

RECOGNITION OF THE AUDIBLE DIMENSION
OF THE WRITTEN CODE

Thesis for the Degree of M. A.
MICHIGAN STATE UNIVERSITY

Joan Abood

1962



RECOGNITION OF THE AUDIBLE DIMENSION
OF THE WRITTEN CODE

By

Joan Abood

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF ARTS

College of Communication Arts, Department of Speech

1962

Q 2 1659
9/27/68

ABSTRACT

RECOGNITION OF THE AUDIBLE DIMENSION
OF THE WRITTEN CODE

by Joan Abood

The purpose of this study is twofold: to measure the performance of subjects as they are asked to identify the written code when stimulated only by hearing the symbols written on a blackboard; and, to determine the effect of training on the recognition task.

The subjects for this study were twenty-four adults. A recording was made on magnetic tape of the sound emitted by chalk forming the letters of the English alphabet in capital printed and script form on a blackboard. The subjects listened to the taped material and recorded their responses on an answer sheet. Two segments of the taped material were accompanied by script and printed alphabet wall cards. The subjects were presented with limited information concerning the taped material. Six subjects were selected randomly from the twenty-four subjects and trained for the recognition task. The trained subjects were presented the taped material and asked to identify the letters.

The findings of this study indicate that subjects are able to identify the written code when stimulated only

by hearing chalk form the symbols on a blackboard; and, that training does affect the recognition task.

The conclusions which were drawn from this study suggest that printed capital letters of the English, with and without visual clues, are recognized more easily than script capital letters, with and without visual clues; and, training of subjects improves the recognition of the script and printed letters. Most frequent confusions of letters were those similar in configuration.

Approved by


Director

TABLE OF CONTENTS

	Page
LIST OF TABLES	111
Chapter	
I. STATEMENT OF THE PROBLEM	1
Introduction	1
Statement of Problem and Purpose of Study.	2
Questions Posed at Outset.	2
Importance of Study.	5
Definition of Terms.	5
Organization of the Thesis	5
II. REVIEW OF THE LITERATURE	7
Frequency of Occurrence	7
Relative Intelligibility of Spoken Alphabet.	7
Effect of Familiarity	8
Audio vs Audio-Visual Clues	9
III. SUBJECTS, EQUIPMENT, MATERIAL, AND PROCEDURES.	10
Subjects	10
Equipment	10
Material	10
Procedures.	13
IV. RESULTS AND DISCUSSION.	17
Results.	17
Discussion.	22
V. SUMMARY AND CONCLUSIONS	27
Summary.	27
Conclusions	28
Implications for Future Research	29
BIBLIOGRAPHY.	31
APPENDICES	33

LIST OF TABLES

Table	Page
1. Per Cent of Recognition of Printed and Script Letter of Alphabet	18
2. Results of <u>t</u> Test for Differences Between Recognition of Printed Letters and Printed Letters With Visual Clues	20
3. Results of <u>t</u> Test for Differences Between Recognition of Printed Letters and Script Letters	20
4. Results of <u>t</u> Test for Differences Between Recognition of Script Letters and Script Letters With Visual Clues	21
5. Results of <u>t</u> Test for Differences Between Recognition of Printed Letters With Visual Clues and Script Letters	21
6. Results of <u>t</u> Test for Differences Between Recognition of Printed Letters With Visual Clues Before Training and Printed Letters Without Visual Clues After Training	23
7. Results of <u>t</u> Test for Differences Between Recognition of Script Letters Before and After Training	23
8. Raw Scores of Recognition of Printed Capital Letters With and Without Visual Clues. . .	34
9. Raw Scores of Recognition of Script Capital Letters With and Without Visual Clues. . .	34
10. Raw Scores of Recognition of Printed Capital Letters With Visual Clues Before Training and Recognition of Printed Capital Letters After Training	35
11. Raw Scores of Recognition of Script Capital Letters Before and After Training	35

Table	Page
12. Relative Frequency of Letters in English. . .	36
13. Per Cent of Recognition by Training Group After Training.	36
14. Confusion Matrix for Printed Capital Letters Without Visual Clues.	37
15. Confusion Matrix for Printed Capital Letters With Visual Clues.	38
16. Confusion Matrix for Script Capital Letters Without Visual Clues.	39
17. Confusion Matrix for Script Capital Letters With Visual Clues.	40
18. Confusion Matrix for Printed Capital Letters With Visual Clues Before Training of Training Group.	41
19. Confusion Matrix for Printed Capital Letters Without Visual Clues After Training of Training Group.	42
20. Confusion Matrix for Script Capital Letters Without Visual Clues Before Training of Training Group.	43
21. Confusion Matrix for Script Capital Letters Without Visual Clues After Training of Training Group.	44

CHAPTER I

STATEMENT OF THE PROBLEM

Introduction

Research reports concerned with measurement of the ability or competency of the human auditory mechanism to receive, transmit, and discriminate sounds in various forms and under various conditions are numerous. It has been found that the hearing mechanism is capable of discerning various sounds and that the human is able to utilize this hearing function for varied activities.

It is generally agreed that the auditory pathway receives many signals without conscious awareness of reception on the part of the receiver. These sounds form the noise background against which the human hears. One of these sounds, for example, is that which arises when the symbols of the alphabet are recorded with chalk on a blackboard. This study is concerned with the recognition of the sounds produced as alphabet letters are written and printed on a blackboard. In other words, it is a study of the perception of the audible dimension of the written code.

Statement of Problem and Purpose of Study

The problem involved in this study is to determine whether or not the auditory dimension of the written code is meaningful to listeners. One purpose of this study is to measure the performance of subjects as they are asked to identify the written code when stimulated by only hearing it written on a blackboard. A second purpose is that of determining the effects of training on this task of recognition.

Questions Posed at Outset

Questions posed at the outset of this study were:

1. What is the per cent of recognition of capital letters of the English alphabet as subjects hear them printed on the blackboard?
2. What is the per cent of recognition of capital letters of the English alphabet printed on the blackboard as the entire alphabet is made visually available to subjects?
3. What is the per cent of recognition of capital letters of the English alphabet as subjects hear them written cursively on the blackboard?
4. What is the per cent of recognition of capital letters of the English alphabet written cursively on the blackboard as the entire alphabet is made visually available to subjects?

5. Is there a significant difference between recognition of capital letters of the English alphabet as subjects hear them printed on the blackboard as compared to recognition of capital letters of the English alphabet printed on the blackboard as the entire alphabet is made visually available to subjects?
6. Is there a significant difference between recognition of capital letters of the English alphabet as subjects hear them printed on the blackboard as compared to recognition of capital letters of the English alphabet as subjects hear them written cursively on the blackboard?
7. Is there a significant difference between recognition of capital letters of the English alphabet as subjects hear them written cursively on the blackboard as compared to recognition of the capital letters of the English alphabet written cursively on the blackboard as the entire alphabet is made visually available to subjects?
8. Is there a significant difference between recognition of capital letters of the English alphabet as subjects hear them printed on the blackboard as the entire alphabet is made visually available to subjects as compared to recognition of the capital letters of the English alphabet written cursively on the blackboard as the entire alphabet is made visually available to subjects.

9. Is there a significant difference in the auditory recognition of capital letters of the English alphabet printed on the blackboard as the entire alphabet is made visually available to subjects before training as compared to recognition of capital letters of the English alphabet as subjects hear them printed on the blackboard after training?
10. Is there a significant difference in the auditory recognition of capital letters of the English alphabet as subjects hear them written cursively on the blackboard before training as compared to recognition of capital letters of the English alphabet as subjects hear them written cursively on the blackboard after training?

Importance of Study

This is considered to be a basic research and the writer does not seek immediate application either in teaching or clinical situations. However, it may one day be relevant in the instruction of the visually handicapped. More importantly, at this time, is the contribution this study can make concerning a somewhat unusual task involving auditory perception.

Definition of Terms

The terms used in this study are defined as follows:

Written code.--The twenty-six letters of the English alphabet.

Print.--Manuscript form of the letters of the English alphabet.

Script.--Cursive form of the letters of the English alphabet.

Visual clues.--Commercial wall cards of the twenty-six letters of the English alphabet in manuscript and cursive form.

Speech discrimination test.--A test employed in the examination of a patient's ability to discriminate among similar sounds or among words that contain similar sounds.¹

CID Auditory Test W-22, List 1A.--A discrimination test list of fifty monosyllabic phonetically balanced words. The word list is available in recorded form.²

Organization of the Thesis

Chapter I contains the statement of the problem and the purpose of the study. It has stated the questions to be discussed, the importance of the study, and defined the terms which will appear in the study.

Chapter II will contain a review of the literature pertaining to the study.

¹Hayes A. Newby, Audiology (New York: Appleton-Century-Crofts, Inc., 1958), p. 114.

²Ibid., p. 110.

Chapter III will consist of discussion of the subjects, equipment, and testing procedures employed in this study.

Chapter IV will contain the discussion of the results of the study.

Chapter V will consist of a summary and conclusions of the study.

CHAPTER II

REVIEW OF THE LITERATURE

In comparison to the number of studies that are reported on the discrimination of various speech sounds, tone signals, words and phrases, etc., there is an extremely limited amount of information reported concerning the discrimination of letters of the English alphabet.

Frequency of Occurrence

In 1923, Godfrey Dewey published a book of the relative frequency of English speech sounds which contained a list of the relative frequency of letters in the English alphabet.¹ This list may be found in the Appendix, Table 12.

Relative Intelligibility of Spoken Alphabet

Curry, Fay, and Hutton conducted a study to ascertain the relative intelligibility of the twenty-six individual spoken letters of the English alphabet when presented to normal listeners over a 45db range of levels. In descending rank order of overall per cent correct for ten presentation

¹Godfrey Dewey, Relative Frequency of English Speech Sounds (Cambridge, Mass.: Harvard University Press, 1923), p. 184.

levels they found: O I R W X L Y A F S H M K U Q N J G E
C Z T P V D B.¹

Effect of Familiarity

In conjunction with frequency of occurrence comes the aspect of familiarity. Reports were not available on familiarity of letters of the alphabet. However, Elmer Owens conducted a study on the intelligibility of words varying in familiarity and reported: "The implication is that normal-hearing persons listening under the best of circumstances will make a substantial number of mistakes on any discrimination test that includes words of low familiarity."² Lists characterized by greater familiarity, even to a slight degree, were significantly more intelligible. In Chapter IV the results of this study will be discussed as to per cent of recognition per letter and comparison will be made as to rank order of recognition with Dewey's list assuming that those letters appearing more frequently will be more familiar to the subjects, and, therefore, more easily recognizable.

¹E. T. Curry, T. H. Fay, Jr., and C. L. Hutton, "Experimental Study of the Relative Intelligibility of Alphabet Letters," The Journal of the Acoustical Society of America, XXXII (September, 1960), p. 1155.

²Elmer Owens, "Intelligibility of Words Varying in Familiarity," Journal of Speech and Hearing Research, IV (June, 1961), p. 122.

Audio vs Audio-Visual Clues

In speaking, the primary source of recognition is the ear. Conversely, in writing, the primary source of recognition is the eye. But, each may utilize the additional sense.

Since one aspect of the data of this study to be analyzed is that of the effect of visual clues on the degree of recognition, O'Neill's report on the visual components of oral symbols to speech comprehension is relevant. O'Neill's report suggests that normal hearing individuals make use of the eye in the reception of speech. The results of his study are as follows:¹

	Per Cent of Recognition by	
	Audio-Visual Clues	Auditory
Consonants	76	49
Words	78	59
Phrases	63	49

The effects of visual clues on the per cent of recognition of the letters of the English alphabet will be discussed in Chapter IV.

¹John J. O'Neill, "Contributions of the Visual Components of Oral Symbols to Speech Comprehension," Journal of Speech and Hearing Disorders, XIX (December, 1954), p. 434.

CHAPTER III

SUBJECTS, EQUIPMENT, MATERIAL, AND PROCEDURES

Subjects

The subjects for this study were undergraduate and graduate students, and wives of students at Michigan State University. All subjects were given a speech discrimination test and were required to identify correctly at least 90 per cent of the word list. They were then divided into four groups of six per group only on the basis of availability at the times scheduled for the experimental testing. The training group was selected in the same manner.

Equipment

Microphone (Electravoice Model 654)

Tape recorders (Ampex Model 601, Model 601-1)

Amplifier (Ampex 620)

Sound Pressure Level Meter (Soundscope Model B set
on C-Scale)

Audiometer (Allison Model 20-A)

Audio-oscillator (Barker and Williamson, Model 200)

Material

A tape recorder (Ampex Model 601) and microphone (Electravoice Model 654) were used to record on magnetic

tape (Scotch Brand No. 111-12) the sounds emitted when chalk was used to form the twenty-six letters of the English alphabet from A to Z in printed and script forms, on a standard wall blackboard. The chalk used was a two inch, ninety-five per cent dustless pure chalk crayon (Amaco Dustless Chalk No. 101). Using random order, the letters were then scrambled and four lists obtained; two for print, and two for script. The sounds from the original tape were re-recorded on a second magnetic tape, the experimental tape, in the four scrambled orders with a ten second pause between each letter. The sounds were transferred from one tape recorder (Ampex Model 601) to a second tape recorder (Ampex Model 601-1). When recording on the original tape it was necessary to set the gain control to a level where the microphone could pick up the sound of the writing. To assure that the scrambling of stimuli on the re-recording was made at the same level, a 1000 cycle per second calibration tone from an audio-oscillator (Barker and Williamson, Model 200) was placed on the original tape at the recording level. When transferring to the experimental tape, the 1000 cycle tone was set so that the needle of the VU meter peaked at zero.

To assure the constant output level of the experimental tape for each group, a sound level meter (Soundscope Model B, set on C-scale) was placed ten feet from the sound source (Ampex Amplifier Model 620) and the gain control of

the amplifier was set so as to bring the level of the pure tone to 60db (0.0002 dyne/cm²).

A spoken number one was placed on the tape before the first segment or list of printed letters. The spoken numbers two, three, and four were used to identify the second list of printed letters and the two lists of script form letters.

Each subject was given a speech discrimination test (CID Auditory Test W-22, List 1-A). It was administered by recorded form, free field, at 40db.

In the testing procedure visual clues were employed at specified times. These were commercial wall cards of the twenty-six letters in manuscript (Ideal School Supply Manuscript Wall Cards No. 282), and in cursive (Ideal School Supply Cursive Wall Cards No. 283). Those letters differing in formation from the test material on the tape were covered over and the letter formation replaced by the desired formation.

Each subject was provided with a scoring sheet on which were four columns of twenty-six numbers and blank spaces. Space was provided at the top of the sheet for name, date, group number, and year in school, if student.

The twenty-six letters of the English alphabet were presented in the forms that would afford the most auditory clues. They were made approximately 6" x 6" in size. For example, Q was printed as , using two strokes instead

of the *Q* form. F was written as *F* with three strokes, in place of *F*. A complete list of the letter formations with arrows indicating direction of movements, may be found in Appendix C.

Procedure

1. Orientation to the test situation.--Each group was given the same general directions.

2. General directions.--The following directions were read to each group before presenting any of the taped material.

You are about to hear a tape recording consisting of sounds recorded while either printing or writing capital letters of the alphabet. These letters were made by using chalk on a blackboard. You are to decide which letter is being made. There will be a ten second pause between each letter. Please make your decision as quickly as possible and mark your answer on the answer sheet. Please try to guess at each letter even if you are uncertain of the letter. If you cannot guess, place a horizontal line through the number and answer space. I will give you three examples of letters that might appear in the tape. What is this letter? (M) Now close your eyes. (Experimenter made M on board with chalk.) What letter did I make? (This procedure was repeated with the printed capital R and the script capital B.)

3. Group directions.--The four segments of the taped material were presented in a different sequence for each group. However, each group received the same directions for each corresponding segment as follows:

Group I. You first will hear printed capital letters. Please begin marking your answers after you hear the spoken number one.

Now you will hear printed capital letters. You may look at the letter cards on the front board. Please

begin marking your answers after you hear the spoken number two.

Now you will hear script capital letters. Please begin marking your answers after you hear the spoken number three.

Now you will hear script capital letters. You may look at the letter cards on the front board. Please begin marking your answers after you hear the spoken number four.

Group II. You first will hear script capital letters. Please begin marking your answers after you hear the spoken number three.

Now you will hear script capital letters. You may look at the letter cards on the front board. Please begin marking your answers after you hear the spoken number four.

Now you will hear printed capital letters. Please begin marking your answers after you hear the spoken number one.

Now you will hear printed capital letters. You may look at the letter cards on the front board. Please begin marking your answers after you hear the spoken number two.

Group III. You first will hear script capital letters. You may look at the letter cards on the front board. Please begin marking your answers after you hear the spoken number four.

Now you will hear script capital letters. Please begin marking your answers after you hear the spoken number three.

Now you will hear the printed capital letters. You may look at the letter cards on the front board. Please begin marking your answers after you hear the spoken number two.

Now you will hear the printed capital letters. Please begin marking your answers after you hear the spoken number one.

Group IV. First you will hear printed capital letters. You may look at the letter cards on the front board. Please begin marking your answers after you hear the spoken number two.

Now you will hear printed capital letters. Please begin marking your answers after you hear the spoken number one.

Now you will hear script capital letters. You may look at the letter cards on the front board. Please begin marking your answers after you hear the spoken number four.

Now you will hear script capital letters. Please begin marking your answers after you hear the spoken number three.

Training Group

4. Subjects for training group.--The six training subjects were selected from the four groups only on the basis of availability at the time scheduled for training and testing. All had participated in one of the group tests.

5. Training procedure.--The twenty-six letters of the printed capital English alphabet were placed on the board in the same form as those used on the tape. The first four letters were discussed as to number of strokes used in forming each letter and, the difference in sound dependent on the direction of the chalk strokes while forming the letters on the board. The subjects were asked to close their eyes and listen to the sounds as each of these four letters was made. After hearing these sounds twice, the examiner scrambled the presentation of the four letters and asked the group to identify the letters. After reviewing the four letters three times each, the next four letters of the alphabet were discussed and the above

procedure repeated adding the second four letters to the first four letters. This process was repeated for all twenty-six letters of the alphabet. The script form of the letters was presented in the same manner. Seventy minutes were allowed for each form of the letters (printed and script) making a total training period of one hundred forty minutes. The subjects were allowed to communicate freely with each other and the examiner.

6. Testing procedure for the training group.--Immediately following the training process, the training group was given the scoring sheets and segments two and three of the tape were presented. The following directions were given:

You will hear printed capital letters. Please begin marking your answers after you hear the spoken number two.

Now you will hear script capital letters. Please begin marking your answers after you hear the spoken number three.

As there was a sizeable numerical difference in favor of the printed capital letters (segment two of the tape) in the results of the data of the four group tests, segment two of the tape was presented to the training group. This would enable comparison of effect of training with the pre-training results of the same scrambled list under the most favorable conditions.

CHAPTER IV

RESULTS AND DISCUSSION

Results

The answer sheets of the subjects were checked for correct responses and the raw scores tabulated. The per cent of recognition by groups under specific conditions was analyzed and tabulated. Table 1 presents the data obtained in response to questions one to four posed in Chapter I, namely:

1. What is the per cent of recognition of capital letters of the English alphabet as subjects hear them printed on the blackboard?
2. What is the per cent of recognition of capital letters of the English alphabet printed on the blackboard as the entire alphabet is made visually available to subjects?
3. What is the per cent of recognition of capital letters of the English alphabet as subjects hear them written cursively on the blackboard?

4. What is the per cent of recognition of capital letters of the English alphabet written cursively on the blackboard as the entire alphabet is made visually available to subjects?

TABLE 1

PER CENT OF RECOGNITION OF PRINTED
AND SCRIPT LETTERS OF ALPHABET

Groups	Print		Script	
	Without Visual Clues	With Visual Clues	Without Visual Clues	With Visual Clues
1	19	23	10	10
2	16	15	7	9
3	17	25	10	15
4	22	21	21	10
Groups 1-4	74	84	42	44

To analyze the data obtained in response to questions 5-8 posed in Chapter I, the following formula was employed:¹

$$t = \sqrt{\frac{M_1 - M_2}{\frac{\sum d^2}{N(N-1)}}$$

Questions five to eight posed in Chapter I were:

5. Is there a significant difference between recognition of capital letters of the English alphabet

¹E. F. Lindquist, Statistical Analysis in Educational Research (New York: Houghton Mifflin Company, 1940), p. 59.

as subjects hear them printed on the blackboard as compared to recognition of capital letters of the English alphabet printed on the blackboard as the entire alphabet is made visually available to subjects?

6. Is there a significant difference between recognition of capital letters of the English alphabet as subjects hear them printed on the blackboard as compared to recognition of capital letters of the English alphabet as subjects hear them written cursively on the blackboard?
7. Is there a significant difference between recognition of capital letters of the English alphabet as subjects hear them written cursively on the blackboard as compared to recognition of the capital letters of the English alphabet written cursively on the blackboard as the entire alphabet is made visually available to subjects?
8. Is there a significant difference between recognition of capital letters of the English alphabet as subjects hear them printed on the blackboard as the entire alphabet is made visually available to subjects as compared to recognition of the capital letters of the English alphabet written cursively on the blackboard as the entire alphabet is made visually available to subjects?

The results are presented in Tables 2, 3, 4, and 5.

TABLE 2

RESULTS OF t TEST FOR DIFFERENCES BETWEEN
RECOGNITION OF PRINTED LETTERS AND
PRINTED LETTERS WITH VISUAL CLUES

Groups	Print	Print With Visual Clues	t	Level of Confidence
	Mean	Mean		
1	29	36	2.3290	Non sig. at .05
2	26	24	2.0000	Non sig. at .05
3	27	39	2.4985	Non sig. at .05
4	34	33	.9259	Non sig. at .05
Groups 1,2,3,4	116	132	4.9073	Sig. at .01

TABLE 3

RESULTS OF t TEST FOR DIFFERENCES
BETWEEN RECOGNITION OF PRINTED
LETTERS AND SCRIPT LETTERS

Groups	Print	Script	t	Level of Confidence
	Mean	Mean		
1	29	15	2.6745	Sig. at .05
2	26	11	2.6360	Sig. at .05
3	27	15	2.5240	Sig. at .06
4	34	24	2.6112	Sig. at .05
Groups 1,2,3,4	116	65	4.9981	Sig. at .01

TABLE 4

RESULTS OF t TEST FOR DIFFERENCES BETWEEN
 RECOGNITION OF SCRIPT LETTERS AND
 SCRIPT LETTERS WITH VISUAL CLUES

Groups	Script Mean	Script With Visual Clues Mean	t	Level of Confidence
1	15	16	.8165	Non sig. at .05
2	11	14	2.5662	Sig. at .06
3	15	23	2.5820	Sig. at .05
4	24	15	2.6540	Sig. at .05
Groups 1,2,3,4	65	68	3.9588	Sig. at .05

TABLE 5

RESULTS OF t TEST FOR DIFFERENCES BETWEEN
 RECOGNITION OF PRINTED LETTERS
 WITH VISUAL CLUES AND SCRIPT
 LETTERS WITH VISUAL CLUES

Group	Print With Visual Clues Mean	Script With Visual Clues Mean	t	Level of Confidence
1	36	16	2.6694	Sig. at .05
2	24	14	2.5427	Sig. at .06
3	39	23	2.6162	Sig. at .05
4	33	15	2.5926	Sig. at .05
Groups 1,2,3,4	132	68	4.9981	Sig. at .01

The formula for t scores was applied to the data obtained from the training group to answer the following questions posed in Chapter II:

9. Is there a significant difference in the auditory recognition of capital letters of the English alphabet printed on the blackboard as the entire alphabet is made visually available to subjects before training as compared to recognition of capital letters of the English alphabet as subjects hear them printed on the blackboard after training?
10. Is there a significant difference in the auditory recognition of capital letters of the English alphabet as subjects hear them written cursively on the blackboard before training as compared to recognition of capital letters of the English alphabet as subjects hear them written cursively on the blackboard after training?

The results are presented in Tables 6 and 7.

Discussion

In per cent of recognition, the subjects were able to recognize most frequently the printed capital letters with visual clues. These were identified correctly twenty-one per cent of the time. Printed capital letters without visual clues followed with eighteen per cent recognition;

TABLE 6

RESULTS OF t TEST FOR DIFFERENCES BETWEEN RECOGNITION
OF PRINTED LETTERS AND VISUAL CLUES BEFORE TRAINING
AND PRINTED LETTERS WITHOUT VISUAL CLUES
AFTER TRAINING

Print With Visual Clues Before Training	Print Without Visual Clues After Training		Level of Confidence
Mean Score	Mean Score	t	
37	66	2.6595	Sig. at .05

TABLE 7

RESULTS OF t TEST FOR DIFFERENCES BETWEEN RECOGNITION
OF SCRIPT LETTERS BEFORE AND AFTER TRAINING

Script Without Visual Clues Before Training	Script Without Visual Clues After Training		Level of Confidence
Mean Score	Mean Score	t	
16	31	5.6561	Sig. at .01

script capital letters with visual clues eleven per cent; and, script capital letters without visual clues ten per cent.

The training group was able to recognize printed capital letters with visual clues before training, twenty-four per cent of the time. After training, they were able to recognize this same scrambled list of printed capital letters, but, without visual clues, forty-two per cent of the time. Before training, this group was able to recognize script capital letters without visual clues ten per cent of the time. After training, the recognition of script capital letters without clues was twenty per cent.

There was no significant difference at the .05 by any group when comparing printed capital letters to printed capital letters with visual clues. There was a significant difference at the .01 level when combining the four groups, indicating that printed letters with visual clues are recognized more easily than printed capital letters without visual clues. At first glance it might seem as though there would not be significant differences for the combined groups at the .01 level when there were non significant differences when the groups were analyzed individually. However, as one combines the individual groups, thus increasing sample size, this can happen.

A significant difference was found in three groups at the .05 level, one group at the .06 level, and the

combined groups at the .01 level, when printed capital letters were compared with script capital letters. Printed letters are recognized more easily. The significant difference at the .06 level of Group III was only .047 from the .05 level of significance.

There was no significant difference in Group I at the .05 level. A significant difference was found at the .06 level for Group II. A significant difference was found at the .05 level for Groups III and IV, and the combined four groups. This indicates that script capital letters with visual clues are recognized more easily than script capital letters without visual clues.

Groups I, III, and IV showed a significant difference at the .05 level, Group II at the .06 level, and the combined four groups at the .01 level. This suggests that printed capital letters with visual clues are recognized more readily than script capital letters with visual clues. Group II missed being significant at .05 level by .0283.

The six subjects in the training group showed a significant difference at the .05 level in pre and post training scores, that printed capital letters without visual clues were recognized more readily than printed capital letters with visual clues. The training procedure for this group has been described in detail in Chapter III.

A significant difference at the .01 level was also found in the training group indicating that after training,

script capital letters without visual clues were recognized more readily than script capital letters without visual clues before training.

The training group, after training, had the highest per cent of recognition for the printed letters E and J, and the script form letters F and M. Dewey lists (Table 12) E as the letter occurring most frequently; J as the twenty-fourth most frequently occurring letter; F, the fourteenth; and, M, the fifteenth. The method of configuration may account for the training group's recognition of the printed J as one of the most easily recognizable letters although the letter occurs infrequently in English. The printed O was the second letter most frequently recognized by the training group after training, and appears as the fourth most frequently occurring letter in English. The script T was the second letter most frequently recognized by the trained training group, and appears as the second most frequently occurring letter in English.

The method of configuration may also account for the confusion responses. For the printed letters, the four groups and the trained group confused most frequently the following letters in stimulus-response order: G-Q, P-D, J-Q, X-T, L-T, O-C. The most frequently confused script letters in stimulus-response order were: Q-T, M-B, G-W, M-W, K-X. See Appendix B for a complete picture of confusions that occurred and Appendix C for an explanation of the manner in which the letters were produced on the blackboard.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The auditory pathway serves as the receiving system for sound signals. These signals are received, transmitted, and discriminated. One of the many different signals received is that which arises when the symbols of the alphabet are recorded with chalk on a blackboard.

The purpose of this study has been twofold: to measure the performance of subjects as they are asked to identify the written code when stimulated by only hearing the letters written on a blackboard; and, to ascertain the effect of training on the recognition task.

The study does not have immediate practical application, but, may have future use for the visually handicapped and for cryptographers.

Review of the literature indicates that little attention has been devoted to the topic of this study.

The subjects for this study were twenty-four adults from a university campus. CID Auditory Test W-22 was employed as a screening device for subject selection. The twenty-four subjects were divided randomly into four groups of six subjects per group. A training group of six subjects

also was selected randomly from the twenty-four adults. The four groups and the training group were presented a tape recording of the sounds made when letters of the English alphabet were written in printed and script form by chalk on a blackboard. Subjects recorded their responses on an answer sheet. Two segments of the taped material were accompanied by visual clues, namely, the printed and script form alphabet cards. The training group was given approximately two hours of training, and then required to identify two segments of the taped material; one of printed letters and one of script letters.

The findings of this study indicate that subjects are able to identify the written code when stimulated only by hearing the sounds that are made when forming the letters with chalk on a blackboard; and, training of subjects does affect recognition of the letters of the English alphabet.

Conclusions

1. Subjects recognize printed capital letters more readily than script capital letters of the English alphabet when the only stimulus is the sound of chalk forming the letters on a blackboard.

2. Subjects recognize script capital letters when given visual clues more readily than script capital letters without the visual clues when the only stimulus is the sound of chalk forming the letters on a blackboard.

3. Subjects recognize printed capital letters when given visual clues more readily than printed capital letters without the visual clues when the only stimulus is the sound of chalk forming the letters on a blackboard.

4. Subjects recognize printed capital letters with visual clues more readily than script capital letters with visual clues when the only stimulus is the sound of chalk forming the letters on a blackboard.

5. Training improves recognition of printed capital letters of the English alphabet when the stimulus is the sound of chalk forming the letters on a blackboard.

6. Training improves recognition of script capital letters of the English alphabet when the stimulus is the sound of chalk forming the letters on a blackboard.

7. The letters of the English alphabet most frequently confused were those similar in configuration.

Implications for Future Research

1. Future study utilizing trained groups to ascertain recognition of words, phrases and sentences when the only stimulus is sound of chalk forming the letters on a blackboard.

2. Future study employing trained groups to determine recognition of letters, words, phrases and sentences when the stimulus is the sound of pen forming letters on paper.

3. Future study to ascertain recognition of letters, words, phrases and sentences when the only stimulus is sound of chalk forming the letters on a blackboard using groups of adults blind before school age as subjects.

4. Future study to ascertain recognition of letters, words, phrases and sentences when the only stimulus is sound of chalk forming the letters on a blackboard using groups of adults blind after completing grades one through six of school, as subjects.

BIBLIOGRAPHY

Books

- Davis, Hallowell and Silverman, S. Richard. Hearing and Deafness. New York: Holt, Rinehart, and Winston, Inc., 1960.
- Dewey, Godfrey. Relative Frequency of English Speech Sounds. Cambridge, Mass.: Harvard University Press, 1923.
- Fletcher, Harvey. Speech and Hearing. Princeton, New Jersey: D. Van Nostrand Company, Inc., 1953.
- Newby, Hayes D. Audiology. New York: Appleton-Century-Crofts, Inc., 1958.

Periodicals

- Bahrck, Harry and Noble, Merrill. "On Stimulus and Response Discriminability," Journal of Experimental Psychology, 61 (June, 1961), pp. 449-454.
- Carterette, Edward and Cole, Michael. "Repetition and Confirmation of Messages Received by Ear and by Eye," Journal of the Acoustical Society of America, 31 (November, 1959), p. 1569.
- Curry, E. T., Fay, T. H., and Hutton, C. L. "Experimental Study of the Relative Intelligibility of Alphabet Letters," Journal of the Acoustical Society of America, 32 (September, 1960), pp. 1151-1157.
- Howes, Davis. "On the Relation Between the Intelligibility and Frequency of Occurrence of English Words," Journal of the Acoustical Society of America, 29 (February, 1957), pp. 296-305.
- Kronvall, Ernest and Diehl, Charles. "The Relationship of Auditory Discrimination to Articulatory Defects of Children With No Known Organic Impairment," Journal of Speech and Hearing Disorders, 19 (September, 1954), pp. 335-338.

- O'Neill, John J. "Contributions of the Visual Components of Oral Symbols to Speech Comprehension," Journal of Speech and Hearing Disorders, 19 (December, 1954) pp. 429-439.
- Owens, Elmer. "Intelligibility of Words Varying in Familiarity," Journal of Speech and Hearing Research, 4 (June, 1961), pp.113-129.
- Pollack, Irwin. "Identification of Elementary Auditory Displays and the Method of Recognition Memory," Journal of the Acoustical Society of America, 31 (August, 1959), pp. 1126-1128.
- Pollack, Irwin, Rubenstein, Herbert, and Decker, Louis. "Intelligibility of Known and Unknown Message Sets," Journal of the Acoustical Society of America, 31 (March, 1959), pp. 273-279.
- Thurlow, W. R. and Rawlings, I. L. "Discrimination of Number of Simultaneously Sounding Tones," Journal of the Acoustical Society of America, 31 (October, 1959) pp. 1332-1336.
- Veniar, Florence. "Effect of Auditory Cue on Discrimination of Auditory Stimuli," Journal of the Acoustical Society of America, 30 (December, 1958), pp. 1078-1081

APPENDICES

APPENDIX A

TABLE 8

RAW SCORE OF RECOGNITION OF PRINTED CAPITAL
LETTERS WITH AND WITHOUT VISUAL CLUES

Subject Number	Group I WOC--WC *		Group II WOC--WC		Group III WOC--WC		Group IV WOC--WC		Total WOC--WC	
1	5	5	4	6	3	6	4	5	16	25
2	8	6	6	3	3	2	4	1	21	12
3	3	6	6	6	4	11	6	8	19	31
4	6	3	5	5	2	6	4	2	17	16
5	5	7	1	1	7	11	10	8	23	27
6	2	9	4	3	8	3	6	9	20	24
TOTAL	29	36	26	24	27	39	34	33	116	132

TABLE 9

RAW SCORES OF RECOGNITION OF SCRIPT CAPITAL
LETTERS WITH AND WITHOUT VISUAL CLUES

Subject Number	Group I WOC--WC		Group II WOC--WC		Group III WOC--WC		Group IV WOC--WC		Total WOC--WC	
1	2	0	0	0	3	1	5	3	10	4
2	6	3	3	3	3	3	3	2	15	11
3	2	3	0	1	2	5	3	0	7	9
4	4	3	2	4	5	6	2	5	13	18
5	1	2	2	2	2	5	5	2	10	11
6	0	5	4	4	0	3	6	3	10	15
TOTAL	15	16	11	14	15	23	24	15	65	68

*WOC = Without Clues; WO = With Clues.

TABLE 10

RAW SCORES OF RECOGNITION OF PRINTED CAPITAL LETTERS
WITH VISUAL CLUES BEFORE TRAINING AND RECOGNITION
OF PRINTED CAPITAL LETTERS AFTER TRAINING

Training Subject	Before Training	After Training
1	8	12
2	8	13
3	9	13
4	3	12
5	3	11
6	6	5
TOTAL	16	31

TABLE 11

RAW SCORES OF RECOGNITION OF SCRIPT CAPITAL
LETTERS BEFORE AND AFTER TRAINING

Training Subject	Before Training	After Training
1	2	11
2	5	3
3	6	7
4	0	3
5	3	3
6	0	4
TOTAL	16	31

TABLE 12

RELATIVE FREQUENCY OF LETTERS IN ENGLISH¹

Letter	Per Cent	Letter	Per Cent	Letter	Per Cent
E	12.68	L	3.94	P	1.86
T	9.78	D	3.89	B	1.56
A	7.88	U	2.80	V	1.02
O	7.76	C	2.68	K	0.60
I	7.07	F	2.56	X	0.16
N	7.06	M	2.44	J	0.10
S	6.31	W	2.14	Q	0.09
R	5.94	Y	2.02	Z	0.06
H	5.73	G	1.87		

¹Godfrey Dewey, Relative Frequency of English Speech Sounds (Cambridge, Mass.: Harvard University Press, 1923), p. 184.

TABLE 13

PER CENT OF RECOGNITION BY TRAINING GROUP
AFTER TRAINING

Printed		Script	
E	23.07	F	19.23
J		M	
O	19.23	T	15.38
R	15.38	H	11.53
Q		N	
C	11.53	S	
K		U	
L		X	
M		A	7.69
N		B	
S		G	
V		I	
D	7.69	O	
B		P	
G		W	
P		Y	
T			
X			
Z			
A	3.84		
F			
I			
U			
W			

APPENDIX B

TABLE 14
CONFUSION MATRIX FOR PRINTED CAPITAL LETTERS WITHOUT VISUAL CLUES

		Stimulus																										
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	
A	1	1				1			2	5	3		1	3	2		1							5		1		
B									1				1	1		4	1				5					1		
C																												
D																												
E	2					1		1	6	4	7	4	1	1								1		1				
F	4				1								1	1														
G	4					5			1	6		1	1					3	2			2	1		3		1	
H						1						1	1				1										6	
I													2		2		2	4	1	1	2	1		1				
J						1		3	2		1							1			5	1	2		1		1	
K	3				1																							
L																												
M					7							6		1										6			8	6
N									8	7																		
O																												
P				9							1		1		1	1	1		1	1	2	1	5		2			
Q								13	1				1			1	1			7								
R	5					1					1	1	1	6	2	6		1						5		1	2	
S														1														
T	1				2						1	3	2		1					1	2	7		1	11			
U																												
V																												
W					4								3	3	1	1					3	1		3			1	
X													1															
Y	2																				2	1	5		2		1	
Z	2											4									3							

Most Frequent Confusions		Stimulus		Responses		Stimulus		Responses		Stimulus		Responses	
G	Q	13				Y	N	8		I	N	7	
P	D	12				H	N	8		S	Q	7	
J	Q	11				E	W	8		U	Q	7	
X	T	11				J	G	7		V	T	7	
D	P	9				E	M	7		H	F	6	
I	H	6				Y	H	6		W	M	6	
K	N	6				Z	N	6		C	O	6	
M	R	6				O	S	6					

TABLE 15

CONFUSION MATRIX FOR PRINTED CAPITAL LETTERS WITH VISUAL CLUES
Stimulus

Response	Stimulus																									
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
A						2	1	3	1	2	2	1	5	1			1	1			2		6		1	
B										2	1								1							2
C																										
D																										
E																										
F	8	2						4	4	2	3			1											1	1
G	5					6			6		4			1			7	1	2	2	5		2		1	2
H								1																		
I																										
J																										
K								8			2	1	1	2												
L										1																
M																										
N																										
O																										
P																										
Q																										
R																										
S																										
T																										
U																										
V																										
W																										
X																										
Y																										
Z																										

Most Frequent Confusions

Stimulus	Responses	Stimulus	Responses	Stimulus	Responses
G	Q - 18	L	T - 16	P	D - 13
O	C - 11	C	O - 11	J	Q - 11
E	W - 10	V	Q - 9	A	F - 8
H	K - 8	T	L - 8	Y	F - 7
Q	G - 7	I	N - 7	D	P - 7
W	B - 6	B	H - 6	F	H - 6
I	H - 6	F	K - 6	K	N - 6
Z	N - 6	W	R - 6	T	V - 6

TABLE 16

CONFUSION MATRIX FOR SCRIPT CAPITAL LETTERS WITHOUT VISUAL CLUES

		Stimulus																										
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	
Response	A	1			3				1	2	2		2	1			1	1	2	1		1	2	1				
	B		1		3		4			2				8			1		1	2		2	1	1	2	2	3	
	C			1				3			2		1		3		1						1	1				
	D		1		2				1	3			1		1			1						2	1	1		
	E			1						2	1		2		2				1	1			1			2		
	F				1				2			4		1			2	1	1	1	3	1			3	3		
	G											1		1			1	1	1			1	1	2	3	1		
	H			6		1		1							1		1					1						
	I				1								4		2			1				1	4					
	J								3				1		1							2				1		
	K			6							5		1		1		2		1			1				2		
	L	2			2					2			1		5			2	6	1	5		3	1	2	1	2	
	M		1		1		4				2		2		1		1	4	1	1	1	4	2	2	1	1	5	
	N			1																			2	2	2	1	2	
	O				3								3										1	2	2	1	2	
	P																						1	2	2	1	2	
	Q																						1	2	2	1	2	
	R																						1	2	2	1	2	
	S																						1	2	2	1	2	
	T																						1	2	2	1	2	
	U																						1	2	2	1	2	
	V																						1	2	2	1	2	
	W																						1	2	2	1	2	
	X																						1	2	2	1	2	
	Y																						1	2	2	1	2	
	Z																						1	2	2	1	2	

Most Frequent Confusions

Stimulus	Responses	Stimulus	Responses	Stimulus	Responses
Q	T - 9	M	B - 8	B	H - 6
B	K - 6	R	M - 6	R	W - 6
J	L - 5	N	M - 5	S	M - 5
Z	M - 5	E	O - 5	H	T - 5
S	W - 5	K	X - 5	G	B - 4
K	F - 4	O	I - 4	L	J - 4
V	J - 4	M	M - 4	G	M - 4
P	N - 4	N	N - 4	C	O - 4

TABEL 18

CONFUSION MATRIX FOR PRINTED CAPITAL LETTERS WITH VISUAL CLUES BEFORE
TRAINING OF TRAINING GROUP

Stimulus

Response	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
A						1		1	1		1															
B																										
C																										
D																										
E																										
F	1							1	1		2															
G										1																
H						2																				
I																										
J																										
K						1																				
L										1																
M																										
N																										
O																										
P																										
Q																										
R																										
S																										
T																										
U																										
V																										
W																										
X																										
Y																										
Z																										

TABLE 19

CONFUSION MATRIX FOR PRINTED CAPITAL LETTERS WITHOUT VISUAL CLUES
AFTER TRAINING OF TRAINING GROUP

		Stimulus																										
Response		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	
		1	4																									
A		1																										
B			1																									
C				1																								
D					1																							
E						1																						
F	2						1																					
G								1																				
H	1								1																			
I										1																		
J											1																	
K	1											1																
L													1															
M														1														
N															1													
O																1												
P																	1											
Q																		1										
R																			1									
S																				1								
T																					1							
U																						1						
V																							1					
W																								1				
X																									1			
Y																										1		
Z																											1	

TABLE 20

CONFUSION MATRIX FOR SCRIPT CAPITAL LETTERS WITHOUT VISUAL CLUES
BEFORE TRAINING OF TRAINING GROUP

Stimulus

[illegible]

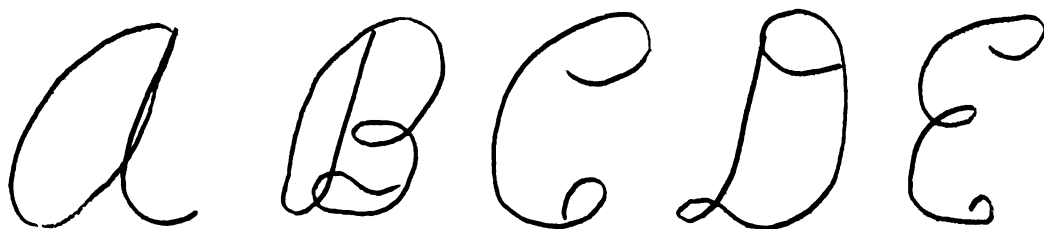
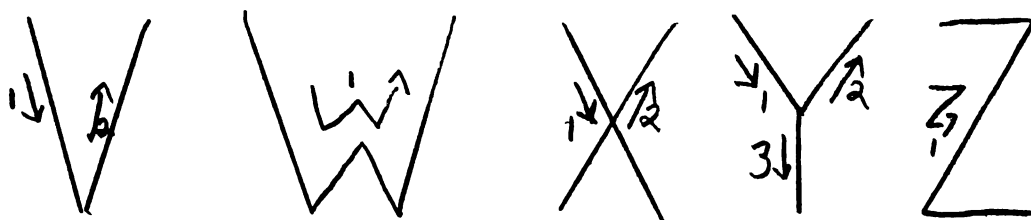
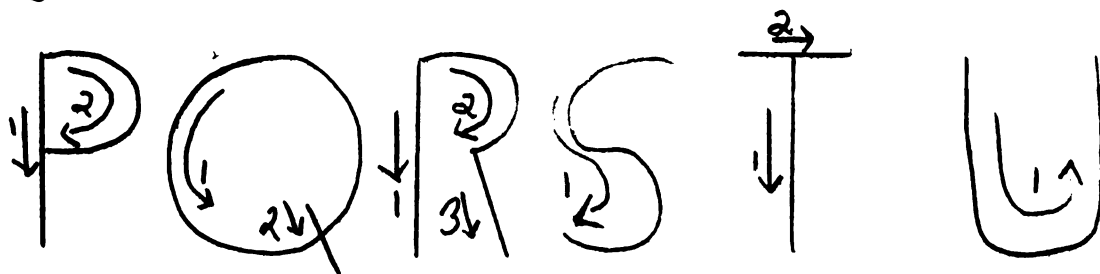
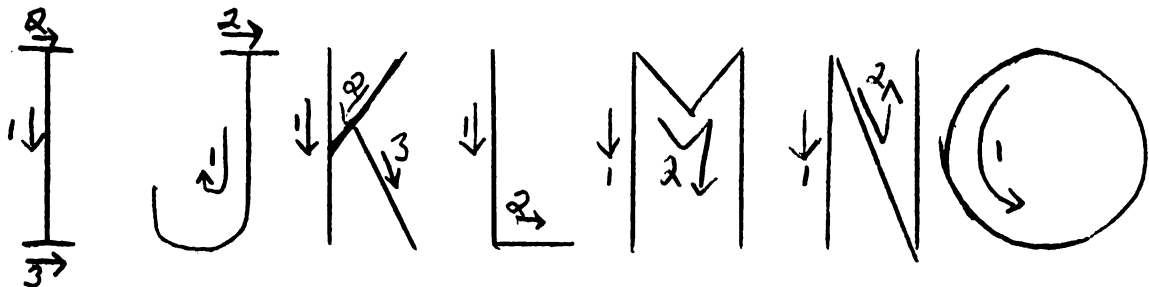
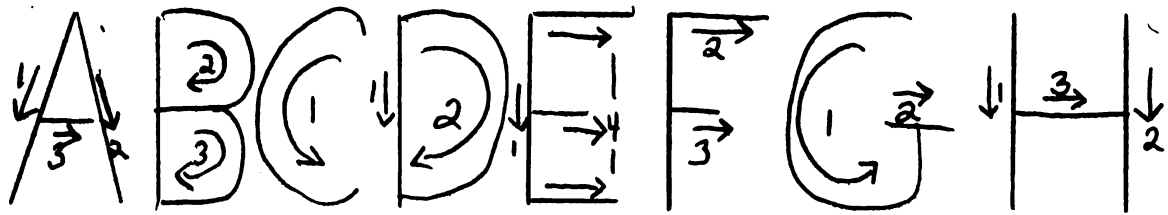
TABLE 21

CONFUSION MATRIX FOR SCRIPT CAPITAL LETTERS WITHOUT VISUAL CLUES
AFTER TRAINING OF TRAINING GROUP

[illegible]

APPENDIX C

PRINTED AND SCRIPT FORMS OF LETTERS EMPLOYED IN
EXPERIMENT (ARROWS INDICATE DIRECTION OF
MOVEMENT IN THE FORMATION OF SYMBOLS)



F G H I

J K L M N

O P Q R S

T U V W

X Y Z

ROOM USE ONLY

~~JUL 19 1963~~

ROOM USE ONLY

JUL 23 1963

JUL 29 1963

~~JUL 27 65~~

~~SEP 2 65~~

OCT 18 65

MICHIGAN STATE UNIVERSITY LIBRARIES



3 1293 03055 9821