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FURTHER STUDIES ON AUDITORY MESSAGES

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16. Abstract

Two reports on variables related to highway advisory radio are presented. In one study, warning material in short, staccato messages was compared to warning material in long, detailed messages. The long, detailed messages were retained consistently better than the short, staccato ones. The second experiment investigated the effect of route numbers as directions in navigation messages on message retention. The results indicate conclusively that as the frequency of route numbers in messages increases, the frequency of route errors increases. In both experiments, the material was presented visually as well as aurally. The results of both experiments indicate that aural messages are retained just as well as the visual messages presented on highway signs.

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Summary

This is a report on two staff studies on variables related to highway advisory radio messages. The studies were conducted in a specially instrumented vehicle that the subjects drove on a public highway.

The first study reported was designed to use warning material in a highway advisory radio message and compare the efficiency of short staccato presentation formats with a long, detailed format. The auditory formats were compared for efficiency to the information presented visually.

The results indicate that the long, detailed messages were consistently, but not significant statistically, retained better then the staccato messages. As in previous experiments, the auditory messages were just as efficient as the traditional visual presentation of highway information.

The second experiment investigated the effect of route numbers as directions in navigation messages on message retention. The results indicate conclusively that as the frequency of route numbers in messages increases the frequency of route errors.

Visually presented messages were compared also to auditory messages in this experiment. The results again confirm the hypothesis that highway advisory radio messages are as efficient as visual sign messages.

FURTHER STUDIES ON AUDITORY MESSAGES

Introduction

The experiments described in this paper are the fourth and fifth of a series of studies on the effect of selected variables on the retention of auditory messages to drivers. All of these experiments were performed in a specially equipped vehicle with the subjects driving.

In the first two experiments of the series, the major variables investigated were (1) the effect of the number of navigation directions contained in an auditory message and (2) the effect of a second repetition of a message on the retention of the message (Gatling, 1975).

The length of the messages used in the experiments was controlled by using units of information. For example, the message "Take Exit 25 East and follow Broad Street to Route 11" contains three units of information (each unit of information is underlined). This method and the recall procedures are explained in detail in the procedure section of Experiment 2 of this paper. It was found that the experimental subjects who had a double presentation of the messages consistently had higher retention scores than the subjects who heard the message only once (see Figure 1).

In the two studies cited above, an increase in the number of message units resulted in an increase in route errors, but the frequency of the route errors in the repeated messages increased sharply when the number of instructions in the messages was greater than four.

Additional evidence for the sharp rise in errors above four instructions has been verified in a later experiment (Gatling, 1976; Figure 2) that also employed navigational messages. From this same experiment, the sharp rise in errors above four units surprisingly was found when the same messages were given visually to the subject.

The three variables of visual presentation, automatic auditory presentation, and manual auditory presentation were tested for their effects upon the retention of highway advisory navigation messages in the third study of the series (Gatling, 1976). In this study, one group was given navigational information visually, a second group received auditory messages automatically over the radio, and a third group also heard information over the radio but had to dial the radio station each time in response to an alerting visual

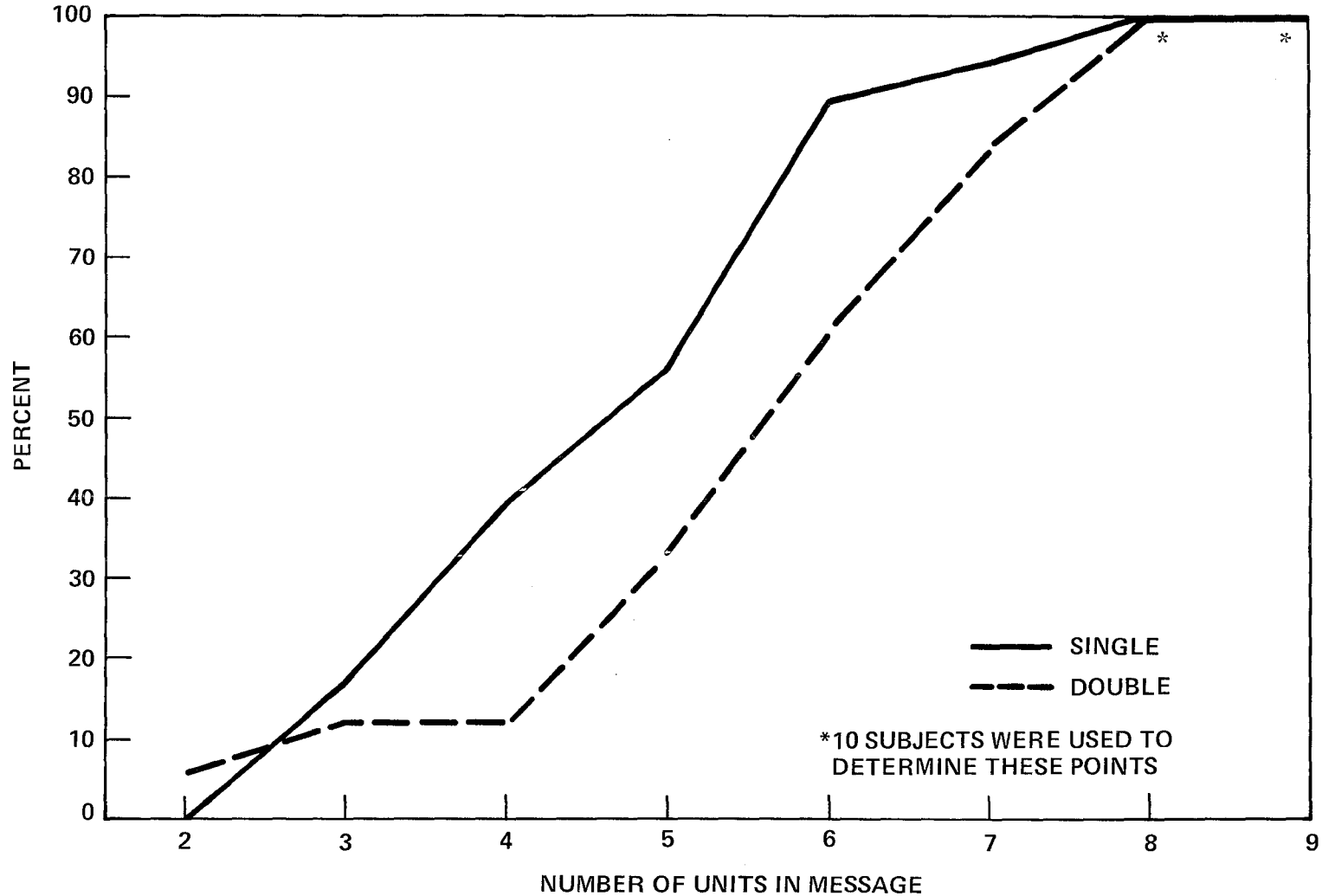

Figure 1. Percent of subjects making a route error as a function of message length and number of repetitions.

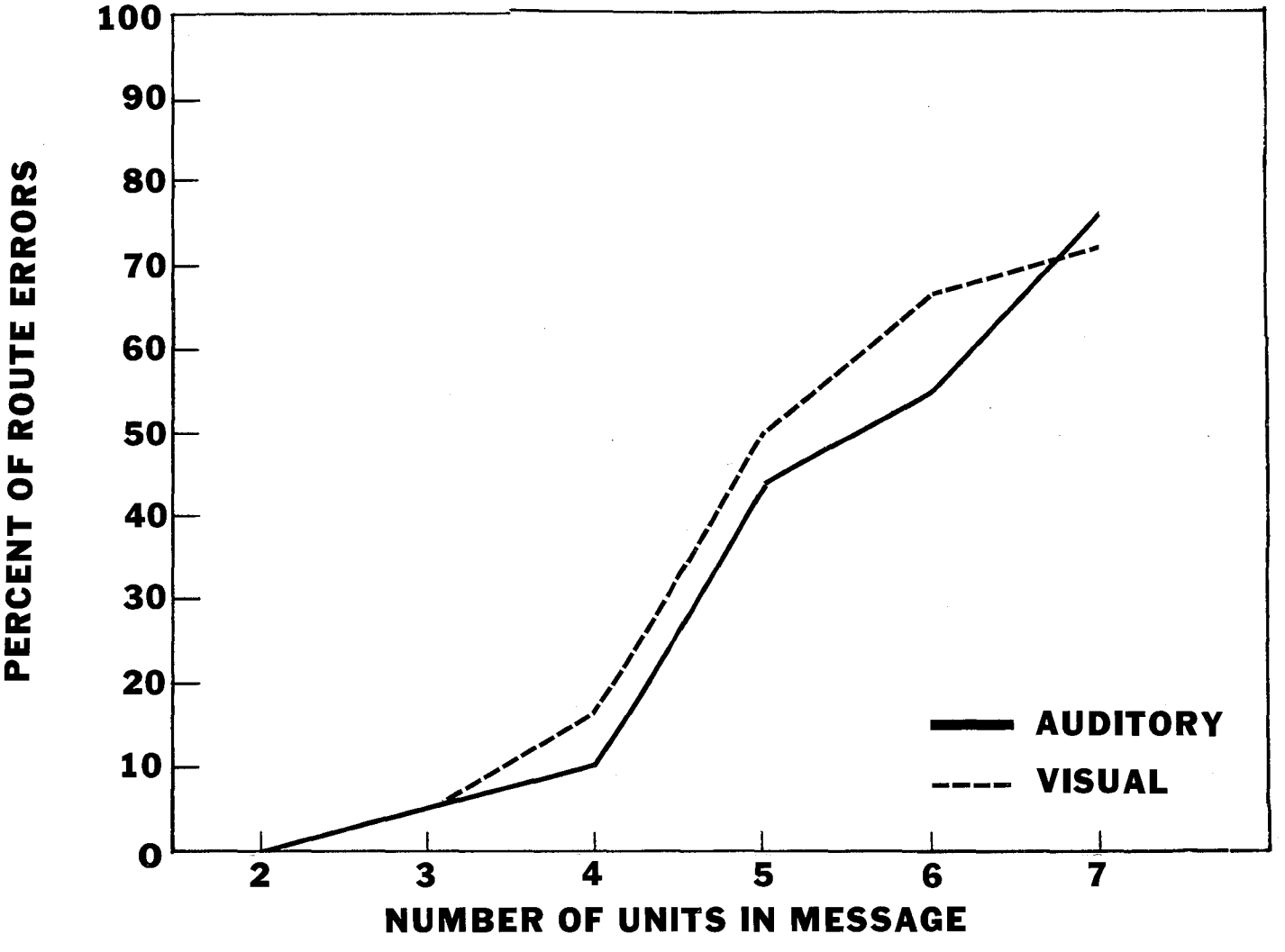

Figure 2. Percent of subjects committing route errors as a function of message length and automatic audio and visual methods of presentation.

highway sign in order to hear the message. The group that had to dial the radio to receive the message measured consistently poorer on message retention than did the other two groups (Figure 3).

The two audio groups and the visual group performed at about the same level. (The data from the three groups did not differ significantly statistically.) The results are important, for they are the first experimental evidence that highway information presented aurally may be just as effective as information presented by the conventional visual signs. (See Figure 3.)

The two following studies report (1) on the efficiency of cautionary material in auditory messages and (2) on the effect of route numbers as information items in auditory messages.

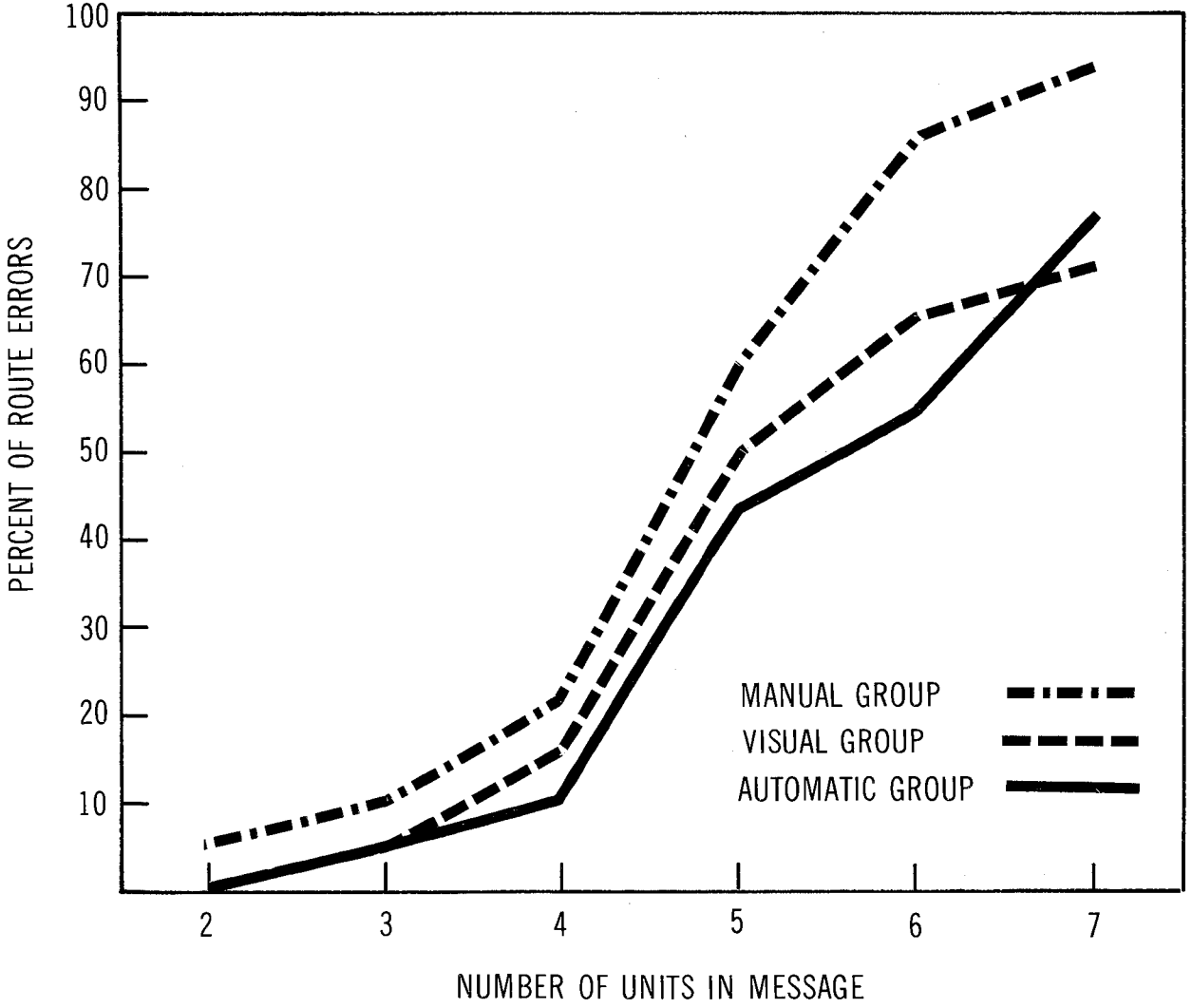

Figure 3. Percentage of subjects making a route error as a function of message length and message type.

THE USE OF CAUTIONARY MATERIAL IN AUDITORY VISUAL MESSAGES

(EXPERIMENT 1)

Introduction

Previous studies that have investigated auditory signs as a means of communication with motorists have used navigation instructions exclusively as experimental material and the data from these experiments have been discussed in the General Introduction. Other types of materials remain untested. For example, a large proportion of highway signs contain cautionary (warning) information and many instances arise when it would be advantageous, by radio, to update and add to these static signs or to inform motorists of impending trouble where no signs exist; e.g., accidents and construction.

The purpose of the present experiment was (1) to employ and compare the efficiency of two auditory presentation formats, and (2) compare the two auditory formats with a visual information presentation.

The visual format consisted of a series of signs that a driver would see on a highway. In one auditory format, the contents of the visual signs were simply read to the driver over the radio unchanged while in the second auditory format, the same visual information was given in a longer, more involved language matrix.

The hypotheses to be tested were (1) that retention would be higher in the visual than in the two auditory groups and (2) that the short auditory messages would be better retained than the long messages.

Subjects

The subjects were 60 men and women recruited by notices posted in universities, grocery stores, etc., and from lists of previously used subjects. The sample consisted of 28 males and 32 females. The average age was 28.9 years old and the educational level averaged 1.8 years of college. Only three people of the sample had less than 12 years of schooling and these were high school students currently enrolled in school. There has been no significant difference in the present experiment, nor in those discussed in the General Introduction, between the performance of men and women subjects as measured by message retention.

Equipment

The major piece of equipment was a four-door passenger style 1968 Oldsmobile. A slide projector and a recorder were mounted on a shelf in the rear seat area of the vehicle.

Figure 4. The test vehicle.

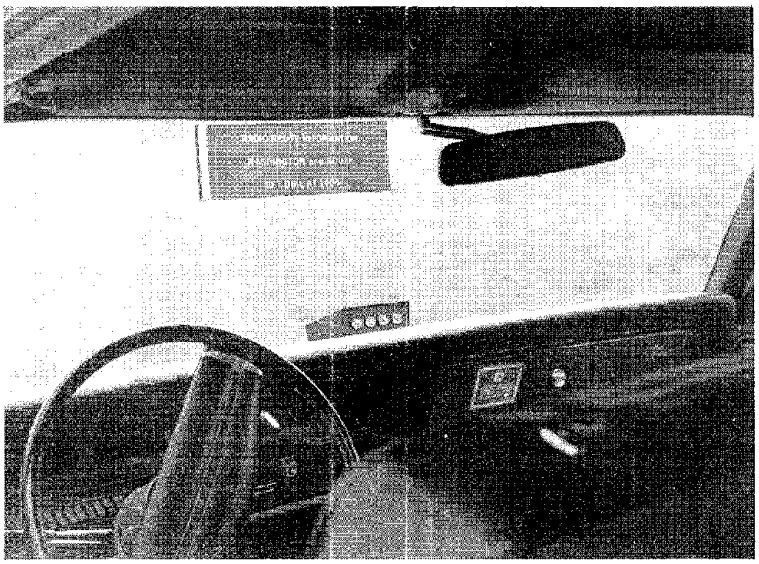

Figure 5. The windshield mounted screen.

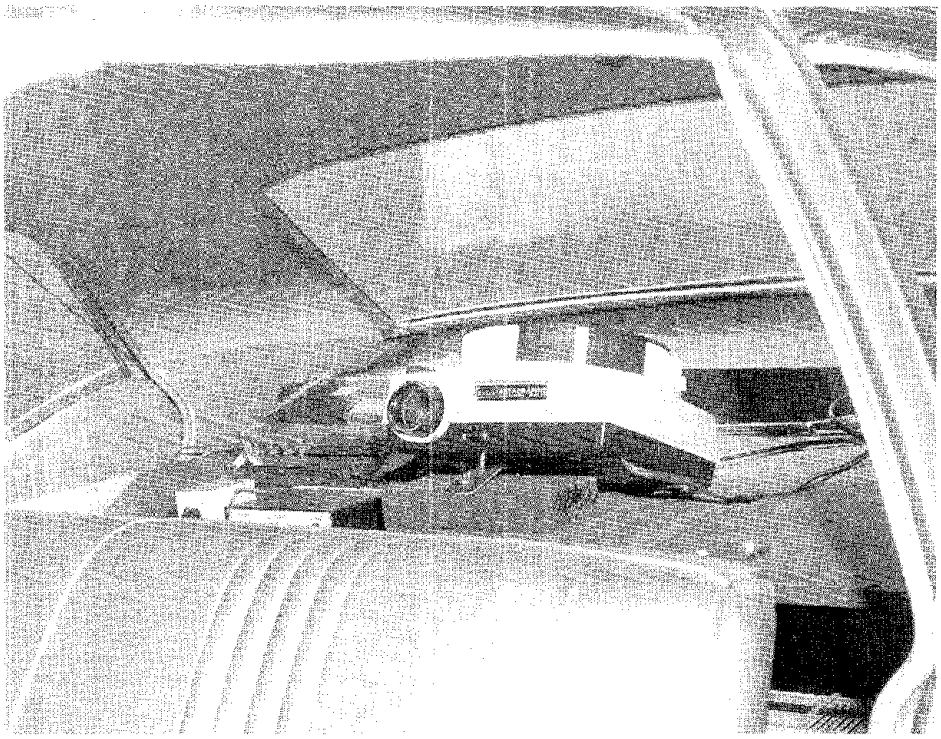

Figure 6. The test vehicle showing the position of the projector and recorder.

Other equipment, such as a DC to AC converter and radio broadcasting apparatus, was secured to the floor of the rear seat area below the shelf. A 4.5- by 11-inch screen was mounted at the top of the windshield immediately to the left of the rearview mirror. Slides containing pictures of street names, route numbers, exit and direction signs were projected on the screen. The messages from the recorder were broadcast over the vehicle's radio. The controls for the projector and recorder were designed to be operated by the experimenter who sat in the front, right-hand seat.

Experimental Design

The experiment used a 3 x 6 factorial design. The factors were six different length messages and three different methods of presenting the six messages. The length of the messages varied from messages that contained two cautionary statements to ones that contained seven. The cautionary information was presented visually to one group of subjects, in a short aural form to a second group, and in a long aural form to a third group.

Table 1. Experimental paradigm.

Methods of Presentation	Units of Information						
	2	3	4	5	6	7	
Visual							20 subjects
Auditory-short							20 subjects
Auditory-long							20 subjects
Total responses per column	60	60	60	60	60	60	

One-third of the subjects were tested for message retention after the visual presentation, one-third after the auditory-short presentation, and one-third after the auditory-long presentation. The order of presentation of the messages within each group was partially counterbalanced.

The subjects were assigned to one of the three groups in a random manner.

The psychological method of unaided recall was used to measure retention. In this method, the subject is simply asked to state the contents of the message. The subject must repeat as much of the message as is remembered without further aid.

Each auditory message was presented once and then repeated once.

Procedure

Six messages containing from two to seven units of cautionary material were constructed.

Each of the six cautionary messages was presented to the visual group by a series of signs. The following series, used as an example, is the four-unit visual message that was used in the experiment.

CONSTRUCTION AHEAD
STAY IN LANE

REDUCED
SPEED
35
M.P.H.

USE SHOULDER
800 FEET

Each unit of information comprised a discrete, individually distinct, cautionary instruction or idea. The above example contains two units of information in the first sign and one unit in each of the next two. A complete list of the signs are in Appendix 1.

Each slide was presented for 10 seconds with a 10-second interval between signs.

The short-auditory messages were made by simply recording the exact words of the visual series so that the drivers of the short-auditory experimental group heard the exact data that the visual group's drivers saw on the signs.

In the long-auditory messages, the cautionary units employed in the visual and short-auditory messages were put into prose language using complete sentences and stated in a longer, deliberately more involved format. The four-unit visual message illustrated above was remodeled into the following long-auditory message: "This is a warning that there is construction work in progress on the highway ahead. When you hear this warning, you are to remain in the lane in which you are now driving until further notice. You are to slow down and drive at a reduced speed of not faster than 35 miles per hour. Eight hundred feet ahead you must leave the highway pavement and drive on the road shoulder."

The retention of the long-auditory messages was scored in the same way as the short-auditory and visual ones were. From the messages above, the subjects had to indicate that there was construction on the road, that vehicles must stay in lane, that the speed limit was 35 miles per hour, and that they would have to drive on the shoulder in 800 feet.

The instructions were the same for the three experimental groups. All drivers were told that they did not have to repeat the message in the order in which it was given and that they did not have to use the exact words of the message. (The instructions are given in Appendix 2.)

The testing situation was the same for all the experimental groups. Five seconds after the end of the visual and the two auditory groups' messages, the subjects were asked, "What did the message say?" The subjects' scores consisted of the number of discrete warning units that were remembered correctly.

The subjects drove the experimental vehicle approximately 5 miles to the highway where the experiment was conducted. The subjects were instructed to drive in the right-hand lane as much as possible and to drive at about 45 miles per hour. At this time, the instructions were given to the subjects. Then the cautionary messages were presented to the three experimental groups as described above. During the entire experimental procedure the driver subject was actively engaged in all the functions necessary to drive a vehicle at 45 miles per hour on a public highway.

Results and Discussion

The data resulting from the three experimental groups are shown in graphical form in Figure 7. Table 1 indicates that as measured by a difference in proportions (Fliess, 1973), the results from the three groups do not differ significantly.

Table 2. Proportional difference between retention of the short, long, and visual groups.*

	Short	Long
Short		
Long	.05	
Visual	.019	.17

* 1.96 standard deviation is necessary for significance at the .05 level of confidence.

When the experiment was designed, a reasonable hypothesis was that the short warning messages would be retained better than the longer messages because of the shorter and more succinct format. While the two groups do not differ statistically, the long messages were consistently retained better than the short ones. The chance that the long messages would be remembered better at all levels, if there was no real difference, is $(1/2)^6$ which is significant between the .05 and the .01 level of confidence.

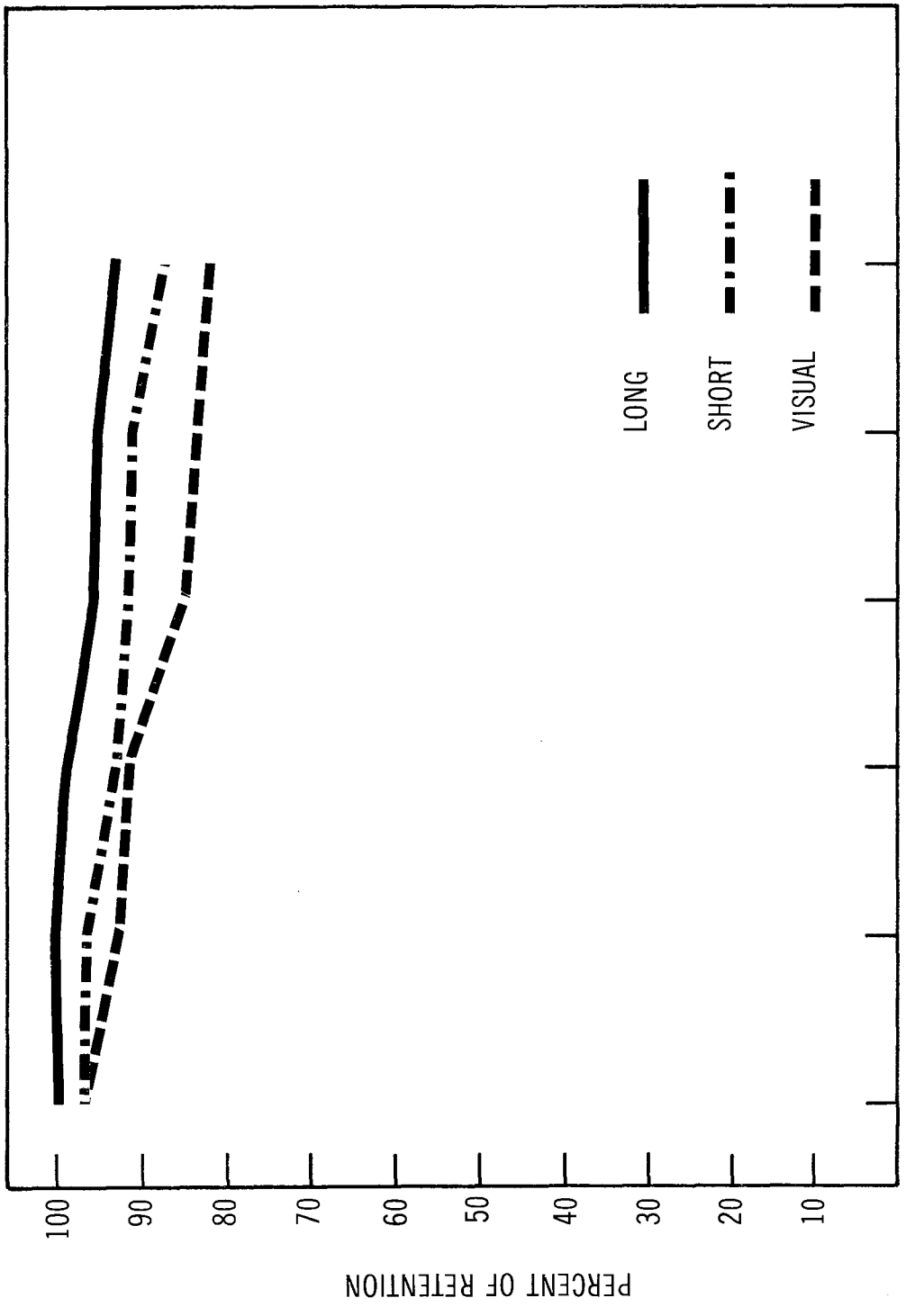

Figure 7. Percent of subjects retaining message items as a function of long, short, and visual modes.

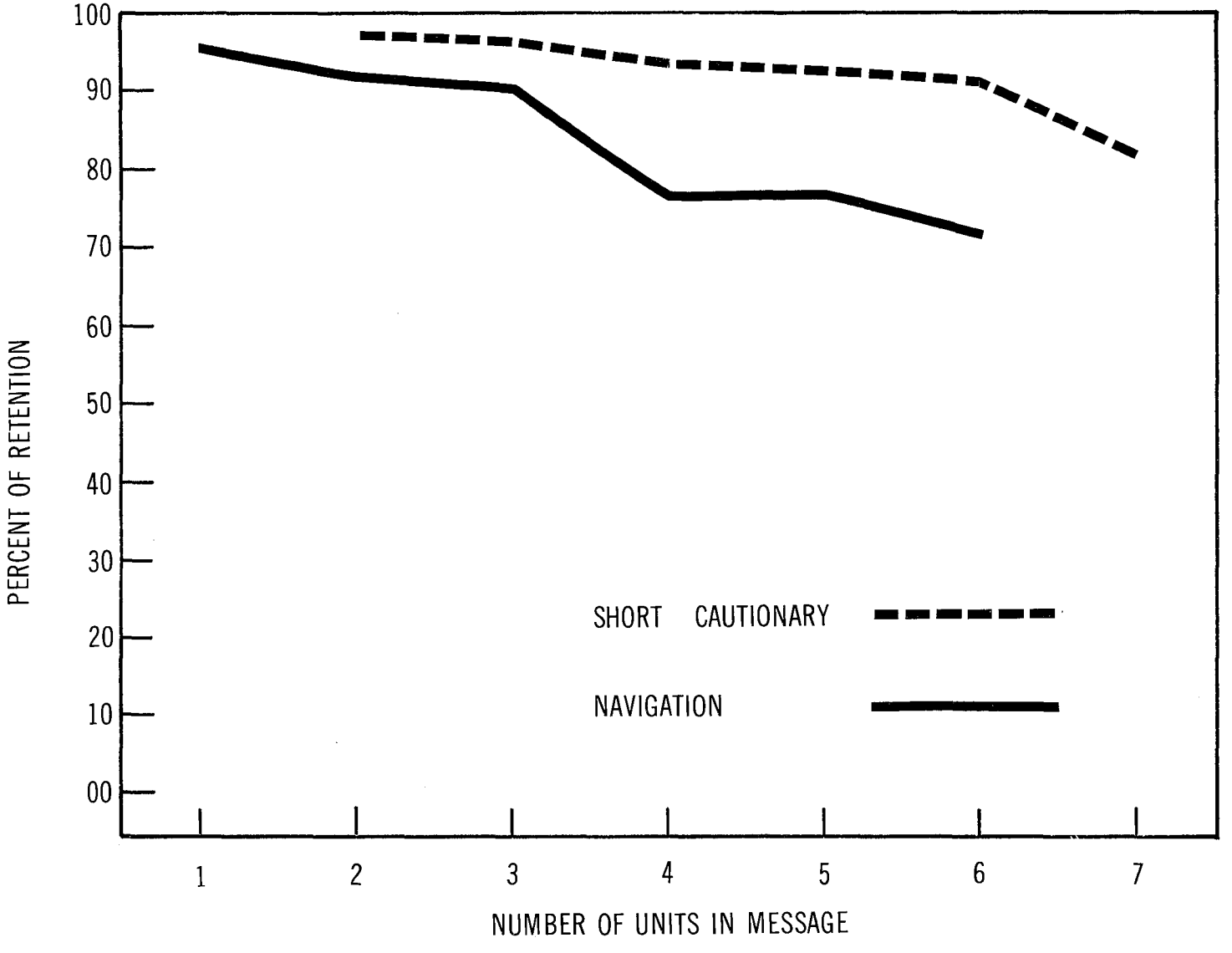

Figure 8. Percentage of subjects retaining message items as a function of short cautionary material and navigational material.

One part of the experiment was designed to compare drivers' retention of material presented by aural messages to material presented by means of visual signs. The data from Table 1 indicates that the aurally received information does not differ significantly statistically from the visual information. A previous experiment by Gatling (Gatling, 1976) using route diversion material also found no difference in retention between aural and visual presentation (Figure 3).

An experiment was done in 1974 (Gatling, 1975) that used exactly the same experimental design to measure retention of highway signing material as did the present experiment. The 1974 study used navigational route directions instead of the cautionary material in the present experiment. The auditory navigational messages were staccato messages as are the short auditory messages in this experiment. A reasonable hypothesis, in the recent study, was that the cautionary material in the signs would be more easily retained than the navigational material because it was more meaningful. The data from the two studies are shown in Figure 8. The 1974 messages contained from one to six information units while the 1977 study message contained from two to seven units. A method of proportions was used to test the difference between the two sets of data using messages two through six. The two data arrays are significant at the .12 level of confidence which indicates that the hypothesis has not been confirmed. Nevertheless, there is a strong tendency toward better retention of the cautionary information for all five message lengths compared.

Conclusions

1. Within the confines of this experiment, cautionary information units in a long-sentence format is retained as well as when information is in a staccato format.

2. Aural presentation of cautionary information is retained just as well as that presented visually.

3. There is a stong tendency for cautionary material to be retained better than navigational material.

THE EFFECT OF ROUTE NUMBERS ON NAVIGATION MESSAGE RETENTION

(EXPERIMENT 2)

Introduction

Previous work on retention of auditory messages has tended to show that numbers, as a class of information, are more difficult to retain than other classes of information. Gatling, using the data from two experiments on message length, states that "the individual classes of items, such as street names, signs, exit numbers, etc., appear in different serial positions and their frequency varies from message to message, so that a completely valid estimate of their difficulty as a class in navigational messages is not possible. However ... the route numbers were the hardest class of units to remember" (Gatling, 1975).

Considering the inevitability of route numbers being present in navigation messages, the effect of this variable on message retention needs to be investigated. This study is designed to test the hypothesis that an increase in the frequency of route numbers in a navigation message will be accompanied by an increase in the difficulty of remembering the message. It should be recognized that the frequency and composition of the numbers are dimensions with many variations. For example, the frequency of digits in a route number can vary from one to three. The experiment was designed deliberately to use three-digit route numbers in order to get the greatest effect from the numbers. The experimental design, it is assumed, could also vary the results by employing various combinations of route designations containing one, two, or three digits.

The study will also investigate the related hypothesis that numbers, as a class of information in navigation messages, are more difficult to remember than the information classes of street, avenue, and road names, and town names or turns.

The third hypothesis is that messages presented visually will give better retention than messages presented audibly.

Equipment

The major piece of equipment was a four-door passenger style 1968 Oldsmobile. A slide projector and a recorder were mounted in the rear seat of the vehicle. A 4.5- by 11-inch screen was mounted at the top of the windshield immediately to the left of the rearview mirror. The messages from the recorder were broadcast over the vehicle's radio. The controls for the projector and recorder were operated by the experimenter in the right front seat.

Subjects

The subjects were 50 men and women recruited by notices posted in universities, grocery stores, etc., and from lists of previously used subjects. The average age of the sample was 33.1 and the educational level was 15 years of school.

Experimental Design

A 2 x 7 factorial design was employed. The factors were six-unit navigation messages containing from zero to six route numbers, respectively (i.e., seven messages), and two different methods of presentation, aural and visual.

Half of the subjects were tested for retention of the six-unit information messages with the varying number of route numbers after hearing the messages, and one half was tested for retention after having the messages presented visually. The order of presentation of the seven messages was partly counterbalanced. The order in which the classes of information on the test slides were presented was varied throughout the messages except for the exit signs which did come first in every series as they would in a diversion message for an interstate highway. The serial order of the correct responses was varied to prevent the subjects from learning a presentation format. The subjects were assigned to the visual or aural groups in a random manner.

Table 3. Experimental design paradigm.

	Frequency of Route Nos. In Message							
	0	1	2	3	4	5	6	
Visual Presentation								25 subjects
Auditory Presentation								25 subjects

The measure of retention used was a route error. A route error occurs when a subject chooses a wrong direction. Only one route error is counted per message even though the subject misses more than one direction, since the missing of one direction is all that is required to divert a driver from the proper route.

Procedure

Seven navigation messages were recorded for auditory presentation and seven slides of highway signs containing the same information were prepared for visual presentation (see Appendix 3).

Each message, both auditory and visual, was constructed to contain six units of navigation information. The following sentence is an example.

1 2 3
EXIT AT GRAND ROAD. TAKE ROUTE 155 to LEEDSTOWN.

4 5 6
TURN LEFT ON SEATON STREET AND GO TO ROUTE 221.

The messages were constructed also so that the units of information consisted of from zero to six route numbers. For example, the above message contains two units of information that are route numbers. A complete list of the messages is in Appendix 3.

The classes of directional information that were used to make up the messages, in addition to route numbers, were exit numbers, street names, town names, turns, and stop signs.

For each auditory and visual message, a series of slides was used for testing the retention of the message. Each slide series consisted of one slide for each direction unit contained in the auditory message, plus nine other slides containing incorrect directions called nonmessage units. Using the above sentence as an illustration, the slide test series was:

Wheat St.

Marshall Rd.

Route 249

Grand Rd.

Route 326

Route 155

Leedstown

Turn Left

Oxford St.

Jefferson St.

Maine Avenue

Broad St.

Seaton St.

Ranton

Route 221

The correct units from the auditory and visual messages are underlined.

The slides of the test series were presented at 15-second intervals until the series was completed. The slide was exposed for 5 seconds and then removed. The screen was kept dark for the 10-second interval until the next slide appeared by using a slide holder containing heavy black paper.

The subject indicated during the 15-second interval whether the exposed slide was one of the streets, exits, etc., for which he was looking.

A 60-second rest was given to the subject between the end of each test series and the beginning of the subsequent auditory message.

The testing procedure described above was identical for both the auditory and visual groups, but the presentation of the message containing the information differed.

Visual Group - A slide containing the appropriate navigation instructions was exposed to each subject for 20 seconds. This is the maximum amount of time that overhead directional signs can be seen by an approaching car at 55 miles per hour. Fifteen seconds after the removal of the navigation message slide, the first slide of the test series was exposed, followed by the other slides of the series at 15-second intervals.

Auditory Group - The subjects were told that they would receive the information messages over the radio automatically. The radio was pretuned by the experimenter. Fifteen seconds after the navigation message was over the test series was presented as it was to the visual group. Each message was repeated once.

The subjects drove the experimental vehicle approximately 5 miles to the highway where the experiment was conducted. The subjects were instructed to drive in the right-hand lane as much as possible and to drive at about 40 miles per hour. At this time, the navigational message with its route instructions was presented to the drivers either visually or

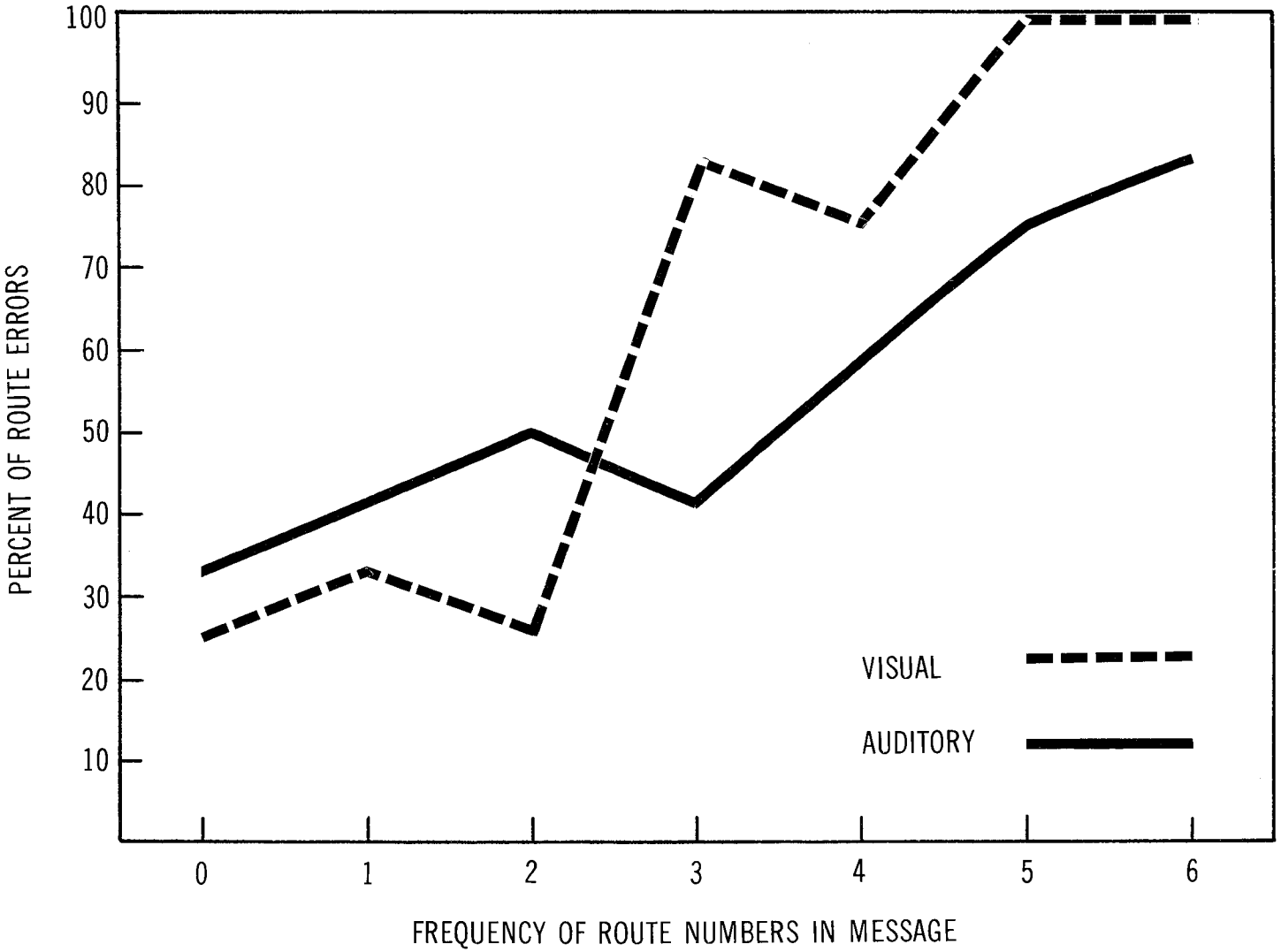

Figure 9. Percent of subjects making a route error as a function of the frequency of route numbers for the visual and auditory conditions.

aurally. Following the messages, a test slide series was presented to each driver. That is, during the entire experimental procedure the driver was actively engaged in all the functions necessary to drive a vehicle at 40 miles per hour on a public highway.

Results and Discussion

Navigational information messages were presented to one group of subjects aurally by means of the experimental vehicle's radio while a second group received the same messages visually on a screen as described in the section on procedure. The results of the message retention for the two methods of presentation (as measured by route errors) are reported in Figure 9. The visual presentation group did better on retention than did the auditory group for the messages with fewer route numbers, but performed more poorly on messages that contained four or more numbers. The difference between the two curves is not significant statistically ($z = .95$--which is a level of confidence of .35 for a two-tailed test). (Fliess, 1973.)

The first experimental evidence that aural and visual highway signing may be equally effective was reported in 1976, Figure 2, (Gatling, 1976). Since the original experiment, two additional studies have attacked the problem--the preceding study in this publication (Figure 7) and the present study (Figure 9). In reviewing the results of all three of these studies, it appears that, for the experimental conditions under which these studies were performed, there is no significant difference between the effectiveness of highway information presented visually or by highway advisory radio.

Since the two curves in Figure 9 do not differ significantly statistically, they were combined into a single curve which is shown in Figure 10. Figure 10 clearly indicates that the hypothesis that an increase in the frequency of route numbers in a message will be accompanied by a corresponding increase in route errors is true, for there was a steady increase in the route errors made by the subjects as the frequency of route numbers in the messages increased from zero to six. The correlation coefficient (Rho) between the frequency of route numbers in a message and the number of route errors committed by the subjects is .99.

The navigation messages contain five classes of information: (1) names of streets, avenues, and roads; (2) names of cities and towns; (3) turns; (4) stop signs; and (5) three-digit route numbers. The strong relationship between the frequency of route numbers in a message and route errors is apparent in Figures 9 and 10 as indicated above, but the class of information upon which the errors are being committed cannot be discerned, even though route numbers are suspect.

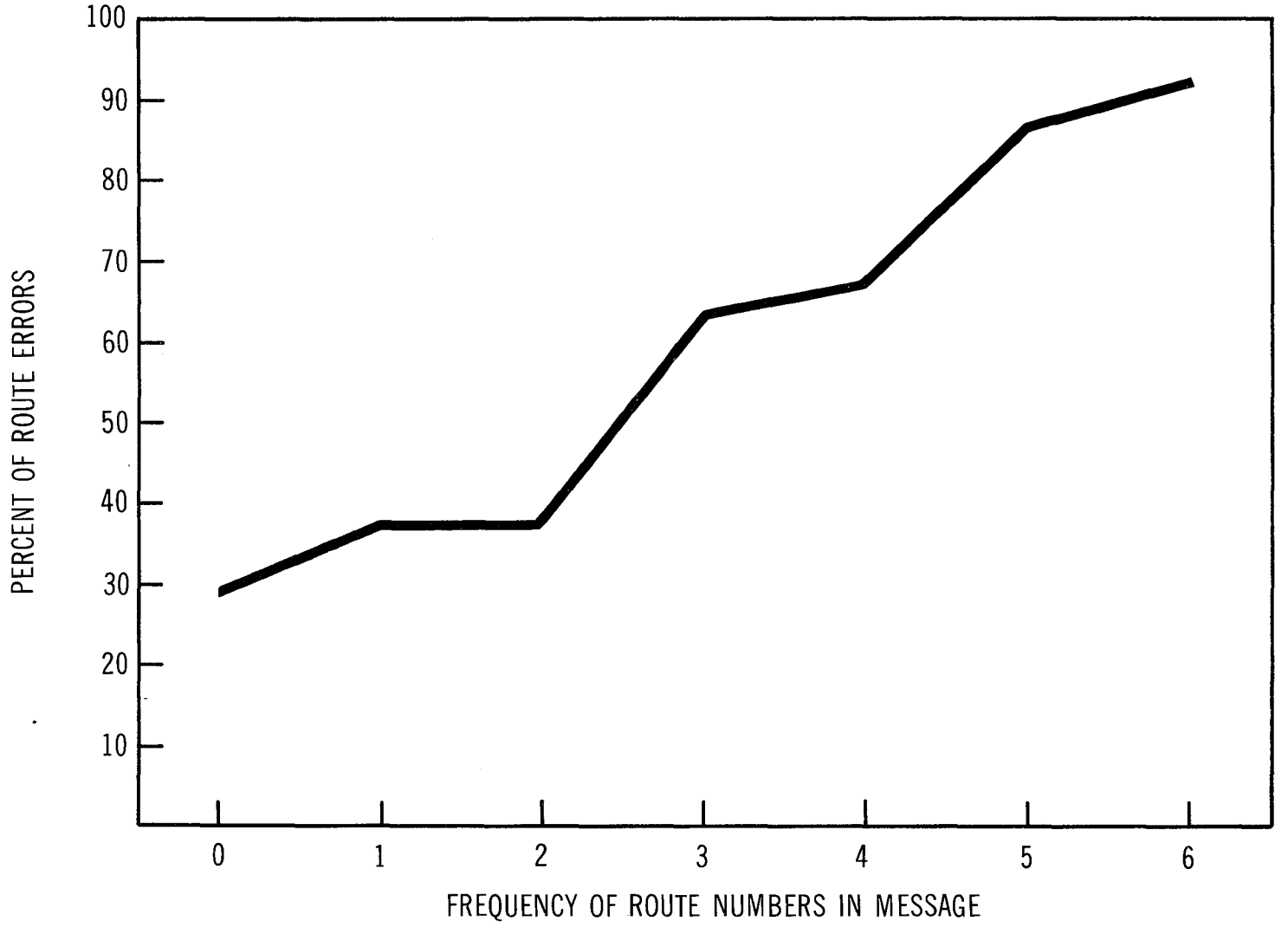

Figure 10. Percent of subjects making a route error as a function of the frequency of route numbers for the visual and auditory conditions - combined curve.

A total of 280 errors were made in the experiment of which 179 were made on route numbers and 101 on the other four classes combined. The difference between the classes was tested by X^2. The X^2 test indicated that the errors on the route numbers differed significantly from the other classes of information errors (X^2 = 70.63 and is beyond the .01 level of significance). This confirms the hypothesis that route numbers, as a class of directions in navigational messages, are more difficult to remember than the classes of information of streets, towns, etc.

The incorrect streets, towns, etc., (nonmessage units) that are interspersed with the correct message directions in navigation messages seldom have been confused with the correct responses in previous experiments. Using data collected on 109 subjects involving 3,132 responses from earlier studies, less than 1 percent (.009) of the nonmessage responses have been selected as part of the route by the experimental drivers. However, the results of the present experiment are quite different from the results of the previous studies, for the subjects in the present experiment chose the incorrect nonmessage responses 5.6 percent of the time. This difference in proportions between the present and earlier experiments is highly significant statistically. (The level of confidence is beyond 10 standard deviations.)

The difficulty that route numbers contribute to the retention of the information items in navigation messages appears to generalize to nonmessage items, causing a significant increase in the number of route errors involving nonmessage items.

It is interesting to note that, of the nonmessage number units chosen incorrectly, the visual group committed 76.7 percent of the errors compared to 23.3 percent of the auditory group.

Conclusions

The results of this experiment indicate that:

1. Navigational information messages are retained equally well when presented either visually of aurally to drivers.

2. There is a strong linear relationship between the frequency with which route numbers occur in navigational information messages and the number of route errors committed by drivers. An increase in the frequency of route numbers in a message results in an increase of route errors.

3. The difficulty that route numbers contribute to the retention of the information items in navigation messages

appears to generalize to nonmessage items, causing a significant increase in the number of route errors involving nonmessage items.

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APPENDIX 1

UNIT INFORMATION SENTENCES - LONG FORMAT AUDITORY

Two Units

Construction men are working on road repairs ahead of you. You are to reduce your speed from the present limit and not drive faster than 30 miles per hour until notified.

Three Units

This highway is now entering a 15-mile long area that often has heavy fogs that completely cover the roadway. You are instructed to stay in the lane in which you are now driving until you leave the area.

Four Units

This is a warning that there is construction work in progress on the highway ahead. When you hear this warning, you are to remain in the lane in which you are now driving until further notice. You are to slow down and drive at a reduced speed of not faster than 35 miles per hour. Eight hundred feet ahead, you must leave the highway and drive on the road shoulder.

Five Units

This message is to advise you that the left lane of this highway is closed to all traffic in 5 miles. Cars traveling in the left lane are to carefully merge with the vehicles in the right lane. After you have finished merging, you are to remain in a single lane. All vehicles are forbidden to attempt to pass other vehicles in this area.

Six Units

This is an advisory message to tell you that both lanes of this highway are closed to all traffic 2 miles ahead. The speed limit has been reduced to 25 miles per hour. The traffic in the left lane must drive on the highway median at the obstruction; the traffic in the right lane must drive on the road shoulder at the obstruction. Starting now, do not pass any other vehicles.

Seven Units

This is a message from the State Highway Department to tell you that this highway is closed 2 miles ahead. The only traffic permitted past that point is local traffic. All highway through traffic must take the next right exit. From this point, you are to reduce your speed and not drive faster than 40 miles per hour. You should be prepared for sudden stops.

UNIT INFORMATION SENTENCES - SHORT FORMAT
AUDITORY

Two Units

Men working - Reduced speed 30 miles per hour.

Three Units

Heavy fog area - next 15 miles - stay in lane.

Four Units

Construction ahead - stay in lane - reduced speed 35 miles per hour - use shoulder 800 feet.

Five Units

Left lane closed - 5 miles ahead - merge right - form single lane - do not pass.

Six Units

Both lanes closed - 2 miles ahead - reduced speed 25 miles per hour - left lane use median - right lane use shoulder - do not pass.

Seven Units

Road closed - 3 miles ahead - local traffic only - speed limit 40 miles per hour - through traffic next right exit - prepare for sudden stops.

UNIT INFORMATION SENTENCES - VISUAL FORMAT
VISUAL

Two Units

MEN WORKING

REDUCED SPEED
30
M.P.H.

Three Units

HEAVY FOG AREA
NEXT 15 MILES

STAY IN LANE

Four Units

CONSTRUCTION AHEAD
STAY IN LANE

REDUCED SPEED
35
M.P.H.

USE SHOULDER - 800 FEET

Five Units

LEFT LANE CLOSED
5 MILES AHEAD

MERGE RIGHT
FORM SINGLE LANE

DO NOT
PASS

Six Units

BOTH LANES CLOSED
2 MILES AHEAD

REDUCED SPEED
25
M.P.H.

LEFT LANE USE MEDIAN
RIGHT LANE USE SHOULDER

DO NOT
PASS

Seven Units

ROAD CLOSED
3 MILES AHEAD

LOCAL TRAFFIC ONLY

SPEED LIMIT
40
M.P.H.

THROUGH TRAFFIC
NEXT RIGHT EXIT

PREPARE FOR SUDDEN STOPS

All the signs conformed to regulation highway signs.

APPENDIX 2

DIRECTIONS TO THE SUBJECTS

AUDITORY WARNING

This experiment is concerned with how well a message about special road conditions--such as construction work--is able to get its message to drivers. You will hear a series of messages over the radio that are connected with some special highway condition. After each message, your job is to tell me what the content of the message was. For example, here is a message. This road is closed to through traffic. Keep right and pass with care. When I ask you to recall the message, you tell me what the message said. You should tell me that the road is closed to through traffic, keep right, and pass with care. You do not have to give me the message in the same order that you heard it. Just give me all the important information that you remember. Your answer would be correct if you said, "pass with care, keep right, and the road is closed ahead to through traffic," which is just the opposite from the order in which you heard it. You do not have to use the exact words, either, but you must indicate that you have remembered all the important information.

Some of the messages will be short, but others will be longer. Each message will be given once and then repeated. Now, any questions?

VISUAL WARNING

This experiment is concerned with how well a series of highway signs about special road conditions--such as construction work--is able to get its message to drivers. I am going to show you some sign series--here on the screen--that are connected with some special highway condition. After each series has been presented, I am going to ask you to tell me what the signs said. For example, here are three signs. Here is the first one, here is number 2, and here is number 3. When I ask you to recall the message given by the signs, you should tell me that the road is closed to through traffic, keep right, and pass with care. You do not have to give me the message in the same order that you saw it. Just give me all the important information that you remember for the signs that you just saw. Just give me all the information that you remember. Your answer would be correct if you said "pass with care, keep right, and the road is closed to through traffic," which is just the opposite from the order in which you saw it. You do not have to use the exact words, either, but you must indicate that you have remembered all the important information. Some of the messages will be short, but others will be longer. Each sign will be exposed for 10 seconds, which is about the amount of time that you would be able to see it on a highway traveling at about 55 to 60 miles per hour.

Now, any questions?

APPENDIX 3

ZERO

Exit at Chaplin Street and go to STOP sign. Turn left and go to Spring Road. Take Mark Avenue to Barlow.

Ridge Ave.

Chaplin St.

Pierce St.

Arch St.

Fulton

STOP Sign

Turn Left

Spring Rd.

Thomas St.

Neal St.

Fairmount Ave.

Melrose

Mark Ave.

Glenville

Barlow

ONE

Exit at Gail Street. Go to Turner and pick up Fenton Street. Turn right on Route 229 and proceed to Woodsboro.

Gail St.

Fairfield

Turner

Brighton Rd.

Moore St.

Bridge St.

345

Fenton

Turn Right

Stuart Ave.

Adams St.

229

Calmont

Donaldson St.

Woodsboro

TWO

Exit at Grand Road. Take Route 155 to Leedstown. Turn left on Seaton Street and go to Route 221.

Wheat St.

Marshall Rd.

249

Grand Rd.

326

155

Leedstown

Turn Left

Oxford Ave.

Jefferson St.

Maine St.

Broad St.

Seaton St.

Ranton

221

THREE

Exit at Route 142 and go to Tarleton. Take Route 375 to Calmont. Turn right on Route 263.

197

142

Randolph St.

139

Marston

Tarleton

Macklin Rd.

334

Green St.

375

Calmont

Masters St.

Wakefield St.

263

Turn Right

FOUR

Exit at Route 392. Go to Route 383 and proceed to Route 167. Turn right and follow Belmont Street to Route 234.

392

Newberg

Ashburn

359

Columbia Ave.

186

383

167

Turn Right

Fulton

Belmont St.

Peter St.

178

362

234

FIVE

Exit at Route 117. Go to Route 372. Go to Melrose and follow Route 284 to Route 159. Then go to Route 181.

237

196

117

Winfield

Bates St.

372

Marston

389

Melrose

226

123

Oxford Ave.

284

159

181

SIX

Exit at Route 337. Follow Route 259 to Route 124. Then take Route 241 to Route 368. Proceed to Route 172.

354

143

348

337

279

259

124

Reardon/Greenspan

Bridge

241

127

368

312

Masters

172

The auditory messages from zero numbers through six numbers were put on slides for visual presentation. The message was white on a black background.

APPENDIX 4

DIRECTIONS

Aural

This experiment is concerned with how well route directions given over the radio can be remembered and followed. A series of messages that give road directions will be automatically presented to you over the radio.

In real life, of course, you would hear only one message and it would have an introduction of some kind. The introduction, for example, might tell you that the highway is closed ahead due to a rock slide or a very bad accident and that directions will follow that will tell you how to get around the obstruction. In the experimental messages that you will hear, the introduction has been omitted and just the directions to get you around the obstruction will be given.

After the route directions have been given, signs of street names, towns, exits, and so forth, will appear on the screen. Your job is to follow the directions correctly and pick out the correct exits, streets, etc. For example, here is a message. "Take Exit 20 West and go 5 miles to Shanklin." Fifteen seconds after the message, a sign will appear, like this - EXIT 30 East. I'll ask you what you are supposed to do at EXIT 30 East. Your answer should be "nothing" or "this is not the correct exit" or "continue on the highway." That is, your answer should indicate that EXIT 30 East is not the exit you are looking for. Here is the next sign, "EXIT 20 West." You must now indicate that this is the exit you are to take to leave the highway. I'll ask you how far you are to go and your answer should be "5 miles." Another sign will appear - "Horton-Dana" - you are not looking for either of them. The next sign is "Shanklin" and you are to indicate that this is the town you are looking for - and so on.

Each message will be presented twice. That is, it will be given once and then repeated.

Any questions?

OK, we'll start. First you will hear the message and then the signs will begin to appear at 15-second intervals. I'll leave the sign on the screen for 5 seconds before I remove it. The next sign will then appear 10 seconds after the previous sign is removed.

Visual

This experiment is concerned with how well route directions given by a highway sign can be remembered and followed. A sign containing directions will appear here on the screen for 20 seconds. After the route direction sign has been removed, signs of street names, towns, exits, and so forth, will appear on the screen. Your job is to follow the directions correctly and pick out the correct exits, streets, etc. For example, here is a sign with the message "Take Exit 20 West and go 5 miles to Shanklin." Fifteen seconds after the message has been removed, a sign will appear, like this - EXIT 30 East. I'll ask you what you are supposed to do at EXIT 30 East. Your answer should be "nothing" or "this is not the correct exit" or "continue on the highway." That is, your answer should indicate that EXIT 30 East is not the exit you are looking for. Here is the next sign, "EXIT 20 West." You must now indicate that this is the exit you are to take to leave the highway. I'll ask you how far you are to go and your answer should be "5 miles." Another signs will appear - "Horton-Dana" - you are not looking for either of them. The next sign is "Shanklin" and you are to indicate that this is the town you are looking for - and so on.

Any questions?

OK, we'll start. First you will see the sign with the directions on it and then the other signs will begin. I'll leave these signs on the screen for 5 seconds before I remove them. The next sign will then appear 10 seconds after the previous sign is removed.

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