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A Study on the Simultaneous Transmission of Incongruent Information

Dennis Keith Smeltzer
Eastern Illinois University

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A STUDY ON THE SIMULTANEOUS TRANSMISSION OF INCONGRUENT INFORMATION

(TITLE)

BY

DENNIS KEITH SMELTZER

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THESIS

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CHAPTER I

Introduction

For many years, the use of a multi-channel communication system has been prevalent in the field of instructional technology and in the production of audio-visual materials. The use of this communication system is based upon the premise that an increase in the number of channels will naturally increase the amount of information a person can receive (20).

The basis for contemporary research in this area has been the work done by D.E. Broadbent. He feels that this held notion of multi-channel communication is not supported by scientific fact:

> ...there are certain areas of behavior in which one can show experimentally phenomena which seem reasonable if limits of capacity are a problem for the nervous system. One device which might be expected, for example, is the use of the same components to serve different functions at different times. This would mean that the system would be capable of carrying a variety of tasks, but not of doing them simultaneously. (3: 458).

Based upon this premise, Broadbent developed a perceptual system that allowed the reception of incoming information from various senses. When this information reached the nervous system simultaneously, there was a mechanism that selected one message and rejected all others (3). Broadbent, in an earlier work, proposed a model that would explain his theory (4; Fig. 1). In this model, the balls of information would drop into a Y-shaped tube. As this information reached the junction of the branches, they would come into contact with a smaller passageway. This

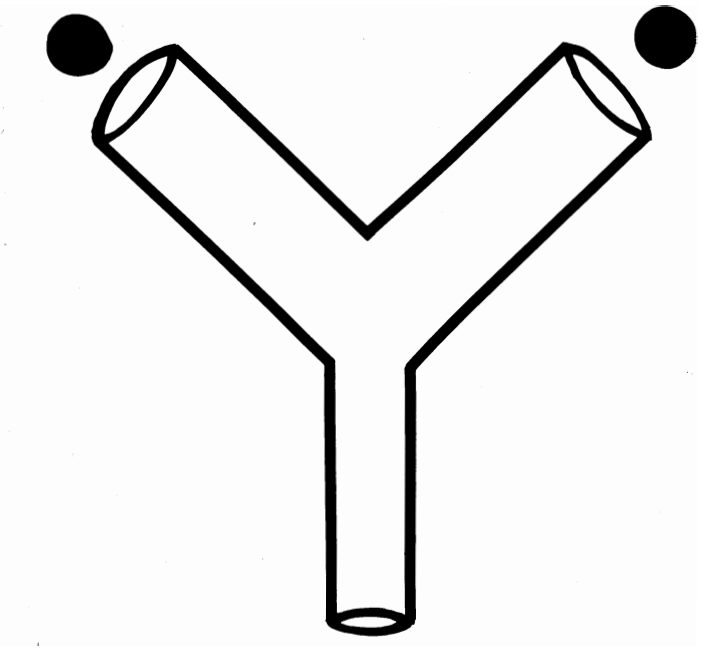


Fig. 1 - Broadbent's Model of Information Processing

meant that when two informational units reached that point, only one could be processed. This, according to Broadbent, results in neurological jamming. This model, therefore, explains the results of many earlier experiments in multi-channel communication (4).

All subsequent research in this area, therefore, has been based upon this model of multi-sensory perception. The conclusion has been made by many that Broadbent's model implies that informa-

tion that enters one sensory channel can be processed by the nervous system, but it is impossible to process multi-sensory information (19, 21). Although research does tend to support this claim, Broadbent noted, in the conceptualization of his model, that it is theoretically possible to process two stimuli simultaneously (4). He further stated that to do this would be dependent upon a variety of factors of which the complexity of the information and the redundancy or the incongruity of the information would be major factors (4).

The failure of subjects to process information simultaneously has occured with both redundant and incongruous information. The inability to obtain significant results, however, may not be the fault of the theory developed by Broadbent. Severin feels that the reason for the results obtained is due to a fault in the experimental design. He has explained that one design fault that is prevalent in this area of research is that material may be presented by two different channels, but the test usually involves only one channel (17).

The use of specific channels in a testing situation is based upon the principle of stimulus generalization. This principle suggests that responses that are evoked by certain stimuli in the presentation channel will be observable again if the same stimuli are used in the testing channel (6). The inference can be made that simultaneous transmission of incongruent information can be enhanced by making the testing channel similar to the presentation channel.

Need for the Study

The ineffectiveness of simultaneously transmitting incongruent multi-channel information had been substantiated by much research. Theoretically, however, such a communication system could operate effectively. Two basic conditions had to be met to allow this system to function. First, the informational quantity used in both channels had to be small. Second, the testing channel had to be similar to the presentation channel. Until this time, no research had been found that tested this communication system incorporating those two factors.

Purpose of the Study

The purpose of the study was to investigate a subject's amount of immediate recall when incongruent auditory and print messages or incongruent auditory and pictorial messages were simultaneously transmitted over a multi-channel communication system.

Analysis of the Problem

In order to answer questions concerning a subject's amount of immediate recall of different messages, the following null hypotheses were formulated so proper tests of significance could be applied to determine whether significant differences existed between the means.

The following hypotheses were tested by means of a two-tailed t-test at the 0.05 level of significance.

1. There was no significant difference in the mean scores, as determined by an immediate recall test, of an auditory message

that was transmitted simultaneously with an incongruent print message and of an identical auditory message that was transmitted alone.

2. There was no significant difference in the mean scores, as determined by an immediate recall test, of a print message that was transmitted simultaneously with an incongruent auditory message and of an identical print message that was transmitted alone.

3. There was no significant difference in the mean scores, as determined by an immediate recall test, of an auditory message that was transmitted simultaneously with an incongruent pictorial message and of an identical auditory message that was transmitted alone.

4. There was no significant difference in the mean scores, as determined by an immediate recall test, of a pictorial message that was transmitted simultaneously with an incongruent auditory message and of an identical pictorial message that was transmitted alone.

Delimitations

1. The subjects involved in this study were students currently enrolled in General Psychology 2310, Sections 001, 002, and 004 during the Spring Semester, 1974, at Eastern Illinois University.

2. Messages of the same level of difficulty, as determined by the number of syllables in the stimuli words and the number of images in the pictures, were used in this study.

3. Only the effects on immediate recall by the variables in this study were investigated.

Limitations

1. Only the variables mentioned above were the concern of this study, therefore, the external variables of practice, length of message, difficulty of message, and channel compatibility may have had an effect on the results.

2. The tests used in the study were not validated and, therefore, may have had an effect on the results.

Method

1. Separate auditory, print, and pictorial messages were prepared.

2. Apparatus to test the individual auditory, print, and pictorial messages were prepared.

3. A pilot study of the control and the experimental sessions was conducted with a group of graduate students in the Department of Instructional Media. Revisions were made where necessary.

4. An audio-print experimental session and a pictorial control session were conducted with Section 001 of General Psychology 2310.

5. An audio-pictorial experimental session and a print control session were conducted with Section 002 of General Psychology 2310.

6. An auditory control session was conducted with Section 004 of General Psychology 2310.

7. All data from the control and the experimental sessions were collected and tabulated.

8. A t-test of the mean difference between the mean of the auditory message in the audio-print experimental session and the mean of the auditory control session was used. A table of the results was prepared.

9. A t-test of the mean difference between the mean of the print message in the audio-print experimental session and the mean of the print control session was used. A table of the results was prepared.

10. A t-test of the mean difference between the mean of the auditory message in the audio-pictorial experimental session and the mean of the auditory control session was used. A table of the results was prepared.

11. A t-test of the mean difference between the mean of the pictorial message in the audio-pictorial experimental session and the pictorial control session was used. A table of the results was prepared.

12. A conclusion and recommendations based upon the results were made.

CHAPTER II

Review of Related Literature

The related literature for this study was categorized under the following topics: (1) simultaneous presentation of redundant information and (2) simultaneous presentation of incongruent information. Some of the studies dealt with both of the above areas.

Simultaneous Presentation of Redundant Information

Hartman (11) reviewed studies concerning all aspects of single and multiple channel communication. In this study, Hartman was concerned with three distinct channels: the pictorial, the auditory verbal, and the print channels. Based upon research Hartman reviewed, the print channel was found to be superior to the auditory channel when information was complex and the subjects were reasonably literate. Hartman also concluded that little could be said about the relative effectiveness of the pictorial channel since little research had been done in that area.

One of the original studies in multi-channel presentations was conducted by O'Brien (16). In this qualitative investigation, O'Brien's subjects were exposed to varying lists of meaningful words and of nonsense syllables in both the auditory and the visual channels. Based upon statistical averages of the correct responses, O'Brien concluded that in an audio-visual presentation the learner seldom responds equally to both channels. Instead, there is a tendency to select one channel to receive the majority of the information.

The effects of identical radio and television broadcasts on retention were a subject of a case study by Goldberg (9). Based upon percentages of correct responses, Goldberg concluded that television viewers retained more facts than radio listeners.

Similar in format, Barrow and Westley (1) compared the teaching effectiveness of radio and television. Using equivalent radio and television versions of a series of background-of-the-news programs, 228 grade school children were tested with a variety of variables. In the analysis of variance (ANOVA), the television group made significantly higher scores than the radio group on the immediate recall of information.

Henneman (12) studied the ability of subjects to comprehend audio and print messages while being distracted. In the control session, there was selection for the visual channel. When distraction occured, however, there was a tendency to select the auditory channel for information.

Klemmer (13) set up a design in which the subjects responded to the simultaneous presentation of different colors and tones by pressing appropriate keys on a panel. After two to five weeks of training, five subjects participated in the experiment. Klemmer, based upon percentages of correct responses, concluded that there was improvement in performance due to the combined audio-visual presentation. When compared to the single-channel visual presentation, the audio-visual presentation was significantly different at the 0.05 level.

Dwyer (7) conducted a study to measure the effectiveness of three types of visual illustrations used to compliment oral instruction. His auditory message was a lecture on the human heart and its functions. This message was accompanied by one of three visual presentations: (1) an abstract line drawing, (2) a detailed shaded drawing, and (3) a realistic photograph. Testing was completed in four parts: (1) a drawing test, (2) an identification test using a three-dimensional model, (3) a terminology test, and (4) a comprehension test. Based upon an ANOVA, Dwyer reported the abstract drawing was the most effective compliment to oral instruction with the detailed shaded drawing being the next most effective. The realistic photograph proved to be the least effective visual illustration and was no more effective than strictly oral instructions.

In a similar study, Dwyer (8) used 269 speech students to measure the relative effectiveness of visual illustrations with different amounts of realistic detail. Using the same methodology as above, Dwyer concluded that visuals were not necessary to compliment oral instruction when tests measured terminology, identification, and comprehension. Dwyer concluded, however, that visuals were necessary for drawing tests.

A series of experiments which investigated the effectiveness of presenting information over single and multiple channel communication systems were conducted by Hartman (10). The stimuli were all of the possible combinations of the auditory, print, and

pictorial channels. Testing was conducted by using the same combinations of the channels. Based upon an ANOVA, Hartman concluded that redundant information simultaneously presented by the auditory and print channels is more effective than either of the single channels.

Following a similar design, but obtaining different results, Van Mondfrans and Travers (21) compared the effectiveness of teaching nonsense syllables using audio-visual presentations, a visual presentation, and an auditory presentation. In varying the length of the stimulus, they found the audio-visual presentation not significantly different from either the auditory or the visual mode of transmission.

In the design of his experiment, Severin (18) studied the effects of a multi-channel system when his subjects were exposed to (1) an auditory message only, (2) a print message only, (3) an audio-print message, (4) an auditory message with related pictures, (5) an auditory message with unrelated pictures of the same category, and (6) an auditory message with unrelated pictures of a different category. Results showed that the test group with the auditory message with related picture scored the highest. The other groups were ranked from high to low: audio with print, print only, audio only, audio with highly unrelated picture, and audio with an unrelated picture. As with the study above, Severin concluded that multi-channel communication was equal to single channel communication when the messages were redundant.

Simultaneous Presentation of Incongruent Information

Mowbray (15) conducted one of the first studies that used incongruent information in the communication channels. Using ten subjects, a series of numbers and letters were presented. The subjects were to identify the missing elements. Mowbray found that there was an increase in the number of errors of omission in the simultaneous presentation. Greater errors were made when an easy task was paired with a difficult task. More errors were made in the easy task. There was also a greater number of errors of comission for the visual channel than the auditory channel when presented together.

In his second study, Mowbray (14) investigated the comprehension of prose passages with varying levels of difficulty. Using relevant, incongruent material, simultaneous presentations of the auditory and the print materials were given. As in the study above, Mowbray found greater errors in the easier material. Unlike his previous study, greater mistakes were made in the auditory channel.

Summary of Related Literature

The review of related literature appears to reveal a few trends in the area of multi-channel communication:

1. If the information is redundant, a multi-channel system is as good as a single-channel system.

2. If the information is redundant, there is a tendency for the visual channel to be selected instead of the auditory channel.

3. If the information is incongruent, a multi-channel system is inferior to a single-channel system.

4. There is conflicting evidence concerning channel selection in a case where incongruent information is being transmitted.

5. Very little information is present on the effects of using the pictorial channel as one of the incongruent channels.

6. There appears to be no evidence of the effect of using the same channel in the stimulus and the testing situations when the information is incongruent and is presented simultaneously.

CHAPTER III

Experimental Design, Procedure, and Results

This study involved three stages of methodology: (1) the development and refinement of presentation and testing stimuli, (2) the presentation and the testing of the stimuli, and (3) the tabulation and the statistical analysis of the results.

Production of the Materials

Because this experiment dealt with projected images, the method of presentation selected was the use of 35mm slides. The production of the visuals involved two steps: (1) the preparation of the materials to be photographed and (2) the photography and the development of the slides used.

Two different types of visuals were used in this study. The first, print visuals, were groups of three one syllable words. The words were selected from the Basic Sight Word List and are shown in Appendix A (2). The second visual, the pictorial, was a 4 x 4 inch square subdivided into four smaller squares. In one of the four squares, there was a ½ inch diameter circle (Appendix B).

Both visuals were photographed and positive images were made. The film was cut and mounted into 35mm cardboard slide mounts. In total, twenty print visuals and twenty pictorial visuals were produced.

The materials used in the auditory message were groups of three one syllable words. The words were selected from the Basic Sight Word List and are shown in Appendix C.

The visual material was synchronized with the auditory material by placing an electronic signal on the tape.

Development of the Testing Instrument

The experimental design used for this study required each subject to participate in one control session and approximately two-thirds of the subjects to be tested in the experimental sessions. A post-test only with a control group was the type of design used in this experiment. This required the preparation of three separate tests.

The auditory test required the subject to write down the three words that he heard (Appendix D). The print test allowed the subject to choose the three words that he saw on the screen from a group of five words (Appendix E). The pictorial test was a multiple choice test (Appendix F). In this test, the subject was allowed to select from four images, the one that was seen on the screen.

Preparation for the Experiment

On March 8, 1974, a pilot study and critiques by the graduate students in the Department of Instructional Media were implemented to improve the experiment.

Changes made as a result of the above meeting were:

1. The audio tape was re-recorded by a senior in the Department of Speech Pathology and Audiology to insure proper diction and pronunciation of the stimulus words.

2. The auditory test was redesigned to use a written form of the test instead of the multiple discrimination test.

3. Since the new auditory test required a manual effort by the subject, the time allotted for answering was increased from ten to fifteen seconds.

4. The blank slides used in the pilot study were found to be unsatisfactory and were replaced with mounted blanks.

5. The instructions given to the subjects were changed and made more specific.

Apparatus and Testing Conditions

All testing sessions took place in room 222 in the Physical Science Building at Eastern Illinois University. This classroom is a large lecture hall equipped with light and sound projection systems. The room was considered to be adequate for the projection of slides and the playing of audio tapes. All conditions of slide projection and sound projection were held constant throughout the experiment. Although the classroom was sufficiently dark for slide projection, enough light was available to answer the questions on the answer sheet.

Procedure

Prior to the subjects viewing the slides and hearing the tape, the projector, the screen, and the tape player were placed into position and all wires were connected. The blinds were closed. The focus was adjusted on the projector and the volume level was set on the tape player.

The investigator was introduced by the instructor and the subjects were told that the investigator was a graduate student in the Department of Instructional Media. The classes were told that they would be involved in an experiment.

The investigator passed out the answer sheets. The subjects were instructed to check the blank to indicate whether they were

male or female. The subjects were then given specific instructions on what they were to do in the session (Appendix G).

The room was darkened and the experimental session or the control session was conducted. In the experimental session, the subjects heard three words and simultaneously saw three different words or a pictorial visual. After the stimulus, the subjects were given fifteen seconds to respond. After fifteen seconds, the next stimulus was given. This procedure continued until a total of twenty groups of stimuli were given. The control session was identical except that only one channel was presented and tested. The total time for each session was approximately five minutes. After the session, the answer sheets were collected.

Results

The criterion variable used in this study was the number of correct responses on a test of immediate recall of various words and pictures that were transmitted simultaneously over two channels.

The 0.05 level of significance was chosen as the acceptance level and the proposed null hypotheses were accepted as tenable or rejected depending on the value of the t-ratios of the observed mean differences. Tables of significance were used (5: 218-219).

Analysis of the Null Hypotheses

Hypothesis Number One

There was significant difference in the mean scores, as determined by an immediate recall test, of the auditory message that was transmitted simultaneously with an incongruent print message and of the control auditory message that was transmitted alone. Table I gives the t-test results for this hypothesis.

TABLE I

Computation of T-Ratio: Hypothesis I

$\bar{X}_1$ (audio message with print message) = 16.1612

$\bar{X}_2$ (audio message alone) = 19.0106

S.D. = 0.3316

t = 8.5928

N_1 = 93 N_2 = 94 df = 185

A t-ratio of 1.960 or larger was required before the observed difference could be considered significant at the 0.05 level. The null hypothesis was rejected.

Hypothesis Number Two

There was significant difference in the mean scores, as determined by an immediate recall test, of the print message that was transmitted simultaneously with an incongruent auditory message and of the control print message that was transmitted alone. Table II gives the t-test results for this hypothesis.

TABLE II

Computation of T-Ratio: Hypothesis II

$\bar{X}_1$ (print message with audio message) = 14.7065

$\bar{X}_2$ (print message alone) = 19.6382

S.D. = 0.4295

t = 11.4824

N_1 = 92 N_2 = 94 df = 184

A t-ratio of 1.960 or larger was required before the observed difference could be considered significant at the 0.05 level. The null hypothesis was rejected.

Hypothesis Number Three

There was significant difference in the mean scores, as determined by an immediate recall test, of the auditory message that was transmitted simultaneously with an incongruent pictorial message and of the control auditory message that was transmitted alone. Table III gives the t-test results for this hypothesis.

TABLE III

Computation of T-Ratio: Hypothesis III

$\bar{X}_1$ (audio message with pictorial message) = 18.6236

$\bar{X}_2$ (audio message alone) = 19.0106

S.D. = 0.1712

t = 2.1839

$N_1 = 93$ $N_2 = 94$ df = 185

A t-ratio of 1.960 or larger was required before the observed difference could be considered significant at the 0.05 level. The null hypothesis was rejected.

Hypothesis Number Four

There was significant difference in the mean scores, as determined by an immediate recall test, of the pictorial message that was transmitted simultaneously with an incongruent auditory message and of the pictorial control that was transmitted alone. Table IV gives the t-test results for this hypothesis.

TABLE IV

Computation of T-Ratio: Hypothesis IV

$\bar{X}_1$ (pictorial message with audio message) = 19.1827

$\bar{X}_2$ (pictorial message alone) = 19.9489

S.D. = 0.1479

t = 5.1805

N_1 = 93 N_2 = 98 df = 189

A t-ratio of 1.960 or larger was required before the observed difference could be considered significant at the 0.05 level. The null hypothesis was rejected.

CHAPTER IV

Summary, Discussion, Conclusion, and Recommendations

The purpose of this study was to investigate a subject's amount of immediate recall when incongruent auditory and print messages or incongruent auditory and pictorial messages were simultaneously transmitted over a multi-channel communication system. The study was initiated because a review of available literature revealed: (1) Broadbent's theoretical foundation that this system could work had not been adequately studied and (2) experimental designs failed to incorporate the concept of stimulus generalization in the testing channel.

To answer the questions posed by this investigation, the development of relatively simple stimulus materials was necessitated. The audio channel transmitted three one syllable words. The print channel transmitted three different one syllable words. The pictorial channel transmitted a graphic representation of a square with a dot located in one of four intersecting squares. In total, twenty stimuli were prepared for each channel. Based on the stimulus channel used, appropriate testing material was selected and developed.

Three sections of Psychology 2310 were selected for this experiment. A total of 286 subjects (141 males; 145 females) participated in this study. All subjects were involved in one of the three control sessions. Two of the three sections participated in the two experimental sessions.

A post-test only with control group design was used in this study. The variables were tested for significance by means of the t-test. The conclusion was based on the results of the tests of significance of the following null hypotheses:

1. There was no significant difference in the mean scores, as determined by an immediate recall test, of an auditory message that was transmitted simultaneously with an incongruent print message and of an identical auditory message that was transmitted alone.

2. There was no significant difference in the mean scores, as determined by an immediate recall test, of a print message that was transmitted simultaneously with an incongruent auditory message and of an identical print message that was transmitted alone.

3. There was no significant difference in the mean scores, as determined by an immediate recall test, of an auditory message that was transmitted simultaneously with an incongruent pictorial message and of an identical auditory message that was transmitted alone.

4. There was no significant difference in the mean scores, as determined by an immediate recall test, of a pictorial message that was transmitted simultaneously with an incongruent auditory message and of an identical pictorial message that was transmitted alone.

Discussion

In all instances in this study, the mean scores of the single-channel communication systems were larger than the mean scores of the multi-channel systems. This finding is consistent

with the results of previous research. Appearing quite probable in this study is the possibility of neurological jamming. The occurance of this phenomenon can be based upon many conditions stated by Broadbent in his perceptual theories. For example, the stimulus material may have been too difficult for the subjects. Secondly, the stimulus, itself, may have been too long which allowed jamming. Finally, the wrong channels may have been used together. That is, information by the auditory, print, and pictorial channels are neurologically perceived homogeneously. Therefore, any of these channels transmitting at the same time would cause interference with the others.

In the multi-channel systems, the selection of the auditory channel for information appeared to have occured. When the mean scores of the channels are studied, the means of the auditory channels are consistently higher. Previous research has observed the same phenomenon. A hypothesis has been purported that this is due to neurological jamming. When this jamming occurs, a person will select one channel for information and ignore the other channel.

As stated in the limitations of the study, the variables of practice, length of message, difficulty of message, and channel compatibility were not investigated. These variables might be involved in the design of the experiment and the design of the stimuli. The results obtained could conceivably have been due to the absence of any one or any combination of these variables.

The experimental design used, however, precludes any discussion on these variables because of a lack of statistical findings.

Conclusion

Based upon the results of this study, all null hypotheses can be rejected and the conclusion can be made that, in this case, the mean scores of the single-channel communication systems were significantly different from the mean scores of the multi-channel communication systems.

Recommendations

Based upon the results and the conclusion of this study, the following recommendations can be made:

1. Further study should be conducted to determine if the presence of practice is a variable in a multi-channel communication system that is simultaneously transmitting incongruent information.

2. Because the difficulty of the material has been established as a variable, further research should include the use of classical perceptual stimuli e.g. tonal disciminations, spatial discriminations, and color discriminations, as a starting point for the informational level.

3. Traditionally, the auditory and the visual channels have been used in this research. Further study should include the use of other channels.

REFERENCES

1. Barrow, L.C. and Westley, B.H. Comparative teaching effectiveness of radio and television. Audio Visual Communication Review, 1959, 7, 14-23.

2. Basic Sight Word List, Department of Speech Pathology and Audiology, Eastern Illinois University, Handout.

3. Broadbent, D.E. Information processing in the nervous system. Science, 1965, 150, 457-462.

4. ----- A mechanical model for human attention and immediate memory. Psychological Review, 1957, 64, 205-215.

5. Brunning, J.L. and Kintz, B.L. Computational Handbook of Statistics, Glenview, IL: Scott, Foresman and Co., 1968.

6. Conway, J.R. Information presentation, information processing, and the sign vehicle. Audio Visual Communication Review, 1968, 16, 403-414.

7. Dwyer, F.M. The effectiveness of selected visual illustrations in teaching science concepts to college freshmen. The Journal of Educational Research, 1961, 61, 343-347.

8. ----- When visuals are not the message. Educational Broadcasting Review, 1968, 2, 38-43.

9. Goldberg, H.D. Liking and retention of a simulcast. Public Opinion Quarterely, 1950, 14, 141-142.

10. Hartman, F.P. Recognition learning under multiple channel presentation. Audio Visual Communication Review, 1961, 9, 24-43.

11. ----- Single and multiple channel communication: a review of research and a proposed model. Audio Visual Communication Review, 1961, 9, 235-262.

12. Henneman, R.H. Vision and audition as sensory channels for communication. The Quarterly Journal of Speech, 1952, 38, 161-166.

13. Klemmer, E.T. Time sharing between frequency coded auditory and visual channels. Journal of Experimental Psychology, 1958, 55, 229-235.

14. Mowbray, G.H. Simultaneous vision and audition: the comprehension of prose passages with varying levels of difficulty. The Journal of Experimental Psychology, 1953, 46, 365-371.

15. ----- Simultaneous vision and audition: the detection of elements missing from overlearned sequences. The Journal of Experimental Psychology, 1952, 44, 292-300.

16. O'Brien, F.J. A qualitative investigation of the effect of mode of presentation upon the process of learning. American Journal of Psychology, 1921, 32, 249-283.

17. Severin, W.J. Another look at cue summation. Audio Visual Communication Review, 1967, 15, 233-245.

18. ----- Pictures vs. relevent cue in multi-channel communication. Journalism Quarterly, 1967, 44, 17-22.

19. Travers, R.M.W., ed. Studies related to the design of audio-visual teaching materials. Final Report on USOE Grant No. 3-20-003, 1966.

20. ----- The transmission of information to human receivers. Audio Visual Communication Review, 1964, 12, 373-385.

21. Van Mondfrans, A.P. and Travers, R.M.W. Learning of redundant material presented through two sensory modalities. Perceptual and Motor Skills, 1964, 19, 743-751.

APPENDIX A

Stimulus Words for the Print Message

1. COME
   GET
   CALL

2. MAKE
   LET
   HOW

3. JUST
   COLD
   BROWN

4. DOWN
   CAME
   DONE

5. LIVE
   HURT
   LIGHT

6. NEW
   OFF
   MUST

7. TRY
   WAS
   SING

8. WHAT
   THINK
   WARN

9. SAID
   THREE
   THEM

10. SOON
    RIDE
    WHY

11. SMALL
    WASH
    USE

12. ONCE
    OLD
    HAS

13. FOUND
    PULL
    STOP

14. KIND
    THE
    SIT

15. MAY
    NOT
    RED

16. READ
    SAW
    RUN

17. THANK
    WENT
    THIS

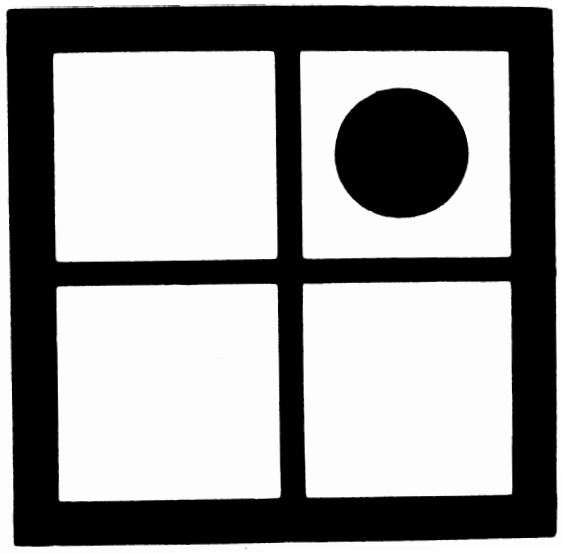
18. LOOK
    FLY
    LIGHT

19. FIND
    HOLD
    GREEN

20. DRINK
    KNOW
    FAR

APPENDIX B

Model of the Pictorial Visual



APPENDIX C

Stimulus Words for the Audio Message

1. PLAY	7. LIVE	13. LIKE	19. PLEASE
WILL	DOWN	HOW	OUT
RUN	CAME	DRAW	TRY
2. COLD	8. GOOD	14. CALL	20. TAKE
WISH	MAY	BIG	ROUND
DONE	JUMP	DRINK	THAT
3. HURT	9. KIND	15. FAR	
RAN	FIRST	FIND	
ALL	HOT	EAT	
4. ASK	10. GROW	16. HOLD	
HAS	MAKE	GREEN	
BLACK	FLEW	SIGHT	
5. FAST	11. BEST	17. LOOK	
HELP	KEEP	CLEAN	
BROWN	BLUE	HURT	
6. FROM	12. BRING	18. SIT	
LONG	FOUND	OLD	
FULL	FIVE	SIX	

The Auditory Test

APPENDIX E

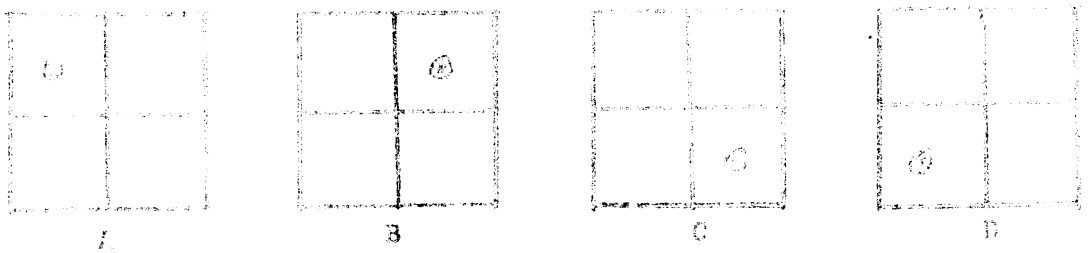
The Print Test

MALE ____ FEMALE ____ Age ____

AFTER you have seen the words on the screen, check those three words in the list of five words that are grouped below.

1. ___ come ___ fall ___ get ___ call ___ let
2. ___ rake ___ make ___ let ___ how ___ now
3. ___ just ___ cold ___ brown ___ down ___ fold
4. ___ down ___ came ___ done ___ just ___ could
5. ___ live ___ hurt ___ light ___ give ___ fight
6. ___ land ___ new ___ pump ___ off ___ must
7. ___ my ___ try ___ was ___ sing ___ ring
8. ___ warm ___ what ___ that ___ think ___ warn
9. ___ said ___ three ___ we ___ them ___ two
10. ___ side ___ soon ___ ride ___ why ___ what
11. ___ small ___ tall ___ fall ___ wash ___ use
12. ___ once ___ had ___ bold ___ old ___ has
13. ___ find ___ found ___ pull ___ stop ___ top
14. ___ kind ___ mind ___ the ___ sit ___ sat
15. ___ may ___ not ___ red ___ dot ___ bed
16. ___ fun ___ read ___ red ___ saw ___ run
17. ___ tank ___ thank ___ went ___ this ___ they
18. ___ book ___ look ___ fly ___ light ___ might
19. ___ find ___ bold ___ hold ___ green ___ kind
20. ___ mink ___ drink ___ know ___ far ___ car

The Pictorial Test



APPENDIX G

Instructions to Subjects

I. Please take out the answer sheet with three blank spaces. In this session, you will hear three words. For example, the tape will say: CAT - MOUSE - CAR. After you have heard those words, you will have fifteen seconds to write down those words in the spaces provided by the answer sheet. Do not worry about spelling or about writing the words in the order that you heard them. Be sure that you do no start writing the words until after you have heard the last word. (Any questions?).

II. Please take out the answer sheet with groups of five words. (At the same time) In this session, you will see three words. For example, (show transparency). After you have seen those words, you will have fifteen seconds to select those words from a group of five words by checking the correct words. Be sure that you do not start selecting the words until the slide is off the screen. Any questions?

III. Please take out the answer sheet with four boxes on the top of the sheet. (At the same time) In this session, you will see a box with four squares. In one of the squares, there will be a dot. For example, (show transparency). After you have seen the box, you will have fifteen seconds to select the correct box from the group of four boxes at the top of

the page and put that letter on the answer sheet. Be sure that you do not start to select the box until after the slide is off the screen. Any questions?

IV. Representation of the Print Transparency

BOY

GIRL

CAT

V. Representation of the Pictorial Transparency