Technical Paper 369

LEVEL II

LISTENING TO COMPRESSED SPEECH: THE EFFECTS OF INSTRUCTIONS, EXPERIENCE, AND PREFERENCE

Paul A. Gade and David Gertman

Aug 79

22p.

EDUCATIONAL TECHNOLOGY AND SIMULATION TECHNICAL AREA

2Q161101A91B

U. S. Army
Research Institute for the Behavioral and Social Sciences

August 1979

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Technical Report 369	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) LISTENING TO COMPRESSED SPEECH: THE EFFECTS OF INSTRUCTIONS, EXPERIENCE, AND PREFERENCE		5. TYPE OF REPORT & PERIOD COVERED -- 6. PERFORMING ORG. REPORT NUMBER --
7. AUTHOR(s) Paul A. Gade and David Gertman		8. CONTRACT OR GRANT NUMBER(s) --
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Ave., Alexandria, VA 22333		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2T161101A91B
11. CONTROLLING OFFICE NAME AND ADDRESS Deputy Chief of Staff for Personnel Washington, DC 20310		12. REPORT DATE August 1979 13. NUMBER OF PAGES 12
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) --		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

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18. SUPPLEMENTARY NOTES

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Compressed Speech
Learning
Training
Speech comprehension
Listening
Epistemic curiosity
Speech rate preference
Auding

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This experiment attempted to assess the effects of different information-seeking strategies on the rate at which individuals chose to listen to passages of time-compressed speech, and on their comprehension of those passages. The research also assessed the effects of prior experience with compressed speech on listening rates and on comprehension of 48 Army enlisted men and women. The various information-seeking strategies employed, produced no significant differences in speed or accuracy of performance. Personnel

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preferred to listen to speech rates well above normal speaking rates ($p < .001$). Although prior experience with compressed speech did not influence preferred listening rates, it did influence the participants' listening rates when they were induced to listen to speech as rapidly as possible ($p < 0.001$). Results are discussed in terms of Berlyne's epistemic curiosity hypothesis and in relation to the results of preference research by Lass, Foulke, Nester, and Comerci (1974).

Technical Paper 369

LISTENING TO COMPRESSED SPEECH: THE EFFECTS OF INSTRUCTIONS, EXPERIENCE, AND PREFERENCE

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Office, Deputy Chief of Staff for Personnel
Department of the Army

August 1979

Army Project Number
2T161101A91B

Performance Enhancement
in Auditory Perception

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FOREWORD

This report is concerned specifically with strategies of training people to comprehend compressed speech. Within the Army Research Institute for the Behavioral and Social Sciences (ARI), basic research in human performance enhancement--locating and expanding the boundaries of sensory perception, particularly spatial orientation and visual or auditory perception--has led to projects in night operations, night training, aircrew performance, and selective listening. Earlier ARI publications on auditory perception have been ARI Technical Papers 295, 296, and 297 on compressed speech and Technical Research Note 236 on speech comprehension. Research for this report was done under Army Project 2T161101A91B, In-house Laboratory Independent Research. The principles developed in this area of research can be applied in any agency that needs rapid review and analysis of large amounts of auditory material.

JOSEPH ZEIDNER
Technical Director

LISTENING TO COMPRESSED SPEECH: THE EFFECTS OF INSTRUCTIONS, EXPERIENCE, AND PREFERENCE

BRIEF

Requirement:

Human Army communications processors need help in rapidly reviewing, evaluating, and summarizing backlogs of taped telecommunications. Speech compression devices allow audio recordings of telecommunications to be played at rates faster than the original recording without changes in pitch. For the Army to make effective use of the technology of time-compressed speech, variables that affect the processing of time-compressed communications, such as listening rate preferences, prior experience with compressed speech, and listener motivation, need to be explored more fully.

Procedure:

Forty-eight Army enlisted personnel were asked to listen to four passages of speech in a self-paced situation. They were told to listen to the passages at rates that would allow them to process the information as rapidly as possible with no loss in comprehension. Before listening to these four passages, half (N = 24) of the participants were required to listen to speech compressed to twice the normal rate; the other half listened to speech at the normal rate. Half of each of these two prior-experience groups (N = 12) were given instructions designed to induce epistemic curiosity motivation. The remaining 12 participants in each of the prior-experience groups were given neutral instructions. All participants were given 10-item, multiple-choice comprehension tests at the end of each speech passage. After listening to the fourth speech passage, participants were asked to indicate their preferred listening rates.

Findings:

Speed and accuracy in listening to compressed speech were not affected by the epistemic curiosity conditions. Prior exposure to compressed speech led to consistently faster listening rates on each of the four passages of speech. Preference data indicate that personnel preferred to listen to speech at rates well above the normal speaking rate. However, prior exposure to compressed speech did not affect subsequent preferred listening rates.

Utilization of Findings:

Army personnel can be induced to listen to compressed speech at faster rates than their preferred listening rates. This effect can be enhanced by giving personnel brief exposure to highly compressed speech before asking them to listen to compressed speech in a self-paced situation. The duration of this enhanced performance is unknown, however.

LISTENING TO COMPRESSED SPEECH: THE EFFECTS OF INSTRUCTIONS, EXPERIENCE, AND PREFERENCE

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INTRODUCTION

Berlyne (1954b) and others (Watts & Anderson, 1971, and Frick & Cofer, 1972) have demonstrated that instructions based on interrogative statements are far more effective in facilitating the learning of reading material than are instructions based on declarative or imperative statements. These studies show that people who are asked questions about a passage before reading that passage remember more than do people who are not given prior questioning.

Berlyne (1954a, 1960) hypothesizes that interrogative statements enhance learning because they arouse epistemic curiosity. According to Berlyne, epistemic curiosity is a motivational state that develops whenever a person perceives a discrepancy between available and needed knowledge. This motivational state can be observed in the mental or overt behaviors people show when attempting to resolve the uncertainty created by this discrepancy. Apparently, questions help motivate the learner by arousing curiosity. To date, however, epistemic curiosity has been explored in reading tasks only. It is not known if prior questioning facilitates learning when material is presented aurally.

Speech compression devices enable audio recordings to be played back at rates faster or slower than originally recorded without changing the pitch. Research has shown that untrained listeners can comprehend compressed speech. For example, Foulke (1968) showed that college students' comprehension scores did not decline significantly until word rate was increased to above 250 words per minute (wpm). Shields (1975) demonstrated that Army communications processors could accurately identify the subject matter of highly technical communications compressed to 1.5 times their normal rate. Recently, deHaan (1977) found good comprehension in subjects who listened to historical material compressed to twice the normal speed.

Numerous studies have shown that subjects can be trained to listen to compressed speech at more than twice the normal rate with no appreciable loss in comprehension (Grumpelt & Rubin, 1972; Lambert, Shields, Gade, & Dressel, 1978). Relatively little is known, however, about how listening rate preferences are influenced by exposure to compressed speech or how these rate preferences influence performance when listening to compressed speech. To make effective use of the technology of rate-controlled speech, the military must fully explore variables such as instruction-induced motivation and listening rate preferences.

This experiment explored the influence of several variables on the performance of Army personnel in a self-paced learning situation using compressed speech. The first question to be answered was whether instructions that fostered epistemic curiosity would have the positive influence on comprehension for compressed speech that they have been shown to have on reading. Furthermore, would epistemic curiosity affect the rate at which subjects elected to listen to compressed speech? Finally, the experiment examined the relationship between preferred listening rates and the maximum rates at which subjects could listen to compressed speech (see Lass, Foulke, Nester, & Comerci, 1974; and Levine, 1975, for discussions of speech rate preferences).

OBJECTIVE

The objective of this research was to assess the relative influence of epistemic curiosity, prior experience with compressed speech, and preferred listening rates on the performance of Army personnel in a self-paced learning situation using compressed speech.

METHOD

Participants

Participants were 37 male and 11 female Army enlisted personnel. All participants had scores of 100 or better on the General Technical scale of the classification battery.

Apparatus

Participants were seated in an IAC[1] acoustical chamber during the experiment. A Crown 800 variable-speed tape recorder/player was used in conjunction with an AmBiChron (Koch, 1974) speech compressor/expander to present passages of speech. Participants listened binaurally to the speech through headphones. Participants controlled speech rates by manipulating a knob on a control box in the audio chamber. All participant responses were automatically recorded on a strip chart and on a small laboratory computer. This computer, an ADDS 1800-E, was used to regulate the onset and offset of the tape recorder and to record listening times.

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[1] Use of commercial names is for purposes of clarity only and does not represent indorsement by the Department of the Army.

Stimulus Materials

Five passages of speech were selected from a Library of Congress recording (talking book), The Proud Tower (Tuchman, 1966). A professional female reader read the passages at an average rate of 130 words per minute (wpm). One of the passages was used as a practice passage. For purposes of counterbalancing and data analysis, the remaining four passages (A, B, C, and D) were combined into pairs (AB and CD). Each pair was treated as a single unit for controlling order effects and in subsequent data analyses.

Design and Procedure

Participants were randomly assigned to one of the 16 cells of a 2^4 completely randomized factorial design. The four factors defining the cells were (a) type of instructions (declarative or interrogative), (b) practice passage speed (normal or twice normal rate), (c) passage presentation order (AB followed by CD, or the reverse), and (d) order of instruction (AB had instructions, while CD had no instructions, or the reverse).

Upon arriving at the laboratory, participants were given a brief description of the experiment and the tasks they would be performing. They were given a practice session during which they were shown how to control the rate of compressed speech. Next, the participants were told to listen to a practice passage and that they would be asked questions later about the passage. They were also told that they would not be able to control the speed of the speech during this practice passage, but that they would have to listen to the passage at either normal speed or twice normal speed, depending on their group assignment. After they finished the questions at the end of the practice passage, participants were told that they would next listen to four more passages, during which they could control the rate of speech. They were asked to listen to each passage as rapidly as possible, but not so fast that they would be unable to answer the questions at the end of each passage.

Overall listening rates for each passage and the number of correct answers on each test served as response measures. After completing the test for the fourth passage, participants were asked to listen to the fourth passage again. While listening, they were asked to adjust the speed of the speech to the rate they preferred. Participants were also asked to adjust the speed of the speech to the rate they least preferred. The order of these two preference judgments was counterbalanced between participants.

RESULTS AND DISCUSSION

Comprehension Scores

A five-way ANOVA with repeated measures on the last factor was performed on the total number of correct answers achieved by participants. The factors analyzed were type of instruction, practice passage speed, passage presentation order, order of instruction, and passage instructed (i.e., whether or not preceded by instructions). The factors of passage presentation order and order of instruction were not independent variables in the truest sense but were created to balance out the possibility of those two types of order effects.

Based on the epistemic curiosity hypothesis, it was expected that comprehension scores for passages preceded by instructions would be significantly higher than scores on passages not preceded by instructions. However, this was not the case, since none of the main effects or interactions of primary concern was significant. The only significant effect was the practice passage speed x passage presentation order x order of instruction x passage instructed interaction ($F(1, 32) = 5.58$, $p < .025$). Although subsequent simple effects testing using Tukey's HSD test (Kirk, 1968) revealed a few significant differences, none of the instructional manipulations had any significant effect on comprehension performance.

The most parsimonious explanation for this failure is that the instructions used were ineffective instructions. Instructional attempts to induce epistemic curiosity effects in auding tasks may be inappropriate, however. McGraw and Grotelueschen (1972) and Boyd (1973) have suggested that prequestion-induced increases in comprehension of written material are produced by fostering rehearsal and review of the answers to the prequestioned material. Review and rehearsal are severely limited by the listening techniques used in the present study; therefore, the failure to find comprehension differences between differentially instructed conditions and groups may be because participants had limited opportunities for review and rehearsal.

Selected Listening Rates

A five-way ANOVA was performed on the listening speed the participants chose. The factors analyzed were the same as those examined in the analysis of the comprehension scores. A significant main effect for practice passage speed was found ($F(1, 32) = 20.01$, $p < .001$). Participants who were required to listen to the practice passage at twice the normal rate chose to listen to the four subsequent passages at faster rates than those who listened to the practice passage at a normal rate ($\bar{X} = 1.69$ times normal versus $\bar{X} = 1.39$ times normal, respectively). Two interactions were also significant: (a) practice passage speed x passage presentation order x passage instructed ($F(1, 32) = 5.34$, $p < .05$) and

(b) passage presentation order x order of instruction x passage instructed ($F(1, 32) = 5.88$, $p < .05$). As with the comprehension data, however, simple effects analyses for both these interactions failed to yield any significant defects for instructional manipulations. No other main effects of interactions were significant.

To determine if participants had modified their selected listening rates during the course of listening to the four experimental speech passages, a two-way ANOVA was performed on the selected listening rate data. The two factors analyzed were practice passage speed and trials (i.e., Trial 1 = first passage heard, Trial 2 = second passage heard, etc.). As Figure 1 shows, no changes in mean selected listening rates were observed in either of the two practice passage speed groups during the four experimental passages. Only the main effect for practice passage speed was significant ($F(1, 31) = 29.79$, $p < .001$). Clearly, the effects established by listening to the practice passage at normal or twice normal speeds were not modified at any time during the experiment.

Preferred Listening Rates[2]

A four-way ANOVA was performed on the preferred listening rate data. The factors analyzed were type of instruction, practice passage speed, passage presentation order, and order of instruction. As in the previous analyses, passage presentation order and order of instruction were pseudo factors created to control those two types of order effects. None of the main effects or interactions in this analysis was significant. A four-way ANOVA of the data on least-preferred listening rate yielded similar results; that is, no main effects or interactions were significant. The results of these two analyses clearly indicate that neither instructional set nor prior experience with compressed speech affected participant preferences in any significant way. It is interesting to note, however, that of the 33 subjects, 31 preferred to listen to speech at a faster than normal rate ($\chi^2(1) = 25.48$, $p < .001$). Furthermore, the mean preferred rate (142% of normal rate) was significantly higher than the normal rate ($t\ (32) = 10.24$, $p < .001$).

A two-way ANOVA was used to analyze the differences between preferred and selected speeds for groups receiving the practice passage either at the normal rate or at twice the normal rate. The group receiving the practice passage at twice the normal rate selected a significantly ($F(1, 62) = 8.92$, $p < .05$) higher rate ($\overline{X}$ = 166% of normal) than did the group receiving practice at the normal rate ($\overline{X}$ = 140% of normal). However, these two groups did not differ in their preferred speech rates, as the respective mean differences show (144% compared to 141% of the normal rate).

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[2] All the analyses for preference data were performed using least-square solutions, because these data were based on the responses of 33 of the 48 participants. Preference data were not collected from the first 15 people who participated in this experiment.

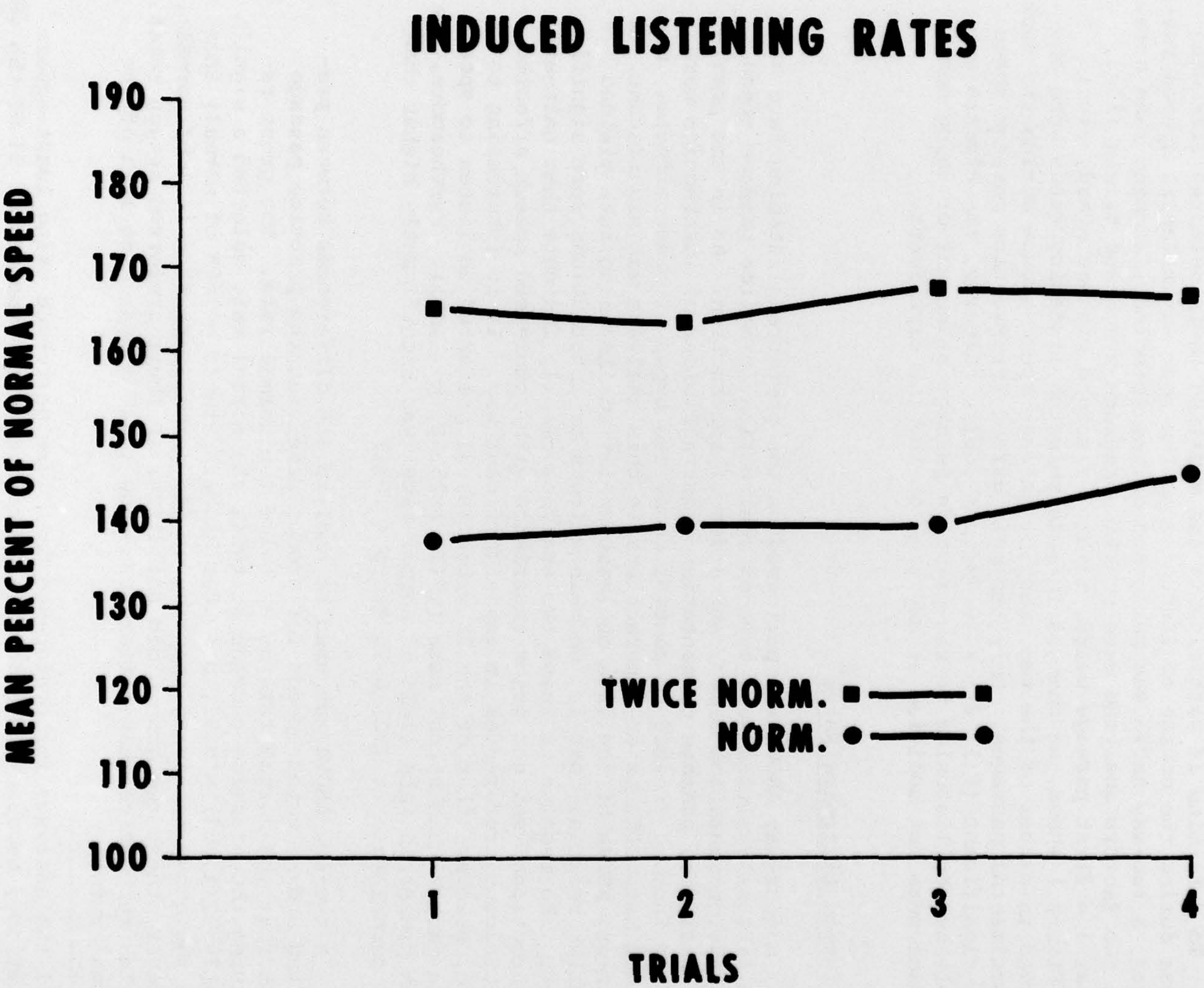

Figure 1. Induced listening rates.

Furthermore, the group given practice at twice normal speed selected speeds ($\bar{X}$ = 166% of normal) significantly higher ($F(1, 62) = 13.90$, $p < .001$) than their preferred speed ($\bar{X}$ = 144% of normal). No such mean differences between selected and most preferred speeds were found for the normal speed practice group. In fact, only 47% of participants in the normal speed practice group elected to listen at a mean rate that was faster than their mean preferred rate; while 94% of the participants in the twice normal group elected a mean listening rate that was faster than their mean preferred rate. This difference in the proportion of individuals selecting mean listening rates above their preferred rates between normal and twice normal practice groups was statistically reliable ($z = +3.49$, $p < .005$).

Taken together, these results seem to indicate that although prior exposure to compressed speech modified the rate at which subjects elected to listen to further passages of speech, it did not influence their preferred listening rates in any significant way. The fact that practice passage speed showed a moderately high point-biserial correlation with selected listening rate ($r(31) = +.55$, $p < .01$) but did not correlate with most-preferred listening rate ($r(31) = +.06$, $p > .05$) lends support to this notion. Preferred listening rate, however, did show a significant and moderately high correlation with selected listening rate ($r(31) = +.47$, $p < .01$). Apparently, preferred listening rate and prior forced exposure to compressed speech combine in an additive fashion to influence selected listening rate. The multiple correlation coefficient using preferred listening rate and practice passage speed as predictors of selected listening rate was relatively high ($\hat{R} = .68$).[3] The proportion of selected listening rate variance accounted for by combining these two predictors ($\hat{R}^2 = .46$) was very nearly the sum of proportion of selected listening rate variance accounted for by each of these predictors considered separately (.22 for most preferred listening rate and .30 for practice passage speed, $\Sigma = .52$).

CONCLUSIONS

The results of this experiment are inconclusive with respect to the effects of epistemic curiosity on listening to time-compressed speech. In this experiment, neither comprehension of speech passages nor listening rates were affected by instructional attempts to induce epistemic curiosity. These results may be attributed to one of three causes. First, the instructions used may have been ineffective in inducing epistemic curiosity. Second, the limited opportunity for review of the aurally

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[3] To better estimate the population correlation coefficient, the multiple correlation coefficient (R) was "shrunken" ($\hat{R}$) according to the formula suggested by Guilford and Fruchter (1978, p. 377). The multiple regression equation based on $\hat{R}$ is $\tilde{X}_1 = 107.91 + .125 X_2 + .184 X_3$ where $\tilde{X}_1$ = predicted selected speed, X_2 = practice passage speed, and X_3 = preferred listening rate.

presented passages may have prevented epistemic curiosity from having its usual effects on comprehension performance. Third, it may be that epistemic curiosity simply does not influence comprehension performance when listening as it does when reading. In our opinion, the first two possible causes are the most probable. The third cause seems most unlikely to us.

The results of this experiment clearly indicate that Army personnel can be induced to listen to speech at rates well above their preferred listening rate with no loss in comprehension. It is also clear that listening rates in a self-paced listening task can be modified relatively easily by recent experience with time-compressed speech. Our results show that people who are required to listen to compressed speech at faster than normal rates subsequently elect to listen to compressed speech at rates further above their preferred rates than do people who are not given such prior exposure. Prior exposure to compressed speech does not seem to influence subsequent accuracy of listening performance nor does it appear to appreciably affect listening rate preferences. A person's least-preferred speech rate seems to have little influence on his or her self-selected auding rate. However, a person's preferred listening rate has a moderate, positive influence on his or her listening rate in a self-paced listening task.

In summary, it seems that preferences for speech rate are not modified by brief listening experiences, whereas induced rates are very easily influenced by such experiences. People given brief exposure to highly time-compressed speech subsequently elect to listen to speech at rates well above their own preferred rates without any loss in comprehension. It appears that a person's listening rate in a self-paced task depends on that person's recent experience with time-compressed speech and his or her preferred listening rate.

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