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THE INFLUENCE OF MESSAGE DISTORTION AND MESSAGE FAMILIARITY

The Third of a Series of Reports on Auditory And Visual Message Presentation Under Distracting Task Conditions

JAMES G. HOLLAND
WILLIAM A. LEE

UNIVERSITY OF VIRGINIA

APRIL 1955

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FOREWORD

This report is the third of a series covering laboratory experiments comparing the auditory and visual presentation of information. The investigation included in the present report was conducted by J. G. Holland and W. A. Lee under the direction of Dr. R. H. Henneman and Dr. L. S. Reid. This study was carried on at the University of Virginia under Contract No. W33(038)-ac-21269. This contract was initiated under a project No. 7192, task No. 71603, 'Visual Message Presentation.' The contract was administered by the Psychology Branch of the Aero Medical Laboratory, Directorate of Research, Wright Air Development Center with James E. Smithson acting as Project Engineer.

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ABSTRACT

Broader generalization of earlier findings comparing the relative intelligibility of verbal messages presented aurally and visually was sought by investigation of two additional variables. These were (1) message presentation in distorted form and (2) previous familiarization with the message population. Both of these conditions apply widely in practical operations. Two closely related experiments were conducted to discover (1) the influence of a distracting task on the reception of distorted messages as related to sense channel of presentation, and (2) the effectiveness of message familiarity in combatting the lowered intelligibility of distorted messages, and the possible influence of sense channel in such an effect.

The principal findings were the following: (1) introduction of the distracting task significantly reduced the intelligibility of the visually presented messages, while leaving the auditory messages essentially unaffected; (2) previous familiarization significantly increased the intelligibility of the distorted messages as presented through either sense channel; (3) familiarization was significantly more effective when provided through the same sense channel as that through which the distorted form of the message was subsequently presented.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

JACK BOLLERUD
Colonel, USAF (MC)
Chief, Aero Medical Laboratory
Directorate of Research

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INTRODUCTION

Previous experiments in this series comparing the relative intelligibility of verbal messages presented aurally and visually have established the superior intelligibility of auditory (voice) messages over visual (printed) messages when subjects are simultaneously engaged in a distracting task (5, 6). This finding is a controversial one in terms of current development of communications equipment. It is in line with the contention of many pilots that voice communication would interfere less with the task of flying the aircraft than would the use of visual presenters. On the other hand, the evidence for the superiority of the auditory sense channel is not in harmony with a number of recent proposals to substitute visual presentation devices in the aircraft for the radio telephone. It therefore seemed important to extend the generalization of the earlier Virginia studies by investigating additional variables involved in the exchange of messages during practical air operations.

In planning further research that would add specificity to the previous experimental results, a possible limitation of the earlier investigations came to mind, namely, that the aurally and visually presented messages had always been free from "noise" at the time of experimental presentation. The practical situation is in contrast to this. In the aircraft or control tower the voice messages heard over the radio telephone are seldom completely free from some degree of physical distortion. Frequently indeed the words are so garbled as to sound like a meaningless babel to the layman. Most visual displays, if substituted for the radio telephone, would also be subject to "noisy" conditions. Therefore, in order to be more certain that the indicated superiority of voice messages would apply under normal operating conditions in aircraft and control towers, it was thought necessary to compare the relative intelligibility of auditory and visual messages, using distorted stimulus presentation.

Another variable, not considered in the earlier Virginia experiments, was the degree of previous acquaintance which the subjects might have had with the message material. Most of the time, though in varying degree, Air Force personnel are highly familiar with the contents of the messages transmitted. It is in fact usually agreed that familiarity plus a high degree of message redundancy combine to offset the low intelligibility of distorted message signals in operational situations.

There is also considerable evidence from the experimental laboratory that previous acquaintance with the population of words facilitates the identification of verbal materials under difficult conditions of perception. Research affording evidence for this generalization has been reported over the past 70 years. Some of the more recent studies may be summarized briefly. Miller, Bruner, and Postman (9) conducted a study of tachistoscopic recognition of eight-letter pseudo-words at different degrees of

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approximation to English. At all of the exposure durations tested (.01 through .50 sec.), the closer the pseudo-word approached the statistical structure of English, the better was the perception of the word.

Additional evidence is furnished by the Howes and Solomon finding (7) that frequently used words are more readily perceived under difficult tachistoscopic conditions than infrequently used words. These investigators obtained high negative correlations --- ranging from -.56 to -.79 --- between frequency of use and correct recognition of words despite the fact that the relative frequency of occurrence in regular English prose of any one test word is at best a crude index of the relative frequency that a given subject has seen the word.

A large amount of research has demonstrated the helpful effect of context in "noisy" perceptual situations. Miller, Heise, and Lichten (10), for example, have shown that the articulation scores for words in sentences are consistently superior to the scores of the same words in isolation. Frick and his associates at the Human Resources Research Laboratories (2) have reported evidence as to the striking effect of contextual redundancy in aiding the correct identification of distorted voice messages in air traffic control operations.

Of direct importance to the present investigation are two studies involving familiarization with relatively restricted stimulus populations. Garvey, using an original method of speeded speech (4) to achieve 2.0 and 2.8 times the rate of normal speech, found that subjects who had heard short sentences on two previous unspeeded, familiarization trials had significantly higher intelligibility scores than those subjects with no previous familiarization (3). A further control group indicated that the increased intelligibility was not due to memorizing the sentences. Miller, Heise, and Lichten (10) have reported consistent increases in articulation scores for first and second repetitions of a message under the same noise conditions as the original presentation.

Several experiments on perceptual set at the University of Virginia have demonstrated the helpfulness of setting cues (as response-restricting information) for the identification of distorted words presented both visually and aurally. [1]

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1. These studies are published as WADC Technical Reports 54-361, The Influence of Sensory Channel of Cuing on the Identification of Aurally Presented Distorted Words, The Sixth of a Series of Reports on "SET" As a Determiner of Perceptual Responses; and 54-362, The Influence of Categorical Cuing on the Identification of Visually Distorted Words Selected from a Logically Organized Population, The Seventh of a Series of Reports on "SET" As a Determiner of Perceptual Responses.

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The direct inference from the various studies cited above is that the intelligibility of verbal messages is a direct function of the range of potential alternatives or degree of response uncertainty. Any condition which reduces the number of alternative responses, whether labeled as familiarization, contextual organization, or setting cues, will serve to increase intelligibility of the verbal material when stimuli are distorted or identification is otherwise rendered difficult.

It therefore seemed fruitful to introduce message familiarity as an additional experimental variable in the investigation of the relative intelligibility of auditory and visual messages. There is the possibility (though admittedly not the likelihood) that the sense channel of message reception is a factor in the helpfulness of familiarity as an aid to the intelligibility of distorted messages. Of special interest in this regard is the question of whether or not the familiarization should be through the same sense channel as that through which the distorted message is later presented.

It was decided to retain the condition of the distracting task in the further experimental comparison of auditory and visual message presentation. This decision was based upon two considerations, (1) most operational situations in the Air Force involve the reception of messages while operators are simultaneously occupied with competing activities, and (2) the results of the present study would be more comparable to the earlier Virginia experiments in this area. The present experiment thus sought to learn the influence of a distracting task on the reception of distorted messages, and whether, under such a condition, message familiarity would act to combat the intelligibility of the distorted message stimuli.

In summary, the investigation was planned to answer the following questions:

1. In what way, if any, does a distracting task influence the identification of distorted verbal messages?

2. Is the sense channel through which the messages are presented a factor in this influence?

3. Does familiarity with a message population facilitate identification under conditions of distorted presentation and a simultaneous distracting task?

4. Does this familiarity affect reception through one channel (auditory or visual) to a greater extent than another?

5. Does the sense modality through which familiarity has been provided interact significantly with the intelligibility of distorted visual and auditory messages?

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These questions could best be answered by two closely related experiments rather than by a single experiment of more complex design. It was planned to compare the intelligibility of distorted messages first, and to follow this experimental comparison with an investigation of the role of message familiarity.

PROCEDURE OF EXPERIMENT I

Experimental Design

In order to answer the first two of the above questions, two experimental variables, sense modality and distracting task, were manipulated to provide four experimental conditions. One group of subjects received visually distorted messages, while performing the distracting task; a second group received the same messages without the task. The remaining two groups received only aurally distorted messages, one while performing the task and the other without the task. Thus a 2 x 2 factorial design was employed, as shown in Table 1.

TABLE 1

Design of the Experiment

	No-Task	Task
Visual Presentation	N = 15	N = 15
Auditory Presentation	N = 15	N = 15

Subjects

Sixty male college students served as subjects, assigned randomly, 15 subjects to a cell.

Message Presentation Apparatus

Message presentation procedure was similar to that of the previous experiments, (5, 6). Auditory messages were first recorded on an Eicor tape recorder and subsequently played back to the subjects through

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earphones. Distortion of the voice messages was provided by mixing noise (from a Harvard Psycho Acoustic Laboratory noise generator Model 422) with the messages as recorded on the tape. Intensity level of the noise was determined by preliminary experimentation, and selected at that level which lowered message intelligibility to approximately 50% under conditions of no distracting task.

Visual presentation was provided by means of lantern slide projection. Visual distortion was obtained by photographing typed sentences out of focus and printing transparencies from these blurred photographs. Examples of the experimental sentences distorted in this manner are shown in Figure 1. Again preliminary experimentation was used to determine a distortion level which would yield approximately 50% intelligibility. The experimental design did not demand precise equation of the distortion levels of the auditory and visual stimuli; nevertheless the intelligibility scores made by the subjects in the no-task condition (see Table 4) indicate that the intelligibility level of the two sets of messages had been in fact rather closely matched. The projected visual messages were viewed by the subjects through a 3-in. x 7-in. screen situated 30 in. in front of the subject's eyes. Message exposure time, three seconds, was the same for both auditory and visual presentation.

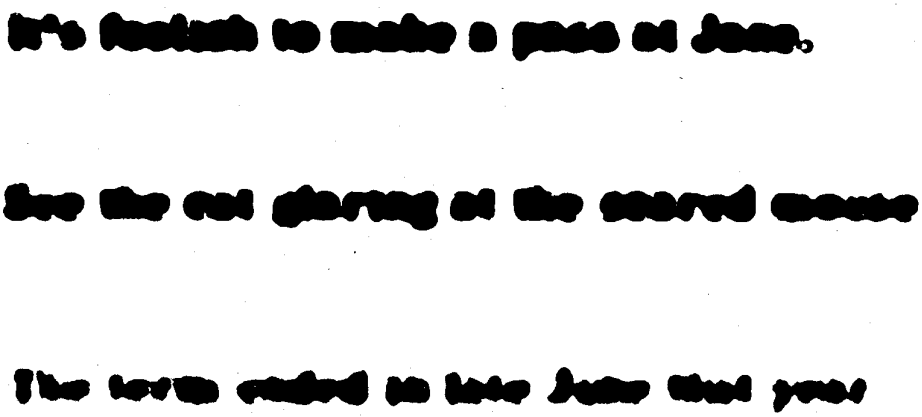

Figure 1. Examples of the distorted sentences used for visual presentation. These sentences read as follows: It's foolish to make a pass at Jane. See the cat glaring at the scared mouse. The term ended in late June that year.

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Message Material

The messages used in the present study were 40 eight-word sentences chosen from the Harvard Psycho Acoustic Laboratory Sentence Intelligibility Test. This type of material was chosen because the vocabulary employed in this test was suited to the use of college students, and because message length was peculiarly adapted for convenience of manipulation and scoring. Each sentence contained five key words, prepositions, articles, and minor verbs being omitted from the scoring. Below are two sample messages with the five key words underlined:

A plump hen is well fitted for stew.

Take the winding path to reach the lake.

Task Apparatus

The distracting task selected for the present experiment was different from those used in the two earlier audio-visual comparisons. The visual motor discrimination task was similar to one of the two component tasks previously used in the investigation of complex task performance (12). It consisted of a panel with four green lights in a row. Horizontally and in front of this panel were four response keys spatially corresponding to the four lights. The lights flashed on singly at a rate of two per second and in random sequence (within a series of 44 steps). The subject was required to press the key corresponding to a given light within the half-second interval that the light was on. The random sequence of lights necessitated the subject's responding by visual guidance alone. Number of correct responses during a trial was recorded automatically.

Procedure

Every subject received 20 one-minute trials during each of which two messages were presented either aurally or visually depending upon the experimental condition. Presentation time for all messages was three seconds. Between trials there was a 30-sec. rest period. Ten seconds after a "ready" signal the first message was presented. Immediately after it had ended the subject repeated it verbally. The experimenter recorded any errors at this time. The second message was presented 35 sec. after the beginning of a trial. Subjects were instructed to repeat every word remembered, guessing when they were not sure.

The subjects in the task condition performed the distracting task throughout these 1-min. trials. They were instructed to give much effort to the task even during the periods of message presentation. Specific instructions were the following:

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You must make every effort not only to learn the sentence, but, also, to maintain as high a level of performance on the key-pressing task as you can. It is important that you perform well on the task at the same time that you are receiving a message. You are scored on both the message and the task.

All instructions were presented over earphones from tape recordings. The instruction period provided one minute's practice on the task alone for the task groups; one isolated sample message for all groups; and a complete practice trial (i.e., combined message reception and task) for all groups.

PROCEDURE FOR EXPERIMENT II

Experimental Design

To provide answers to the last three questions noted in the Introduction two variables, sense channel of presentation and familiarity with message, were manipulated in 2 x 2 analysis of variance design (shown in Table 2). Subjects in all four experimental conditions performed the distracting task during message reception and all messages were presented in distorted form. Subjects in the familiarity condition received one non-distorted presentation of each of the messages prior to its presentation in distorted form. The subjects of one of these cells later listened to these messages mixed with noise, while the subjects of the other cell viewed a visually blurred presentation of the messages. Subjects of the non-familiarity cells received no familiarization before being presented the distorted messages.

TABLE 2

Basic Design of Experiment II

	No Familiarity	Familiarity
Visual Presentation	N = 12	N = 12
Auditory Presentation	N = 12	N = 12

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Each subject in the two familiarity groups received half of the messages through the visual, and half through the auditory channel during the familiarization period. This procedure was followed for control purposes, but it also afforded the possibility of obtaining additional findings. Analysis by means of a split-plot technique would provide information regarding the influence of the sense channel by which familiarity was received. For this analysis the familiarization groups were broken down into sub-groups (see Table 3), and a comparison was made between those messages for which familiarity was received by the same modality as the later test presentation, and those for which the familiarity was received by a different modality than the test. This analysis thus involves a comparison between two measures made with the same subjects. The split-plot technique takes this into consideration by using the subjects x measures interaction as the error term for all within-subject comparison.

In order that such a comparison could meaningfully be made, counterbalancing was employed for the sense channel first used in the familiarity period, and for the particular set of 12 messages presented aurally, and the set presented visually during familiarization.

Subjects

Forty-eight male college students were assigned randomly, 12 subjects to a cell as shown in Table 2.

TABLE 3

Split-Plot Design of the Familiarity Group

	Familiarity by Same Channel	Familiarity by Different Channel
Visual Presentation	N = 12	
Auditory Presentation	N = 12	

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Apparatus and Procedure

The apparatus and much of the procedure of the second experiment were the same as those of Experiment I. The same distracting task was employed. Method of distorting the auditory and visual stimuli, and levels of distortion were the same as those of the previous study. Methods of message presentation and measurement of message intelligibility were the same as before.

Twenty-four of the 40 sentences from the previously used Sentence Intelligibility Test material were selected as the experimental messages. They were chosen so as to yield the middle range of errors and to minimize sense channel differences in intelligibility when the distracting task was performed.

Prior to the experimental test for intelligibility of these distorted messages, the two familiarization groups were given one previous presentation of each sentence in a non-distorted form and without the distracting task. Twelve of these sentences were presented visually and 12 were presented aurally over earphones. Exposure times were equated for both sense channels at 3 sec. each. Immediately after the message ended, the subject repeated it back. Twelve seconds between successive messages were provided for the subject's response.

After the familiarization period the subjects received the experimental presentation of the distorted messages while performing the distracting task. The subjects performed the task for one-minute trials, during each of which two distorted sentences were presented -- either aurally or visually depending on the group to which they belonged. Any one subject was presented the 24 distorted test messages through only one sense channel.

As in the preceding experiment each subject was instructed to perform maximally on the task while receiving the messages. Immediately following each 3-sec. interval of message transmission the subjects were required to repeat any part of the sentence that could be remembered. The 24 sentences contained five key words each thus providing a possible 120 correct responses for each subject.

RESULTS

Results of Experiment I

The principal results of Experiment I are shown in Tables 4 and 5. Table 4 presents the means and standard deviations of the message intelligibility scores for each of the four experimental conditions.

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TABLE 4

Means and Standard Deviations of Number of Correct Responses Under No-Task and Task Conditions

	No-Task		Task	
	Mean	S. D.	Mean	S. D.
Visual Presentation	107.40	20.96	80.73	30.27
Auditory Presentation	105.53	13.74	103.53	22.79

TABLE 5

Analysis of Variance of Number of Correct Responses Under No-Task and Task Conditions

Source of Variation	Sum of Squares	df	Mean Square	F
Sense Channel	3,081.67	1	3,081.67	5.97**
Task	1,643.26	1	1,643.26	3.18
Channel x Task	2,281.67	1	2,281.67	4.42*
Within	28,898.00	56	516.04	
Total	35,904.60	59		

** Significant at the 1% level.
* Significant at the 5% level.

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Inspection of this table shows the same trends as those obtained in the earlier experiments comparing auditory and visual message presentation (5, 6). Visual and auditory presentation are equally intelligible under the no-task condition. Introduction of the distracting task, however, interferes strikingly with reception of the visual messages, but leaves the intelligibility of the voice messages essentially unchanged. This differential effect of distracting task upon message intelligibility as presented aurally and visually is reflected in the results of the analysis of variance shown in Table 5.

The effect of message reception upon task performance was not of primary concern in the present experiment, but it is of interest to ask whether the intelligibility of the auditory messages during task performance is maintained at the expense of proficiency on the task. Accordingly the number of correct task responses made during simultaneous message reception were tabulated and the means compared for auditory and visual message presentation. The mean number of correct responses during auditory presentation is 128.33, and during visual presentation, 104.47. The t-ratio of the difference between these two means is 1.23, hence the difference is not significant. However, it is striking that the trend is toward both higher intelligibility and greater task proficiency when the distorted sentences are received in voice form. This result too is in line with the findings of the earlier studies (5, 6).

Results of Experiment II

From an inspection of the raw scores obtained under the four experimental conditions in the second experiment, it was apparent that for both auditory and visual presentation the subjects who had been familiarized with the sentences had higher intelligibility scores. However, it was also obvious that the two familiarization groups of subjects made fewer correct responses on the distracting task than did the non-familiarization subjects. It was therefore necessary to determine the genuineness of the apparent influence of familiarization upon message intelligibility by removing these differences in task performance from the data. Accordingly an analysis of covariance was made, using task scores as the covariant. The results are shown in Table 7. The mean number of correct message responses, corrected by the covariant analysis, are shown in Table 6. From Table 7 it is obvious that even when the correction is applied the variable of familiarization remains significant beyond the 1% level of confidence. Neither sense channel of presentation nor the interaction between presentation channel and familiarity is significant. Thus the facilitating influence of previous acquaintance with the messages is independent of the sense channel through which they are presented.

When task scores are analyzed by covariance, using the message scores as the covariant, the condition of familiarity no longer results in significant differences in task performance. This result apparently

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TABLE 6

Adjusted Means of the Number of Correct Message Responses Under No-Familiarity --- Familiarity Conditions

	No Familiarity	Familiarity
Visual Presentation	48.9	51.1
Auditory Presentation	66.8	73.6

TABLE 7

Analysis of Covariance of the Number of Correct Message Responses With Task Responses as Covariant

Source of Variation	Sum of Squares	df	Mean Square	F
Familiarity	4,388	1	4,388	20.80**
Sense Channel	245	1	245	1.16
Familiarity x Channel	64	1	64	
Within Groups	9,060	43	211	
Total	13,757	46		

** Significant at the 1% level

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indicates that differences in task performance are attributable to differences in message intelligibility, a finding which will be discussed subsequently.

In order to determine the influence of the sense channel by which familiarization with the sentences was achieved, the message scores for the two familiarization groups of subjects were separated into two sets, on the basis of sameness or difference between sense modality of familiarization and sense modality of presentation during task performance. These results are shown in Table 8 which indicates that a larger number of correct responses was made when the same sense channel was used for both familiarization and subsequent presentation in distorted form. The split-plot analysis of these data is shown in Table 9 which shows that significantly higher intelligibility scores are obtained when familiarity and later test presentation are made through the same sense channel. The data of Tables 8 and 9 further suggest that the effect of using different channels for familiarization and later testing in distorted form may be less for auditory than for visual presentation. The test for significance of the familiarity-channel times test-channel interaction falls between the 5% and 10% levels of confidence.

TABLE 8

Means of Correct Message Responses

	Familiarization	
	Same Channel	Different Channel
Visual Presentation	38.2	28.3
Auditory Presentation	39.6	35.3

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TABLE 9

Split-Plot Analysis of Familiarity Groups

Source of Variation	Sum of Squares	df	Mean Square	F
Test Channels	212.52	1	212.52	1.79
Subjects in Same Group	2,614.96	22	118.16	
Total Between Subjects	2,827.48	23		
Familiarity Channels	595.03	1	595.03	21.92**
Familiarity Channels x Test Channels	93.50	1	93.50	3.44*
Pooled Subjects x Familiarity Channels	596.97	22	27.14	
Total Within Subjects	1,285.50			
Total	4,112.98			

** Significant at 1% level.
* Significant between 5% and 10% level.

DISCUSSION

The results of the two experiments taken together, generally confirm the findings of previous investigations in this series and extend the generality of the comparison of auditory (voice) and visual (printed) message presentation. Previously found superiority of auditory presentation under distracting task conditions is not removed when the messages are presented in distorted form. Familiarity with the messages increases their intelligibility under the dual condition of distorted presentation and a distracting

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task. This facilitative effect of familiarization applies to both auditory and visual presentation. The findings of the two experiments, as specifically related to the five questions raised in the Introduction may now be considered in more detail.

The first two questions were concerned with the effect of a distracting task upon the identification of distorted messages. The results of Experiment I indicate that if such messages are presented through the ear (i.e., by voice) there is little or no loss of intelligibility when the distracting task is introduced, whereas with visual presentation message intelligibility is significantly lowered. As in the first experiment of this series (using undistorted messages), if there is no difference in message intelligibility between the two sense channels when the subjects are not distracted by a competing task, then visual reception will suffer more than auditory reception when the subject has to shift back and forth between message reception and task performance (5). This auditory superiority during simultaneous task performance was also found in the second investigation of this series (6). Thus from three separate experiments there has now been derived evidence for the greater efficiency of message reception by voice where the message receiver is engaged in competing activities. This differential effect of task upon sense modality of message presentation is perhaps not as surprising in the present study as in the two earlier experiments, since the competing task in the present instance was visually controlled. However, the competing activities of both pilots and ground controllers at the time of message reception are usually visually directed. Both flying the aircraft and tracking on a radar scope largely involve the visual sense. Thus the laboratory task employed in the present study probably affords greater generalization to practical operations than the previously used tactual-kinesthetic tasks (5, 6).

The third question of the introduction had to do with the effect of message familiarization in facilitating the identification of distorted messages received under distracting task conditions. Positive results were obtained. Previous familiarization with the sentences in the present experiment appeared to have had a dual effect, (1) increased intelligibility scores for the distorted messages, and (2) a correlated decrease in proficiency of task performance. This latter effect is probably attributable to an overall "task set" adopted by the subjects because of extra effort to seek cues in the distorted messages by which they could recognize a previously perceived sentence. This cue-seeking effort was not possible for the subjects who had received no previous familiarization, i.e., had neither heard nor viewed the sentences ahead of the test presentation. This indication of mutual interference between message reception and task performance is in line with the findings of the second audio-visual comparison study previously reported (6).

However, even after correction was made for the lowered task performance associated with familiarization, the intelligibility scores of the familiarization subjects still remained significantly higher than those of the control groups. It is rather striking that this should be so even

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though the familiarization had consisted of only a single presentation of each sentence in non-distorted form. This helpful effect of familiarization on the identification of distorted verbal material is in line with the findings of other investigators summarized in the Introduction (2, 3, 7, 8, 9, 10). Thus the present results extend the earlier findings to situations in which the ambiguous verbal stimuli are perceived during distracting task performance. For practical operations this is an important extension of the generalization.

With respect to the influence of sense modality of message presentation on the facilitating effect of message familiarity (Question 4 of the Introduction), the results of the present study did not reveal either sense channel to be influenced more than the other by familiarization. This finding suggests that previous acquaintance with the message population is equally helpful to the intelligibility of auditory and visual messages. The practical consequence of this evidence is that the choice between the auditory and visual sense channels, so far as familiarization is involved, may be made on the basis of other practical factors. This finding is again in agreement with previously published laboratory research by other investigators and points to a general principle of perception which may be widely applicable in practical situations.

However, the role of the sense channel as related to message familiarization is somewhat complicated by the results of the present experiment as they bear upon the fifth question of the Introduction. The analysis of the sub-groups of familiarization subjects (see Tables 8 and 9) provides evidence that familiarization is maximally effective when it is received through the same sense modality as that by which the message material is later presented in distorted form. The inference from this finding is that acquaintance with message materials prior to their presentation in the process of communication should be provided through the same type of presenter as that employed in the communication system.

There is no directly related evidence in the literature concerning the efficacy of using the same sense modality for both original presentation and subsequent recognition, for highly meaningful material. Those investigators who have compared auditory and visual presentation of meaningful material have used only one sense modality for the recognition tests. DeWick (1) and Stanton (13), using advertising copy, for example, employed only visual recognition tests. Nagge, using discrete nonsense syllables---stimuli considerably less meaningful than the present material, did find that retention is best when original learning and recognition both took place through the same sense modality (11). He also found retroactive inhibition to be weakest when the interpolated material was presented through a sense modality different from that of the original material.

Some word of explanation should be attempted relative to this last finding of the present experiment. Most commonly, the facilitative effects of familiarization with a stimulus population have been regarded as the

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direct result of restricting the range of potential response alternatives (3, 7, 9, 10). It may well be, however, that the action of familiarization goes beyond mere restriction of response. Licklider (8) has argued that comprehension of meaning is "more a matter of correlation than of filtering". While reducing the range of response alternatives, familiarization can be thought of as simultaneously generating hypotheses or guesses within the perceiver against which he can correlate the incoming messages.

The present investigators would suggest that two factors are involved in the process of recognizing the previously perceived sentences from a distorted presentation. These factors are (1) retention of the general content or theme of the sentences, and (2) perception of critical cues, e.g., key words, letter combinations, or voice inflections. Presumably, memory of content would aid later recognition regardless of the sense channel involved in either the original familiarization or the subsequent recognition. But if the message receiver is to utilize cues from the speech or printed form of the undistorted presentation, obviously the sense channel would have to be employed for the recognition test. It is possible that this process of utilization of cues is what Licklider had in mind in speaking of "correlation" rather than "filtering". Certainly the results of the present experiment seem best explained by conceptualizing previous familiarization as playing a dual role in facilitating the intelligibility of messages presented in distorted form.

SUMMARY AND CONCLUSIONS

The present study was planned to extend the generalization of previous experimental findings at the University of Virginia comparing the relative intelligibility of verbal messages presented aurally and visually. Because message reception in practical operations frequently requires the identification of distorted stimulus patterns, it was judged advisable to verify the findings of the earlier experiments, using distorted message presentation. Furthermore, since operational personnel are usually highly familiar with the contents of the messages to be received, it was decided to investigate the influence of message familiarity as a variable in the relative intelligibility of auditory and visual messages. The condition of a simultaneous distracting task during message reception was retained also for reasons of greater generalization to the practical situation.

The investigation thus had a dual purpose. It sought to discover (1) the effect of a distracting task on the relative intelligibility of distorted messages presented aurally and visually; and (2) the effect of message familiarity in combatting the low intelligibility of distorted message stimuli, as related to sense channel of familiarization and that of subsequent presentation.

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Two closely related experiments were conducted. In the first, sense channel of presentation and task or no-task were the variables manipulated. In the second, sense channel and previous familiarization with the messages were the variables. All messages were presented in distorted form (at approximately 50% intelligibility) in both experiments. All subjects in the second experiment performed the competing task while receiving the messages. Message materials were short sentences selected from a standardized intelligibility test, each containing five key words. Message intelligibility was measured by having the subjects repeat as much of the sentence as possible immediately following reception. Auditory distortion was achieved by mixing noise with the sentences before presentation. Visual distortion was provided by photographing typed sentences out of focus and subsequent printing as transparencies for slide projection.

The principal findings were the following:

1. Introduction of the distracting task significantly reduced the intelligibility of the visually presented messages, while leaving that of the auditory messages essentially unaffected.

2. Previous familiarization with the messages significantly increased the intelligibility of the distorted messages as presented through either sense channel.

3. Familiarization was significantly more effective when provided through the same sense channel as that through which the distorted form of the message was subsequently presented.

It is concluded that the present results substantially confirm earlier findings and extend their generalization.

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