Both the rate of speech and the signal distortion due to the compression process can attenuate the comprehension of time-compressed speech, with the effects of signal distortion becoming significant with low-redundancy materials.

(7) Linguistic factors such as sequencing of words into story form, inflection, and phraseology can modify the comprehensibility of listening materials.

Educational and Training Implications

These results have certain implications for education and training. The fact that an individual may differ in his reading or listening skills implies that, for the most efficient training, and where feasible, reading and listening materials should be made available to students, so that those who perform better with one skill than with the other may exercise that skill. The listening materials could be subjected to a moderate degree of compression without seriously reducing comprehension, at least so long as the word rate did not exceed 250-275 wpm.

Secondly, since listening efficiency may improve with time compression of speech, the time saved might be used to selectively review or extend materials to improve peak comprehension levels, although the present results speak against the simple repetition of the material. Further research is needed to determine whether peak comprehension can be improved by selective repetition or extension of compressed materials.

To possibly improve both listening and reading ability of low aptitude men, time expansion or compression of speech might be used for training in discriminating speech sounds. Experiment 3 in Part II suggests that low aptitude men may have difficulties in discriminating speech sounds, which might produce deficiencies in both reading and listening. Special discrimination training might be incorporated into a special literacy training program for low aptitude men who are functionally illiterate.

Finally, if time-compressed speech is used in a training or on-the-job setting, it will be best used in moderate amounts and with materials having at least the redundancy of "normal" prose.. Materials involving low probability sequences and difficult words appear to be unwieldy by the listening process when fast rates of speech are used. In addition, with such material, the signal distortion introduced by the compression process may interact with the speech-rate variable to further attenuate performance.

Motivational and Other Implications

Two features to be considered when evaluating any educational innovation, such as compressed speech, are its effectiveness in the transfer of information and its motivational properties. The results of the present studies suggest that moderate compression can be an effective means of transferring information by listening. Whether the availability of time-compressed materials would motivate students to study would have to be determined empirically.

There is, however, some indication that the availability of listening materials, whether moderately compressed or not, might serve to motivate some students to study. Some 25% of a sample of 322 inductees questioned in connection with REALISTIC research not included herein reported that they would prefer to listen rather than read for information.[1] Thus, a significant segment of the military population might be induced to study, or might study more effectively, if listening materials were made available. For those men for whom reading is not a functional skill, the availability of appropriate listening material might remove a stumbling-block in their job and career development.

[1]This was especially true for Category III and IV personnel.

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AND
APPENDICES

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Appendix A

READING/LISTENING TESTS FROM PART I

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD

Reading (Listening) Performance Evaluation
[The same cover page was used for Form A and Form B]

Name ______________________________

How many years of school have you completed? ______________________________

What was your civilian occupation? ______________________________

As a civilian, about how much time a day did you spend:
reading ______________________________
watching T.V. ______________________________
listening to the radio ______________________________

As a civilian, how did you get most of your information about things and events in general:
reading ______________ listening ______________ (check one)

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DO NOT WRITE BELOW THIS LINE

AFQT: __________

Scores on Reading Tests: 1 _____ 2 _____ 3 _____ 4 _____ 5 _____
6 _____ 7 _____ 8 _____

Scores on Listening Tests: 1 _____ 2 _____ 3 _____ 4 _____ 5 _____
6 _____ 7 _____ 8 _____

FORM A

SELECTION NUMBER 1

An article about a combat mission

Grade Difficulty Level: 7.5
Reading and Listening Time: 40 Sec.

"Smith! Jones!" The platoon leader cried. "Get five men, each of you. I have a reconnaissance detail for you. I want you to circle around to the east of that white pile of bricks and check to see if there are mortar locations there. If there are, call me on Alpha 3-8-1 and report the Y and Z coordinates of their locations on this field artillery map. We need this information within 50 minutes because a supply truck is coming up from Charlie Company about 1620 hours, and we have to disable any mortars in the areas."

Turn to the next page and answer the questions for Selection Number 1.

QUESTIONS FOR SELECTION NUMBER 1

1. What were the last names of the two men called for:
   a) Smith b) Jones
2. Who called the men: the platoon leader
3. Which direction were the men to circle: east
4. What color was the pile of bricks: white
5. What were the men supposed to look for: mortar (locations)
6. What two map coordinates were mentioned: a) y b) z
7. Which company was sending up a vehicle: Charlie
8. What kind of vehicle was mentioned: supply truck
9. What time was the vehicle supposed to arrive: 1620 hours
10. How fast did they need the reconnaissance information: 50 minutes
11. What kind of map was used: field artillery map
12. How many men were needed for the detail: 12

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SELECTION NUMBER 2

A description of a transfer unit of a 2 1/2 ton truck

Grade Difficulty Level: 14.5
Reading and Listening Time: 1 Min. 10 Sec.

The transfer is a two-speed unit, driven by the transmission, which distributes power through propeller shafts to the front and rear axles. Driver's control of high and low ranges is by a shift lever located in the cab. Transfer gearing is designed to drive the front axle when the rear axle speed exceeds the front axle speed (as during slipping or spinning of the rear wheels). An overrunning clutch on the front axle drive automatically eliminates delivery of power to the front axle when the speed of the rear axle is the same as that of the front axle, as during normal operation. When the transmission is shifted into reverse gear, a mechanical linkage automatically shifts the overrunning clutch into the reverse position. Power is then delivered to the front and rear axles, during reverse operation of the truck, in the same manner as described earlier for forward motion.

Turn to the next page and answer the questions for Selection Number 2.

QUESTIONS FOR SELECTION NUMBER 2

1. What unit of the 2 1/2 ton truck was the article about? ______ the transfer unit ______
2. Where is the driver's control shift located? ______ cab ______
3. Through what kinds of shafts does the transmission distribute power? ______ propeller ______
4. What kind of clutch is used to change the delivery of power to the front axle? ______ overrunning ______
5. How many axles are there on the truck? ______ 2 ______
6. In the article, during what kind of operation was the speed of the axles the same? ______ normal ______
7. What kind of linkage shifts the special clutch into the reverse position? ______ mechanical ______
8. How many speeds did the unit described in the article have? ______ 2 ______

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SELECTION NUMBER 3

An article about military maps

Grade Difficulty Level: 7.5
Reading and Listening Time: 1 Min. 30 Sec.

The purpose of a map is to furnish information of the terrain in the area covered by the map. A map is a picture of the area covered, drawn to scale, but it is not a photographic sort of picture. Objects on the ground are represented by map symbols. Many of these symbols closely resemble the things they represent. For instance, roads are represented by lines which try to reproduce the curves of the road in a faithful fashion, but the lines for surfaced roads are red. Lines drawn for railroads have crossbars to represent ties. The symbol for a church is a building outline with a cross on it. For a schoolhouse, the symbol has a flag on it. You can recognize many map symbols by their color: black means man-made objects; brown is used for the contour lines which are used to outline high and low ground. In short, a map is a very useful device for presenting a great deal of information about the area it covers in a very compact form.

Turn to the next page and answer the questions for Selection Number 3.

QUESTIONS FOR SELECTION NUMBER 3

1. On a map, what are objects on the ground represented by? symbols
2. How are dirt roads represented on the map? lines
3. How are surfaced roads represented on the map? red lines
4. What is the symbol for a church? building outline with cross
5. What is the symbol for a school? flag
6. What color represents man-made objects? black
7. What do the lines drawn to represent railroads have to stand for ties? crossbars
8. Is the map a photographic sort of picture? no

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SELECTION NUMBER 4

An article about fire drills

Grade Difficulty Level: 6.5
Reading and Listening Time: 1 Min.

Here is what you men in this building should do in case of a fire or fire drill.

When the fire bell sounds, leave all your tools right where they are and walk—don't run—from this room to the front stairway. At the bottom of the stairway turn left and go on to the third door on the left. Go through that door out into the courtyard. Go across the courtyard, past the badminton courts, and assemble near the radio tower located on the other side of the badminton courts.

You should wait at the tower until you hear four (4) short blasts of the fire horn. At that time, the building Fire Marshal will march you, in formation, around to the North entrance of the building. You will then be dismissed and should enter the building in an orderly manner and report to your duty stations.

Turn to the next page and answer the questions for Selection Number 4.

QUESTIONS FOR SELECTION NUMBER 4

1. Do the men assemble in the courtyard? ______ no ______
2. Which entrance is used after the fire drill? ______ north ______
3. Was the fire exit to the right or left of the stairway? ______ left ______
4. How many blasts of the fire horn signal the end of the fire drill? ______ 4 ______
5. Do the men march in formation into the building? ______ no ______
6. What do the men assemble next to during the fire drill? ______

   ______ radio tower ______
7. What sport was mentioned in the article? ______ badminton ______

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FORM B

SELECTION NUMBER 1

An article about field medical corpsmen

Grade Difficulty Level: 7.5
Reading and Listening Time: 40 Sec.

The third bombardment of the night began just when the new medical corpsmen arrived.

"Get out of that jeep and take cover in that dirt covered bunker!" the platoon sergeant shouted.

Inside the bunker the sergeant told the new corpsmen how to carry the stretchers across the muddy terrain.

"Keep to the west of the tree-lined ridge about 150 yards to the right of this bunker," he said. "Keep your head low, no more than about three feet from the ground. Two men work with one stretcher, and remember, keep the feet lower than the head."

Turn to the next page and answer the questions for Selection Number 1.

QUESTIONS FOR SELECTION NUMBER 1

1. Was the terrain wet or dry? wet
2. How many bombardments had begun that night? 3
3. What were the corpsmen riding in when they arrived? jeep
4. What was the bunker covered with? dirt (mud)
5. Had the corpsmen worked at this bunker before? no
6. Who shouted at the corpsmen? platoon sergeant
7. How far was the ridge from the bunker? 150 yards
8. How many men were to work with one stretcher? 2
9. Were the men to keep to the west of the ridge? yes
10. Which was to be lower, the head or the foot of the stretcher? feet
11. What was the ridge lined with? trees
12. On which side of the bunker was the ridge? right

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SELECTION NUMBER 2

An article about direct responsibility in supply

Grade Difficulty Level: 14.5
Reading and Listening Time: 1 Min. 10 Sec.

As distinguished from command responsibility, direct responsibility applies to an individual to whom public property has been entrusted and who is specifically charged with its care and safekeeping, whether such property is in his personal possession, in use, or in storage. The signature of an individual on a hand receipt is evidence that he has accepted responsibility for its care and safekeeping. The assignment to duty such as commander of a unit or activity in which responsibility for property is inherent is also evidence that the individual so assigned is charged with responsibility for its care and safekeeping. Such assignment to duty may be either written or verbal orders of a superior acting in his official capacity and simultaneously the new commander will be provided a suitable inventory listing of the property. If the accuracy of the listing is questioned, physical inventory may be ordered prior to acceptance of transfer of responsibility.

Turn to the next page and answer the questions for Selection Number 2.

QUESTIONS FOR SELECTION NUMBER 2

1. In this article, what kind of responsibility was the main topic? direct
2. What kind of responsibility was mentioned, but not talked about? command
3. Was the property discussed private or public? public
4. Orders to duty may be written or verbal
5. An inventory listing is a listing of property
6. What kind of inventory may be ordered if the listing is questioned? physical
7. What kind of receipt was mentioned in the article? hand

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SELECTION NUMBER 3

An article about camouflage methods

Grade Difficulty Level: 14.5
Reading and Listening Time: 1 Min. 30 Sec.

There are three fundamental ways of concealing installations and activity: By hiding, blending and deceiving.

Hiding is the complete concealment of an object.

Blending is the arrangement of camouflage materials on, over, and around an object so that it appears to be part of the background. The aim is to prevent detection of the object by a change in the natural appearance of the position. Because the works of man are usually geometric in form, they present easily recognized outlines and rectangular shapes and shadows which are very unlike the average terrain in features. Blending distinctive man-made objects into the normal terrain's pattern is necessary in order to restore and simulate its normal and natural appearance.

Deceiving simulates an object or situation, or disguises it so that it appears to be something else. Deception misleads the enemy as to identity, strength, intentions, or activity; deception divides his attack and draws his fire away from essential targets. Well planned decoys are among the most effective ways to deceive the enemy as to our strength and location of positions.

Turn to the next page and answer the questions for Selection Number 3.

QUESTIONS FOR SELECTION NUMBER 3

1. How many camouflage methods were named? 3
2. The complete concealment of an object was called? hiding
3. Making an object look like something else was called? deceiving
4. What kinds of forms do the works of man usually have? geometric
5. Making an object appear to be part of the natural background was called? blending
6. Deception divides an enemy's attack
7. To draw an enemy's fire away from an essential target, you could use a: decoy
8. Camouflage is used to conceal installations and activity

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SELECTION NUMBER 4

An article about first first aid

Grade Difficulty Level:	6.5
Reading and Listening Time:	1 Min.

In case somebody receives a serious burn while working in this facility, you should all know where the first aid supplies are located.

Behind each of the five doors in the boiler room there is a grey chest hanging on the wall. This is the first aid chest. Don't confuse it with the white chest which houses the fire hoses.

Inside the first aid chest there is a kit which contains several items; bandages, tape, scissors, and so forth. Also, there is some oil to be used to soothe minor burns. The oil is in a green tube. The yellow tube in the kit contains a cleansing jell used to disinfect open wounds. Don't put the jell on burns!

If the burn is serious enough to warrant professional treatment, there is a phone number directly to the left of the first aid kit to be used to summon help.

Turn to the next page and answer the questions for Selection Number 4.

QUESTIONS FOR SELECTION NUMBER 4

1. What kind of injuries were of main concern in this article? burns
2. What color was the first aid chest? grey
3. Did the article say that the telephone was to the right or left of the first aid kit? no
4. How many tubes were in the first aid kit? 2
5. How many doors were in the boiler room? 5
6. Was the oil used to clean open wounds? no

Appendix B

SPEECH-COMPRESSION EQUIPMENT

The equipment used to prepare the compressed speech was the Eltro Information Rate Changer.[1] Compression is accomplished as follows: The tape containing the recorded message passes over the surface of a cylinder containing four reproducing (playback) heads. These heads are spaced equally around the cylinder with "dead" spaces separating them. When the cylinder is stationary, and the tape is moving at 15 inches per second, the normal recording speed, it makes contact with one of the reproducing heads and the signal is reproduced onto an auxiliary tape as recorded.

To compress a message, the speed of the tape is increased and the cylinder begins to rotate in the direction of tape motion. As the speed of the tape is increased, the rotational speed of the cylinder is increased so as to maintain a relative speed of 15 ips between the tape and reproducing heads located in the cylinder. As the cylinder rotates, each of the four reproducing heads makes and then loses contact with the tape. The heads are spaced so that, just as one head is leaving the tape, the next head is making contact. There is thus a continuous message being reproduced.

However, since the small space between heads is dead, no message is reproduced where this dead segment comes into contact with the tape. Small segments of the recorded message are therefore discarded from the message being transferred to the auxiliary tape. The amount of compression is determined by the speed at which the tape and cylinder head move. The faster this speed, the greater the number of speed segments discarded per unit time, and the greater the amount of compression of the reproduced message.

Messages can be expanded by slowing down the tape to a speed less than 15 ips. In this case, the rotation of the cylinder is reversed, and small segments of speech are reproduced. The perceptual effect is a reduction in speech rate.

[1]Distributed by Gotham Audio Corporation, 2 West 46th Street, New York, N.Y. 10036. Citation of trade names or products in this report does not constitute HumRRO or official Department of the Army endorsement or approval.

Appendix C

CLOZE TESTS USED IN PART II, EXPERIMENT 5

Selection No. 1

She gave Ace two cars, one chest and an urn. She could give him ham. She could carve an oak tree by day and send him that tree. With what she could give him, Ace could live with ease. She could own him, or else hurt him. One day she could show them that Ace could live not die with what she does.

Selection No. 2

She ran to him. You hurt your chest and jaw with that high wire dad. I'll send them to hunt your cap. Their young twins could see them by that oak tree and knew poor dad could die. It felt odd to see dad ache. It hurt them to see him smart. An owl could see and knew what two twins could not. That smart owl knew that ice could bathe dad and send that new ache off with an east air.

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13. ABSTRACT

A series of studies was performed to explore the possibility of substituting listening for reading requirements, with special reference to marginally literate Category IV personnel. Time-compressed speech was evaluated as a means of producing listening rates comparable to silent reading rates. The results indicated that for both average and low aptitude men, listening was as effective as reading for obtaining factual information from test passages varying in difficulty level. Both high and low aptitude men learned more efficiently with moderate (36%) amounts of time compression than with no compression of the listening selections. Additional evaluations of time-compressed speech were made, and education and training implications of the research were discussed.

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	ROLE	WT	ROLE	WT	ROLE	WT
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Training Methodology						
Verbal Ability						

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10	CG USA FORCES SOUTHERN COMD ATTN SCARCD FT AMADOR C2
1	CG US ARMY ALASKA ATTN ARACO APO 98749 NY
2	CG US ARMY EUROPE APO 09403 NY ATTN OPNS DIV
1	CO ARMY TRANS RES COMD FT EUSTIS ATTN TECH LIB
1	CG US ARMY AD COMD ENT AFB ATTN ADGCB
6	CG 1ST ARMY ATTN DCSOT FT MEADE MD
1	CG 3RD ARMY ATTN DCSOT FT MCPHERSON
2	CG 4TH ARMY ATTN AKADC-B(UT) FT SAM HOUSTON
1	CG FOURTH ARMY FT SAM HOUSTON ATTN G3
5	CG FIFTH ARMY FT SHERIDAN ATTN ALFGC TNG
1	CG EUSA ATTN AG-AC APO 96301 SAN FRAN
2	CG EUSA ATTN G-3 APO 96301 SAN FRAN
1	CLIN PSYCHOL SERV DEPT OF NEUROPSYCHIAT WALTER REED GEN HOSP
1	DIR HEL APG MD
1	CG USA CDC EXPERIMENTATION COMD FT ORD
2	ENGNR PSYCHOL LAB PIONEERING RES DIV ARMY NATICK LABS NATICK MASS
1	TECH LIB ARMY NATICK LABS NATICK MASS
2	INST OF LAND CBT ATTN TECH LIB FT BELVOIR VA
1	REDSTONE SCIENTIFIC INFO CTR US ARMY MSL COMD ATTN CHF DOC SEC ALA
1	CO USAPA MBLTV DET TOBYHANNA ARMY DEPOT
1	CO FT HUACHUCA SPT COMD USA ATTN TECH REF LIB
12	CO 1ST AIR DEF GUIDED MSL BRGD TNG FT BLISS
1	SIXTH USA LIB DEPOT BLDG M 13 14 PRES OF SAN FRAN
1	PLANS OFFICER PSYCH HDQTRES USACDCEC FORT ORD
5	CG FT ORD ATTN G3 TNG DIV
1	DIR WALTER REED ARMY INST OF RES WALTER REED ARMY MED CTR
2	DIR WRAIR WALTER REED ARMY MED CTR ATTN NEUROPSYCHIAT DIV
1	CO HQ ARMY ENLISTED EVAL CTR FT BENJ HARRISON
1	TECH LIB BOX 22 USACDC EXPERIMENTATION COMD FT ORD
1	HUMAN FACTORS TEST DIV (ADHZ) USAF HOSP EGLIN AFB
1	CO FRANKFORD ARSNL ATTN SMUFA-N6400/202-4
3	6TH RGN USARADCOM FT BAKER
1	4TH ARMY MSL COMD AIR TRANSPORTABLE SAN FRAN
1	DIR ARMY BD FOR AVN ACCIDENT RES FT RUCKER
2	CO PICATINNY ARSNL DOVER N J ATTN SUMPA VCI
1	DEF SUPPLY AGY CAMERON STATION ATTN LIB
2	CO USA CDC AG AGCY FT BENJ HARRISON IND
1	REF M MS IS NASA ALA
1	CBT OPRS RES GP USACDC SP OPRS ANALYST HUMAN FACTORS ALEX VA
1	CO ARMY CDC INF AGY FT BENNING
1	CO ARMY CDC ARMOR AGY FT KNOX
1	EVAL DIV OAO ARMY SIG CTR + SCH FT MONMOUTH
1	CO US ARMY CDC AVN AGCY FT RUCKER
1	CHF CURRICULUM BR RESIDENT INSTR DEPT ARMY LOGISTICS MANGT CTR FT LEE
15	CG USA TNG CTR AD ATTN ACOFS G3 FT BLISS
1	CG USA TNG CTR ARMOR ATTN ACOFS G3 FT KNOX
12	CO USA TNG CTR (FA) ATTN ACOFS G3 FT SILL
1	CG USA TNG CTR & FT LEONARD WOOD ATTN ACOFS G3
1	CG USA TNG CTR INF ATTN ACOFS G3 FT BENNING
1	CG USA TNG CTR INF ATTN ACOFS G3 FT DIX
1	CG USA TNG CTR ATTN ACOFS G3 FT JACKSON
1	CG USA TNG CTR INF ATTN ACOFS G3 FT LEWIS
1	CG USA TNG CTR INF & FT ORD ATTN ACOFS G3
30	CG USA TNG CTR INF ATTN ACOFS G3 FT POLK
5	CO USA MED TNG CTR ATTN DIR OF TNG FT SAM HOUSTON
1	CG USA TNG CTR INF ATTN ACOFS G3 FT BRAGG
1	CG USA TNG CTR INF ATTN ACOFS G3 FT CAMPBELL
3	CIVLN PERS OFCR US ARMY SPT CTR ST LOUIS ATTN EMPLOYEE DEVEL OFCR
3	LIB ARMY WAR COLL CARLISLE BKS
1	COMDT USA INTELL SCH ATTN AHBH-S-AO FT HOLABIRD
1	COMDT COMD + GEN STAFF CO FT LEAVENWORTH ATTN ARCHIVES
1	DIR OF MILIT PSYCHOL + LDRSHP US MILIT ACAD WEST POINT
1	US MILIT ACAD WEST POINT ATTN LIB
1	COMDT ARMY AVN SCH ATTN DIR OF INSTR FT RUCKER
2	COMDT ARMY SECUR AGY TNG CTR + SCH FT DEVENS ATTN LIB
2	COMDT NATL WAR COLL FT LESLEY J MCNAIR ATTN CLASSF RECORDS BR LIB
1	MED FLD SERV SCH BROOKE ARMY MED CTR FT SAM HOUSTON ATTN STIMSON LIB
5	DIR OF INSTR ARMOR SCH FT KNOX
1	COMDT ARMY ARMOR SCH FT KNOX ATTN WEAPONS DEPT
1	COMDT USA CHAPLAIN SCH ATTN DOI FT HAMILTON
1	COMDT ARMY CHEM CORPS SCH FT MCCLELLAN ATTN EDUC ADV
1	COMDT USA FINANCE SCH ATTN CHF DOC DEV LIT PLN DIV ODOI FT BENJ HARRISON
1	USA FINANCE SCH FT BENJ HARRISON ATTN EDUC ADV
4	COMDT ARMY ADJ GEN SCH FT BENJ HARRISON ATTN EDUC ADV
1	EDUC ADV USAIS ATTN AJIIS-H FT BENNING
1	DIR OF INSTR USAIS ATTN AJIIS-D-EPRD FT BENNING
1	HQ US ARMY ADJ GEN SCH FT BENJ HARRISON ATT COMDT
1	LIB ARMY QM SCH FT LEE
1	COMDT ARMY QM SCH FT LEE ATTN EDUC ADV
1	COMDT ARMY TRANS SCH FT EUSTIS ATTN EDUC ADV
1	CO USA SEC AGY TNG CTR & SCH ATTN IATEV RSCH ADV FT DEVENS
1	COMDT ARMY MILIT POLICE SCH FT GORDON ATTN DIR OF INSTR
2	COMDT US ARMY SOUTHEASTERN SIG SCH ATTN: EDUC ADVISOR FT GORDON
1	COMDT USA AD SCH FT BLISS
1	CO USA ORD CTR & SCH CFC OF OPS ATTN AHBN-O APG MD
5	ASST COMDT ARMY AIR DEF SCH FT BLISS ATTN CLASSF TECH LIB
4	CG USA FLD ARTY CTR ATTN AVN OFCR FT SILL
1	COMDT ARMY DEF INTEL SCH ATTN SI+AS DEPT
1	COMDT ARMED FORCES STAFF COLL NORFOLK
1	COMDT USA SIG CTR & SCH ATTN DOI FT MONMOUTH
1	COMDT JUDGE ADVOCATE GENERALS SCH U OF VA
1	DPTY COMDT USA AVN SCH ELEMENT GA
1	DPTY ASST COMDT USA AVN SCH ELEMENT GA
1	USA AVN SCH ELEMENT OFC OF DIR OF INSTR ATTN EDUC ADV GA
1	EDUC CONSLT ARMY MILIT POLICE SCH FT GORDON
6	COMDT USA ENGR SCH ATTN EDUC ADV FT BELVOIR
2	COMDT US ARMY SCH EUROPE ATTN REF LIB APO 09172 NY
1	CHF POLICY + TNG LIT DIV ARMY ARMOR SCH FT KNOX
1	COMDT ARMY AVN SCH FT RUCKER ATTN EDUC ADV
1	COMDT ARMY PRIMY HEL SCH FT WOLTERS
1	DIR OF INSTR US MIL ACAD WEST POINT NY
1	DIR OF MILIT INSTR US MILIT ACAD WEST POINT
1	USA INST FOR MIL ASSIST ATTN LIB FT BRAGG
4	USA INST FOR MIL ASSIST ATTN COUNTERINSURGENCY DEPT FT BRAGG
1	ARMY SIG CTR + SCH FT MONMOUTH ATTN TNG LIT DIV OAO
1	COMDT US ARMY MGT SCH FT BELVOIR
2	COMDT USA MSL & MUN CTR & SCH ATTN CHF OFC OF OPS REDSTONE ARSNL
2	COMDT US WAC SCH US WAC CTR ATTN AJMCT FT MCCLELLAN
2	HQ ABERDEEN PG ATTN TECH LIB
1	COMDT USA INTELL SCH ATTN DIR OF ACADEMIC OPS FT HOLABIRD
1	COMDT USA INTELL SCH ATTN DIR OF DOC & LIT FT HOLABIRD
1	COMDT USA C&GSC OFC OF CHF OF RESIDENT INSTR FT LEAVENWORTH
1	COMDT USA CA SCH ATTN DEPT OF RSCH ANALYSIS & DOC FT GORDON
1	COMDT USA CA SCH ATTN DOI FT GORDON
1	COMDT USA CA SCH ATTN EDUC ADV FT GORDON
1	COMDT USA CA SCH ATTN LIB FT GORDON
1	COMDT USA SCH & TNG CTR ATTN ACOFS G3 TNG DIV FT MCCLELLAN
1	COMDT USA SCH & TNG CTR ATTN ACOFS G3 PLNS & OPS DIV FT MCCLELLAN
10	COMDT USA INST FOR MIL ASSIST ATTN DOI FT BRAGG
1	COMDT USA CBR WPNS ORIENTATION COURSE ATTN DOI DUGWAY UTAH
1	COMDT USA FLD ARTY SCH ATTN DOI FT SILL
1	COMDT USA ARTY & MSL SCH ATTN EDUC SERVICES DIV FT SILL
1	COMDT USA ARTY & MSL SCH ATTN EDUC ADV FT SILL
1	COMDT USA TRANS SCH ATTN DIR OF DOC & LIT FT EUSTIS
1	COMDT USA TRANS SCH ATTN LIB FT EUSTIS
1	USA INST FOR MIL ASSIST ATTN EDUC ADV FT BRAGG
1	COMDT ARMY QM SCH OFC DIR OF NONRESID ACTVY FT LEE ATTN TNG MEDIA DIV
1	COMDT USA ARTY & MSL SCH ATTN LIB FT SILL
1	CG USA SCH & TNG CTR ATTN ACOFS G3 FT GORDON
1	COMDT USA AD SCH ATTN AKBAAS-DL-EA FT BLISS
2	DIR BRGD + BN OPNS DEPT USAIS FT BENNING
1	LEADERSHIP COM CO OPS DEPT US ARMY INF SCH FT BENNING
1	DIR COMM ELEC USAIS FT BENNING
1	DIR ABN-AIR MOBILITY DEPT USAIS FT BENNING
2	DIR COMPANY TACTICS DEPT USAIS FT BENNING
1	CG US ARMY SIGNAL CTR & SCH ATTN SIGOTL-3 (COBET II)
1	SECY OF ARMY, PENTAGON
1	DCS-PERS DA ATTN CHF C+S DIV
1	DIR OF PERS STUDIES & RSCH ODCSPER DA WASH DC
2	ACSFOR DA ATTN CHF TNG DIV WASH DC
1	CG USA MAT COMD ATTN AMCRD-TE
1	CHF OF ENGNRS DA ATTN ENGTE-T
1	HQ ARMY MAT COMD R+D DRCTE ATTN AMCRD-RC
1	CLIN PSYCHOL CONSLT OFC OF CHF PSYCHIAT + NEUROL CONSLT OFC OF SURG GEN
2	CG ARMY MED R+D COMD ATTN BEHAV SCI RES BR
1	US ARMY BEHAVIORAL SCI RES LAB WASH, D.C. ATTN: CRD-AR
1	OPO PERS MGT DEV OFC ATTN MOS SEC (NEW EQUIP) OPOMO
1	ARMY PROVOST MARSHAL GEN
1	DIR CIVIL AFFAIRS DRCTE ODCSOPS
1	OFC RESERVE COMPON DA
2	CG USA SEC AGCY ARL HALL STA ATTN AC OF S G1 VA
50	ADMIN DDC ATTN: TCA (HEALY) CAMERON STA ALEX., VA. 22314
1	CO US ARMY MED RES LAB FT KNOX
1	CHF OF R+D DA ATTN CHF TECH + INDSTR LIAISON OFC
2	CG ARMY MED R+D COMD ATTN MEDDH-SR
1	U S ARMY BEHAVIORAL SCI RES LAB WASH, D.C. ATTN CRD-AIC
1	COMDT USA CBT SURVEIL SCH & TNG CTR ATT ED ADV FT HUACHUCA
1	COMDT USA CBT SURVEIL SCH & TNG CTR ATTN ORG DOC & NEW EQUIP FT HUACHUCA
2	TNG + DEVEL DIV ODCS-PERS
1	COMDT USA CBT SURVEIL SCH & TNG CTR ATTN 1ST CBT TNG BRGDE FT HUACHUCA
1	CAREER MGT BR ATTN R DETIENNE CAMERON STA ALEX VA
1	PRES ARMY INF BD FT BENNING ATTN FE+SP DIV
1	PRES ARMY MAINT BD FT KNOX
2	PRES ARMY ARTY BD FT SILL
1	DPTY PRES ARMY MAT COMD BD ABERDEEN PG
15	CG USCONARC ATTN ATIT-RD-RD FT MONROE
2	CG USCONARC ATTN LIB FT MONROE
1	CO ARMY CBT DEVEL COMD MILIT POLICE AGY FT GORDON
1	US ARMY ARCTIC TEST CTR R & D OFFICE SEATTLE
1	CHF USA AD HRU FT BLISS
1	CHF USA ARMOR HRU FT KNOX
1	CHF USA AVN HRU FT RUCKER
1	CHF USA INF HRU FT BENNING
1	CHF USA TNG CTR HRU PRES OF MONTEREY
3	CG 4TH ARMORED DIV ATTN DCSOT APO NY 09326
1	CO 3D ARMORED CAV REGT APO 09034 NY
1	CO 14TH ARMORED CAV REGT APO 09026 NY
2	CG ARMY ARMOR & ARTY FIRING CTR FT STEWART ATTN AC OF S TNG OFCR
1	1ST ARMORED DIV HQ & HQ CO FT HOOD ATTN AC OF S G2
10	CO 1ST BN 63RD ARMOR 1ST INF DIV ATTN S3 FT RILEY
2	CO 1ST BN 64TH ARMOR 3RD INF DIV ATTN S3 APO NY 09031
8	CO 2ND BN 68TH ARMOR 8TH INF DIV ATTN S3 APO NY 09034
1	CO COMPANY A 3D BN 32D ARMOR 3D ARMORED DIV (SPEARHEAD) APO 09039 NY
1	CO 5TH BN 33D ARMOR ATTN S3 FT KNOX
1	CO 3RD BN 68TH ARMOR 8TH INF DIV ATTN S3 APO NY 09028
1	CO 3RD BN 37TH ARMOR 4TH ARMORED DIV ATTN S3 APO NY 09066
6	CO 2ND BN 34TH ARMOR 25TH INF DIV ATTN S3 APO SAN FRAN 96266
2	CALIF NG 40TH ARMORED DIV LOS ANGELES ATTN AC OF SG3
1	55TH COMD HQ DIV ARMY NG JACKSONVILLE FLA
1	CG HQ 27TH ARMORED DIV NY AIR NG SYRACUSE
1	TEXAS NG 49TH ARMORED DIV DALLAS
1	CG ARMY ARMOR CTR FT KNOX ATTN G3 AIBKGT
2	CG 1ST INF DIV ATTN ACOFS G3 APO SAN FRAN 96345
1	CG 3RD INF DIV ATTN ACOFS G3 APO NY 09036
3	CG 4TH INF DIV ATTN ACOFS G3 APO SAN FRAN 96262
1	CG 7TH INF DIV ATT ACOFS G2 APO SAN FRAN 96207
1	CG 8TH INF DIV ATTN ACOFS G2 APO NY 09111
1	CG 5TH INF DIV (MECH) & FT CARSON ATTN ACOFS G2 COLO
3	CG 82ND ABN INF DIV ATTN ACOFS G3 FT BRAGG
1	CO 197TH INF BRGD FT BENNING ATTN S3
1	CO 1ST BN (REINF) ATTN S3 FT MYER
1	CO HDQTRS 2ND BN 6TH US INF REGT ATTN S3 APO NY 09742
7	CO 3RD BN 6TH INF REGT ATTN S3 APO NY 09742
1	CO 171ST INF BDE ATTN S3 APO SEATTLE 98731
3	CG 25TH INF DIV APO 96225 SAN FRAN
1	CO 4TH BN 30TH INF ATTN S3 FT SILL
1	CO 1ST BN 39TH INF 8TH INF DIV ATTN S3 APO NY 09034
1	CO 2ND BN 15TH INF 3RD INF DIV ATTN S3 APO NY 09026
5	CG 24TH INF DIV ATTN ACOFS G3 FT RILEY
5	CO 1ST BN (MECH) 52ND INF 198TH INF BDE ATTN S3 APO SAN FRAN 96219
7	CO 4TH BN (MECH) 54TH INF ATTN S3 FT KNOX
1	CO USA PARTIC GP USN TNG DEVICE CTR FLA
2	CONSOL RES GP 7TH PSYOP GP APO 96248 SAN FRAN
2	DA OFC OF ASST CHF OF STAFF FOR COMM-ELCT ATTN CETS-6 WASH
1	CHF MED RES PROJ ARMY HOSP US MILIT ACAD WEST POINT
1	CG MILIT DIST OF WASHINGTON
1	DIR ARMY LIB PENTAGON
1	STRATEGIC PLANNING GP CORPS OF ENGNR ARMY MAP SERV
1	CHF OF MILIT HIST DA ATTN GEN REF BR
1	CO USA 10TH SPEC FORCES GP FT DEVENS
1	CO 24TH ARTY GP (AD) ATTN S3 RI
1	CG 31ST ARTY BDE AD ATTN S3 PA
1	CO 49TH ARTY GP AD ATTN S3 FT LAWTON
2	HQS 4TH BN 59TH ARTY REGT ATTN S3 NORFOLK
1	CO 28TH ARTY GP AD ATTN S3 SELFRIDGE AFB

1 CO 52ND ARTY BDE AD ATTN S3 FT HANCOCK
1 HQ NIAGARA-BUFFALO DEF 31ST ARTY BRGD AIR DEF LOCKPORT
1 HQS 45TH ARTY BDE AD ATTN S3 ARL HTS ILL
1 CO 35TH ARTY BDE AD ATTN S3 FT MEADE MD
1 CG 101ST ABN DIV (AIRMOBILE) ATTN ACOFS G3 APO SAN FRAN 96383
1 CG 1ST CAV (AIRMOBILE) ATTN ACOFS G3 APO SAN FRAN 96383
1 US ARMY GEN EQUIP ATTN TECH LIB FT LEE
1 US ARMY TROPIC TEST CTR PO DRAWER 942 ATTN BEHAV SCIENTIST FT CLAYTON
8 CG III CORPS & FT HOOD ATTN G3 SEC FT HOOD
30 CO 1ST ARMORED DIV ATTN G3 SEC FT HOOD
30 CG 2D ARMORED DIV ATTN G3 SEC FT HOOD
25 CO 13TH SUPT BGDE ATTN S3 SEC FT HOOD
10 CG USAFAC ATTN G3 SEC FT SILL
20 CO III CORPS ARTY ATTN G3 SEC FT SILL
20 CG USA AD CTR ATTN G3 SEC FT BLISS
3 CG ATTN G3 SEC FT POLK LA
1 BESO ARO OFC CHF OF R&D WASH DC
1 CHF OF R&D DA ATTN SCI INFO BR RSCH SPT DIV WASH DC
2 CINC US PACIFIC FLT FPO 96614 SAN FRAN
1 CINC US ATLANTIC FLT CODE 312A USN BASE NORFOLK
1 CINC PACIFIC OPNS ANLS SECT FPO 96610 SAN FRAN
1 CDR TNG COMMAND US PACIFIC FLT SAN DIEGO
1 CHF BUR OF MED + SURG DN ATTN CODE 513
1 CHF RES DIV BUR OF MED + SURG DN
1 HEAD CLIN PSYCHOL SECT PROFESNL DIV BUR OF MED + SURG DN
5 TECH LIB PERS 11B BUR OF NAV PERS ARL ANNEX
3 DIR PERS RES DIV BUR OF NAV PERS
1 TECH LIB BUR OF SHIPS CODE 210L NAVY DEPT
1 BUR OF YDS + DKS DN ATTN ASST CHF FOR RES DEVEL TEST + EVAL
2 NAV AIR SYS COMD REP ATLANTIC NAV AIR STA NORFOLK
1 HUMAN FACTORS BR PSYCHOL RES DIV ONR
1 ENGNR PSYCHOL BR ONR CODE 455 ATTN ASST HEAD WASH DC
3 CO + DIR NAV TNG DEVICE CTR ORLANDO ATTN TECH LIB
1 CO FLT ANTI-AIR WARFARE TNG SAN DIEGO
1 CO NUCLEAR WEAPONS TNG CTR PACIFIC U S NAV AIR STA SAN DIEGO
1 CO NAV AIR DEVEL CTR JOHNSVILLE PENNA ATTN NADC LIB
2 CO FLT TNG CTR NAV BASE NEWPORT
1 COR FLT TNG GP NAV BASE CHARLESTON
2 CO FLT TNG CTR NORFOLK
1 CO FLEET TNG CTR U S NAV STA SAN DIEGO
1 CLIN PSYCHOL MENTAL HYGIENE UNIT US NAV ACAD ANNAPOLIS
1 PRES NAV WAR COLL NEWPORT ATTN MAHAN LIB
3 CO SERV SCH COMD NAV TNG CTR SAN DIEGO
3 CO NAV GUIDED MSL SCH DAM NECK VA BEACH
2 CO + DIR ATLANTIC FLT ANTI-SUB WARFARE TACTICAL SCH NORFOLK
1 CO NUCLEAR WEAPONS TNG CTR ATLANTIC NAV AIR STA NORFOLK
2 CO FLT SONAR SCH KEY WEST
1 CO FLT ANTI-SUB WARFARE SCH SAN DIEGO
1 CHF OF NAV RES ATTN SPEC ASST FOR R & D
1 CHF OF NAV RES ATTN HEAD PERS + TNG BR CODE 458
1 CHF OF NAV RES ATTN DIR PSYCHOL SCI DIV CODE 450
1 CHF OF NAV RES ATTN HEAD GP PSYCHOL BR CODE 452
1 DIR US NAV RES LAB ATTN CODE 5120
1 DIR NAVAL RSCH ATTN LIB CODE 2029 (ONRL) WASH DC
1 CHF OF NAV AIR TNG TNG RES DEPT NAV AIR STA PENSACOLA
1 CO NAV SCH OF AVN MED NAV AVN MED CTR PENSACOLA
1 LIB NAV MED RES LAB NAV SUB BASE GROTON
1 CO MED FLD RES LAB CAMP LEJEUNE
1 CDR NAV MSL CTR POINT MUGU CALIF ATTN TECH LIB CODE 3022
1 DIR AEROSPACE CREW EQUIP LAB NAV AIR ENGNR CTR PA
3 OIC NAV PERS RES ACTVY SAN DIEGO
1 NAV NEUROPSYCHIAT RES UNIT SAN DIEGO
2 NAVAL MSL CTR (CODE 5342) PT MUGU CALIF
1 DIR PERS RES LAB NAV PERS PROGRAM SUPPORT ACTIVITY WASH NAV YD
1 NAV TNG PERS CTR NAV STA NAV YD ANNEX CODE 83 ATTN LIB WASH
1 COMDT MARINE CORPS HQ MARINE CORPS ATTN CODE AO-1B
1 HQ MARINE CORPS ATTN AX
1 DIR MARINE CORPS EDUC CTR MARINE CORPS SCH QUANTICO
1 DIR MARINE CORPS INST ATTN EVAL UNIT
1 CHF OF NAV OPNS OP-01P1
1 CHF OF NAVL OPS OP 037 WASH DC
1 CHF OF NAV OPNS OP-07T2
2 COMDT HQS 8TH NAV DIST ATTN EDUC ADV NEW ORLEANS
1 CHF OF NAV AIR TECH TNG NAV AIR STA MEMPHIS
1 DIR OPS EVAL GRP OFF OF CHF OF NAV OPS OP03EG
2 COMDT PTP COAST GUARD HQ
1 CHF OFCR PERS RES + REVIEW BR COAST GUARD HQ
1 CO US COAST GUARD TNG CTR GOVERNORS ISLAND NY
1 CO US COAST GUARD TNG CTR CAPE MAY NJ
1 CO US COAST GUARD TNG CTR & SUP CTR ALAMEDA CALIF
1 CO US COAST GUARD INST OKLA CITY OKLA
1 CO US COAST GUARD RES TNG CTR YORKTOWN VA
1 SUPT US COAST GUARD ACAD NEW LONDON CONN
1 OPNS ANLS OFC HQ STRATEGIC AIR COMD OFFUTT AFB
1 AIR TNG COMD RANDOLPH AFB ATTN ATFTM
1 TECH DIR TECH TNG DIV(HRD) AFHRL LOWRY AFB COLO
1 CHF SCI DIV DRCTE SCI + TECH DCS R+D HQ AIR FORCE AFRSTA
1 FAA DRCTE OF PLNS & OPS HQ USAF WASH DC
1 CHF OF PERS RES BR DRCTE OF CIVILIAN PERS DCS-PERS HQ AIR FORCE
1 CHF ANAL DIV (AFPDPL (R) DIR OF PERSONNEL PLANNING HQS USAF
2 DPTY TIG USAF (AFIAS-G1) NORTON AFB
1 HQ AFSC SCBB ANDREWS AFB
1 ROME AIR DEVEL CTR RASH GRIFFISS AFB
2 CDR ELEC SYS DIV L G HANSCOM FLD ATTN ESRHA BEDFORD MASS
2 SMAMA (SMACU-PERS RSCH) MCCLELLAN AFB
1 ATC ATXRQ RANDOLPH AFB
1 HQ SAMSO (SMSIR) AF UNIT POST OFC LA AFS CALIF
2 MILIT TNG CTR OPE LACKLAND AFB
2 AFHRL (HRT) WRIGHT-PATTERSON AFB
1 AMD AMRH BROOK AFB TEXAS
1 HQS ATC DCS/TECH TNG (ATTMS) RANDOLPH AFB
4 HQS ATC (ATCTD-M) RANDOLPH AFB TEXAS
1 CDR ELEC SYS DIV LG HANSCOM FLD ATTN ESTI
1 DIR AIR U LIB MAXWELL AFB ATTN AUL3T-63-253
1 DIR OF LIB US AIR FORCE ACAD
1 COMDT DEF WPNS SYS MGT CTR AF INST OF TECH WRIGHT-PATTERSON AFB
1 COMDT ATTN LIB DEF WPNS SYS MGT CTR AF INST OF TECH WRIGHT-PATTERSON AFB
1 DRCTE OF AEROSPACE SAFETY AFIAS-L DPTY IG NORTON AFB
1 6570TH PERS RES LAB PRA-4 AEROSPACE MED DIV LACKLAND AFB
1 TECH TNG CTR (LMTC/OP-I-L1) LOWRY AFB
2 AF HUMAN RESOURCES LAB MRHTO WRIGHT-PATTERSON AFB
2 CO HUMAN RESOURCES LAB BROOKS AFB
1 PSYCHOBIOLOGY PROG NATL SCI FOUND
1 DIR NATL SECUR AGY FT GEO G MEADE ATTN TDL
1 DIR NATL SECUR AGY FT GEO G MEADE ATTN DIR OF TNG
5 CIA ATTN OCR/ADD STANDARD DIST
1 SYS EVAL DIV RES DIRECTORATE DOD-DCD PENTAGON
1 DEPT OF STATE BUR OF INTEL + RES EXTERNAL RES STAFF
1 SCI INFO EXCH WASHINGTON
2 CHF MGT & GEN TNG DIV TR 200 FAA WASH DC
1 BUR OF RES & ENGR US POST OFC DEPT ATTN CHF HUMAN FACTORS BR
1 EDUC MEDIA BR OE DEPT OF HEW ATTN T D CLEMENS
1 OFC OF INTERNATL TNG PLANNING & EVAL BR AID WASH DC

1 FAA MED LIB HQ 640 WASH DC
1 DEPT OF TRANS FAA ACQ SEC HQ 610A WASH DC
2 SYS DEVEL CORP SANTA MONICA ATTN LIB
2 DUNLAP + ASSOC INC DARIEN ATTN LIB
2 RAC ATTN LIB MCLEAN VA
1 RAND CORP WASHINGTON ATTN LIB
1 DIR RAND CORP SANTA MONICA ATTN LIB
1 GP EFFECTIVENESS RSCH LAB U OF ILL DEPT OF PSYCHOL
2 U OF SO CALIF ELEC PERS RES GP
1 COLUMBIA U ELEC RES LABS ATTN TECH EDITOR
1 MITRE CORP BEDFORD MASS ATTN LIB
2 SIMULATION ENGR CORP ATTN DIR OF ENGR FAIRFAX VA
2 U OF PGH LEARNING R+D CTR ATTN DIR
1 WESTERN ELECTRIC CO INC NY
1 HUMAN SCI RES INC MCLEAN VA
2 TECH INFO CTR ENGNR DATA SERV N AMER AVN INC COLUMBUS O
1 CHRYSLER CORP MSL DIV DETROIT ATTN TECH INFO CTR
1 CTR FOR RES IN SOCIAL SYS AMER U ATTN LIBN
1 RAYTHEON SERV CO ATTN LIBN BURLINGTON MASS
2 EDUC & TNG CONSULTANTS ATTN L C SILVERN LA
1 GEN DYNAMICS POMONA DIV ATTN LIB DIV CALIF
2 MARQUARDT INDSTR PROD CO CUCAMONGA CALIF
1 OTIS ELEVATOR CO DIV ATTN LIB STAMFORD CONN
1 MGR BIOTECHNOLOGY AEROSPACE SYS DIV MS 8H-25 BOEING CO SEATTLE
2 CTR FOR RES IN SOCIAL SYS FLD OFC FT BRAGG
1 IDA RSCH & ENG SUPT DIV ARL VA
1 HUGHES AIRCRAFT COMPANY CULVER CITY CALIF
1 DIR CTR FOR RES ON LEARNING + TEACHING U OF MICH
1 R M STOGDILL OHIO STATE UNIV
1 EDITOR TNG RES ABSTR AMER SOC OF TNG DIRS U OF TENN
1 U OF CHICAGO DEPT OF SOC
1 CTR FOR RES IN SOCIAL SYS AMER U
6 BRITISH EMBSY BRITISH DEF RES STAFF WASHINGTON
3 CANADIAN JOINT STAFF OFC OF DEF RES MEMBER WASHINGTON
3 CANADIAN ARMY STAFF WASHINGTON ATTN GSO2 TNG
2 CANADIAN LIAISON OFCR ARMY ARMOR BD FT KNOX
3 ACS FOR INTEL FOREIGN LIAISON OFCR TO NORWEG MILIT ATTACHE
1 ARMY ATTACHE ROYAL SWEDISH EMBSY WASHINGTON
1 DEF RES MED LAB ONTARIO
3 AUSTRALIAN NAV ATTACHE EMBSY OF AUSTRALIA WASH DC
1 OFC OF AIR ATTACHE AUSTRALIAN EMBSY ATTN: T.A. NAVGN WASH, D.C.
2 AUSTRALIAN EMBSY OFC OF MILIT ATTACHE WASHINGTON
2 U OF SHEFFIELD DEPT OF PSYCHOL
1 MENNINGER FOUNDATION TOPEKA
2 AMER INST FOR RES SILVER SPRING
1 AMER INST FOR RES PGH ATTN LIBN
1 DIR PRIMATE LAB UNIV OF WIS MADISON
1 COLUMBIA U SCH OF BUS
3 MATRIX CORP ALEXANDRIA ATTN TECH LIBN
1 AMER TEL+TEL CO NY
1 U OF GEORGIA DEPT OF PSYCHOL
1 OBERLIN COLL DEPT OF PSYCHOL
1 DR GEORGE T HAUTY CHMN DEPT OF PSYCHOL U OF DEL
1 GEN ELECTRIC CO SANTA BARBARA ATTN LIB
1 VITRO LABS SILVER SPRING MD ATTN LIBN
1 HEAD DEPT OF PSYCHOL UNIV OF SC COLUMBIA
1 TVA ATTN CHF LABOR RELATIONS BR DIV OF PERS KNOXVILLE
1 U OF GEORGIA DEPT OF PSYCHOL
1 U OF UTAH DEPT OF PSYCHOL
1 GE CO WASH D C
1 AMER INST FOR RES PALO ALTO CALIF
1 MICH STATE U COLL OF SOC SCI
1 N MEX STATE U ATTN PROF OF PSYCHOL
1 ROWLAND + CO HADDONFIELD NJ ATTN PRES
1 OHIO STATE U SCH OF AVN
1 SCI RSCH ASSOC INC DIR OF EVAL CHICAGO ILL
1 AIRCRAFT ARMAMENTS INC COCKEYSVILLE MD
2 OREGON STATE U DEPT OF MILIT SCI ATTN ADJ
1 TUFTS U HUMAN ENGNR INFO + ANLS PROJ
1 AMER PSYCHOL ASSOC WASHINGTON ATTN PSYCHOL ABSTR
1 NO ILL U HEAD DEPT OF PSYCHOL
1 BELL TEL LABS INC TECH INFO LIB WHIPPANY LAB NJ ATTN TECH REPORTS LIBN
1 ENGNR LIB FAIRCHILD HILLER REPUBLIC AVN DIV FARMINGDALE N Y
1 WASHINGTON ENGNR SERV CO INC KENSINGTON MD
1 LIFE SCI INC FT WORTH ATTN PRES
1 AMER BEHAV SCI CALIF
1 SAN DIEGO STATE COLL PUBLIC ADMIN CTR
2 DIR INSTR RESOURCES STATE COLL ST CLOUD MINN
1 COLL OF WM + MARY SCH OF EDUC
1 SO ILLINOIS U DEPT OF PSYCHOL
2 COMMUNICABLE DISEASE CTR DEVEL + CONSULTATION SERV SECT ATLANTA
1 HONEYWELL ORD STA MAIL STA 806 MINN
1 NY STATE EDUC DEPT ABSTRACT EDITOR AVCR
1 AEROSPACE SAFETY DIV U OF SOUTHERN CALIF LA
1 MR BRANDON B SMITH RES ASSOC U OF MINN
1 CTR FOR THE ADVANCED STUDY OF EDUC ADMIN ATTN IONE PIERRON U OF OREG
2 WASH MILITARY SYS DIV BETHESDA MD
1 NORTHWESTERN U DEPT OF INDSTR ENGNR
1 DR V ZACHERT RT 2 NORMAN PARK GA
1 J P LYDON DIR JR ROTC SAN ANTONIO TEXAS
1 DR E FOULKE DEPT OF PSYCH UNIV OF LOUISVILLE
1 DR E PERKINS PROF OF PSYCH ST CLOUD STATE COLL MINN
1 CHF PROCESSING DIV DUKE U LIB
1 U OF CALIF GEN LIB DOCU DEPT
1 FLORIDA STATE U LIB GIFTS + EXCH
1 PSYCHOL LIB HARVARD UNIV CAMBRIDGE
1 U OF ILL LIB SER DEPT
2 U OF KANSAS LIB PERIODICAL DEPT
1 U OF NEBRASKA LIBS ACQ DEPT
1 OHIO STATE U LIBS GIFT + EXCH DIV
1 PENNA STATE U PATTEE LIB DOCU DESK
1 PURDUE U LIBS PERIODICALS CHECKING FILES
1 STANFORD U LIBS DOCU LIB
1 LIBN U OF TEXAS
1 SYRACUSE U LIB SER DIV
1 SERIALS REC UNIV OF MINN MINNEAPOLIS
1 STATE U OF IOWA LIBS SER ACQ
1 NO CAROLINA STATE COLL DH HILL LIB
2 BOSTON U LIBS ACQ DIV
1 U OF MICH LIBS SER DIV
1 BROWN U LIB
2 COLUMBIA U LIBS DOCU ACQ
1 DIR JOINT U LIBS NASHVILLE
1 U OF DENVER MARY REED LIB
1 LIB GEO WASH UNIV ATTN SPEC COLL DEPT WASH DC
2 LIB OF CONGRESS CHF OF EXCH + GIFT DIV
1 U OF PGH DOCU LIBN
1 CATHOLIC U LIB EDUC & PSYCHOL LIB WASH DC
1 U OF KY MARGARET I KING LIB
1 SO ILL U ATTN LIBN SER DEPT
1 KANSAS STATE U FARRELL LIB
1 BRIGHAM YOUNG U LIB SER SECT
1 U OF LOUISVILLE LIB BELKNAP CAMPUS

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