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AN EXPERIMENTAL STUDY USING SINGLE SENSORY AND MULTI-SENSORY STIMULI PRESENTATION IN A PAIRED-ASSOCIATIVE LEARNING TASK

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CHAPTER I

INTRODUCTION

A problem of major importance in the education of young children has been the selection of the most effective medium for the presentation of material to be learned associatively. Material to be learned must be presented to one or more than one of the sense organs of the subject. The response to the material presented is mediated to the organism by the receptor or receptors. The relation between the sense organ stimulated and the rate of learning is a significant problem.

A review of educational procedures for presenting learning materials reveals varied approaches. The dominant philosophy of sensationalism during the nineteenth century resulted in educational techniques that were aimed primarily at training the senses. Montessori, Seguin, Binet, Itard, and Descoeudres were all proponents of developing sense perception. Reading specialists have emphasized the importance of visual and auditory discrimination

with varied practices in initial instructional methods. Oral, non-oral, and phonetic systems of teaching beginning reading were devised and followed. Remedial experts such as Fernald and Keller have claimed great success for a combined multi-sensory system in which visual, auditory, tactile, and kinaesthetic modes of learning were used. The current emphasis by beginning reading teachers on intensive training in phonetics, the combined multi-sensory stimulation practiced by modern speech therapists, and the influx of audio-visual materials, plus the interest in teaching machines all pointed to a renewed emphasis on multi-sensory presentation of stimuli for learning tasks.

This study was concerned with an investigation of four types of stimuli presentation for an associative learning task with average first-grade elementary school children. Which of the four methods of stimuli presentation: visual, visual and auditory, visual and vocalized, or visual and kinaesthetic was the most effective medium? Which method produced the most rapid rate of learning? With which method did first grade children make fewer errors?

Review of the Experimental Literature

Much material has been written about the influence of sense organs upon the rate of learning. As early as March, 1912, in The Psychological Review, V. A. C. Henmon reviewed experimental studies and the evidence for various modes of stimuli presentation. He cited twenty-three studies concerned with this problem of the most effective sensory method of stimuli presentation. After his

comprehensive review of the studies Henmon concluded: "This summary of available evidence bears out the statement that the results on the effects of the methods of presentation on learning and retention are not in accord."[1]

Studies which support the single sensory mode of presentation. As early as 1897, an article appeared by J. O. Quantz entitled Problems in the Psychology of Reading which discussed his work on visual and auditory memory-spans for words and notes. He stated: "the use of eye and ear together, the words being read aloud by the subject, is little advantage over either separately, when the words are read to him or silently by him."[2] He then implied that the combined presentation might be a hindrance.

J. Finzi, in 1900, presented letters, numbers, and nonsense syllables to subjects by visual means, auditory and articulatory combined, and articulatory alone. His results were that the visual method alone gave the most reliable results.[3]

Latin words and nonsense words were presented to school children by Kemsies in 1900. He used auditory, visual, and visual-auditory methods. He concluded that auditory presentation was superior in all cases. The combined method proved poorer than the visual or auditory presentations.[4]

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[1] V. A. C. Henmon, "The Relation between Mode of Presentation and Retention," The Psychological Review, XIX (1912), p. 84.

[2] J. O. Quantz, "Problems in the Psychology of Reading," Psychological Review Monographs Supplement No. 5, (December, 1897).

[3] Henmon, op. cit., p. 82.

[4] Ibid., p. 82.

E. Frankl in 1905 suggested that there was a type of imagery which was natural to the individual. His experiments comparing visual, visual-auditory-motor, auditory, and auditory-motor methods resulted in a statement that single presentation was better than combined presentation, also that visual presentation was better with visual types, and auditory presentation was better with auditory types.[5]

J. Segal brought more evidence to Frankl's conclusions in 1908. Neither Frankl nor Segal suggested to the reader how the natural imagery type should be determined.[6]

The auditory and visual-auditory modes of presentation were investigated by M. C. Schuyten. He used a series of eight two-place numbers with his subjects. He found auditory presentation to be superior to visual-auditory presentation.[7]

The literature in education and psychology of the last two decades records only one experimental study of the learning process with elementary school children using single sensory and bi-sensory stimuli presentation. In 1951, W. Lloyd Graunke reported results of an experimental study on the effect of visual-auditory presentation on memorization with children with impaired hearing. Graunke stated: "A common presumption is that learning is enhanced by simultaneous

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[5] Ibid., p. 83.

[6] Ibid.

[7] M. C. Schuyten, "Sur la validite de l'enseignement intuitif primaire.," Archives des Psychologie, V., (1906).

presentation of visual and auditory information. The experimental evidence on this point is scanty and contradictory."[8]

Graunke used six groups of children for his study; four groups from pupils in a school for the deaf and two groups of youngsters of comparable reading achievement with normal hearing. Two associative learning tasks were required of each child. Each child faced the memorization task twice, one for each condition of presentation.

> Each subject learned one series of ten-word pairs which was presented only by a memory drum and a second series of ten-word pairs which had spoken words reproduced electronically in a synchronization with the visual presentations. The number of trials required to achieve full mastery of the list was accepted as a measure of efficiency in learning the lists.

Graunke concluded that for condition and types of subjects in the investigation that: "visual memorization of word pairs is either more efficient or equivalent in efficiency to auditory-visual learning of these materials. Combined presentation of materials seemed to be inhibitory to most efficient learning." Graunke stated:

> Generally speaking learning tended to be faster when presentation of material to be learned was by vision alone. The only exception was for the group of normal hearing children who practiced with the visual-auditory presentation and here the advantage for the visual-auditory presentation was not statistically significant.[9]

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[8] W. Lloyd Graunke, Effect of Visual Auditory Presentation on Memorization by Children with Hearing Impairment, Evanston, Illinois, (June, 1959), p. 31.

[9] Ibid., p. 83.

Studies which support the multi-sensory mode of stimuli presentation. During the first decade of the twentieth century, Munsterberg and Bigham experimented with visual, auditory, and visual-auditory methods of stimuli presentation. They wrote:

> A series of presentations offered to two senses at the same time is much more easily reproduced than if given only to sight or only to hearing. There is a significant superiority in the combined method. When taken alone visual memory excels strongly the aural.[10]

Jonas Cohn tested the combined methods of visual, auditory, auditory and motor against the single presentation of each. His results subscribed to those of Munsterberg and Bigham.[11]

A. Von Sybel worked with nonsense syllables in 1909. He found that reading aloud, the visual-auditory-motor method, was better for learning in almost all cases than silent reading (visual). He wrote: "Visual-auditory presentation is almost without exception better for learning than the visual, but retention is better with visual presentation."[12]

Immediate memory for digits was tested on Chicago public school children by Smedley. He concluded that the auditory-visual method was better than either alone. He added the third factor, articulation. Visual-auditory-articulatory presentation was superior to the visual-auditory method.[13]

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[10] Henmon, op. cit., p. 80.

[11] Ibid., p. 82.

[12] Ibid., p. 83.

[13] Ibid., p. 82.

Pohlmann in an extensive investigation studied the effect of visual, auditory, visual-auditory, and visual-auditory-motor presentations of words, nonsense syllables, and numbers on school children from nine to fourteen years of age. He found:

> Auditory presentation is better than visual with significant material (words) but that visual presentation is better with nonsense material (numbers and syllables). The value of visual presentation for words increases with age and finally surpasses the auditory. The combined visual-auditory presentation shows on the average in all cases a slightly better result than with the auditory or the visual alone. The visual-auditory-motor presentation gives poorer results.[14]

Henmon designed a study to test the influence of visual, visual-auditory, and visual-auditory-motor (articulatory) presentations on retention. He used three sorts of material: concrete nouns, two place numbers, and nonsense syllables. One, two, and three repetitions were given. Six subjects, who were university students, were used. Henmon concluded that auditory presentation was superior to visual presentation in immediate memory of adults. This finding held for all materials. Bi-sensory (visual-auditory) presentation was slightly inferior to auditory stimulation, but decidedly superior to visual stimulation. Multi-sensory (visual-auditory-motor) presentation was slightly inferior to the auditory and the visual-auditory presentations. The three-sensory stimulation was superior to visual stimulation alone.[15]

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[14] Ibid., p. 83.

[15] Ibid., p. 94.

A current proponent of the multi-sensory mode of presentation is Grace Fernald. She cited reports on individuals and their learning experiences that supported her theory that the addition of the kinaesthetic stimulation to the visual or the auditory stimulation or to both exerted a positive effect on learning rate. However, it must be remembered that the work done by Fernald has been done with children whose learning process had been blocked or had broken down. According to Fernald, failure to learn might be due to "emotional instability, lack of visual and auditory perceptions, poor eye coordinations, failure to distinguish between similar stimuli, and inversions, confusion of symbols, and so forth." Fernald concluded:

> It seems that most cases of reading disability are due to blocking of the learning process by the use of limited, uniform methods of teaching. These methods, although they have been used successfully with the majority of children, make it impossible for certain children to learn because they interfere with the functioning of certain abilities that these children possess. At present one of the main blocks is the use of the extremely visual method of presentation with suppression of such motor adjustments as lip, throat, and hand movements.[16]

The Fernald method of presenting a word follows:

> The word is written for the child with crayola on paper in plain blackboard-size script, or in print, or manuscript writing is used. The child traces the word with finger contact, saying each part of the word as he traces it. He repeats this process as many times as necessary in order to write the word without looking at the copy.

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[16] Grace M. Fernald, Remedial Techniques in Basic School Subjects, (New York: McGraw Hill Book Co., Inc., 1943), p. 176.

In explaining points to be noted in connection with the process, Fernald adds:

> The individual must say part of the word either to himself or aloud as he traces it and as he writes it. It is necessary to establish the connection between the sound of the word and its form, so that the individual will eventually recognize the word from the visual stimulus alone. It is important that the vocalization of the word should be natural; that is, that it should be a repetition of the word as it actually sounds, and not a stilted, distorted sounding out of letters or syllables in such a way that the word is lost in the process.... It takes a little practice to get the connection established between the articulation of the word and the hand movements involved in tracing and writing it, but after a brief period the two activities occur simultaneously with no effort.[17]

The current interest in multi-sensory instructional materials was illustrated in the January, 1961 issue of The National Elementary Principal in which eight of the twelve featured articles dealt with sensory stimulation aids, visual-auditory programmed materials, and teaching machines. These articles supported the idea that multi-sensory stimulation improved learning processes.

Backus and Beasley in their textbook for speech therapists discussed at great length the processes of the individual in perceptual organization. They emphasized the associations made by the individual through stimuli received by the various sense organs. They quoted Russell Meyers, M. D.:

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[17]Ibid., p. 41.

> He points out that sensory, motor, associative functions are always inextricably bound up in responses of the organism, that what one sees or hears through sensory channels is always influenced by the motor patterns which have been developed.

They concluded their discussion: "Thus the process of perceptual organization is promoted by procedures which combine emphasis upon the sensory, motor, associative (evaluative) aspects of behavior."[18]

Some speech correctionists have regarded the perception of speech as a bi-sensory (auditory-visual) phenomenon. John J. O'Neill made an experimental study through which he attempted to analyze the visual components of oral symbols in the speech corrective processes. He concluded: "Even individuals with normal hearing made appreciable use of visual cues (lipreading) to gain information in some communication channels." He analyzed four types of material: vowels, consonants, phrases, and words under four experimental visual conditions and under four experimental non-visual conditions. His experiment supported his proposal that when the visual supplemented the auditory channel there was an increase in understandability of the vowels, consonants, words, and phrases that were transmitted.[19]

Of the studies examined only five used school children as subjects. Pohlmann's and Graunke's studies included the youngest

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[18] Ollie Backus and Jane Beasley, Speech Therapy with Children, (Chicago: Houghton Mifflin Co., 1951), p. 66.

[19] John J. O'Neill, "Contributions of the Visual Components of Oral Symbols to Speech Correction," Journal of Speech and Hearing Disorders, XIX, (December, 1954), pp. 429-439.

children (nine years of age). In many of the studies the number of subjects was too small to give a representative sampling. Kinds of materials used in the studies were: digits, syllables, nonsense syllables, nonsense words, and Latin words. The materials, except for the digits and syllables, were unfamiliar or meaningless materials. No conclusive evidence was gathered in the reviewed studies.

The lack of experimental evidence for supporting a preferred approach for stimuli presentation of learning materials for beginning elementary school children pointed up the appropriateness of an investigation of several modes of stimuli presentation for learning tasks. It seemed particularly important to make the study using familiar materials similar to those used in early reading assignments and in reading readiness exercises with first-grade children. Average children should be studied first as these children make up the majority of children in first-grade classrooms. It is possible that if fruitful results are obtained from the study, the information may be useful in selecting more effective educational procedures in presenting learning activities to young children.

CHAPTER II

STATEMENT OF THE PROBLEM

The purpose of this study was to investigate the differences, if any, in the learning rates and the number of errors made in reaching the criterion of learning of average first-grade elementary school children in an associative learning task with four different modes of stimuli presentation. The four variables of stimuli presentation were: (1) visual stimulation, (2) combined visual and auditory stimulation, (3) combined visual and vocalized stimulation, and (4) combined visual and kinaesthetic stimulation. In pulling out of the total learning situation a very narrow but important aspect of learning, associative learning, the purpose was to find out how first-grade children of average intelligence operated with these various modes of stimuli presentation. Was one method more effective than the other methods in requiring fewer number of trials for mastery of material? Was one method more efficient than the other methods resulting in fewer errors made by the subjects in reaching the criterion of learning?

In order to determine the differences, if any, in the

rates of learning and the number of errors made by the various methods, the following null hypotheses were tested:

1. There is no statistically significant difference in the number of trials required to meet the criterion of learning in a paired-associative learning task of average first-grade children who received stimuli presentation on the variables of visual stimulation, combined visual and auditory stimulation, combined visual and vocalized stimulation, and combined visual and kinaesthetic stimulation.

2. There is no statistically significant difference in the number of errors made in reaching the criterion of learning on a paired-associative learning task by average first-grade children who received stimuli presentation on the variables of visual stimulation, combined visual and auditory stimulation, combined visual and vocalized stimulation, and combined visual and kinaesthetic stimulation.

CHAPTER III

PROCEDURE OF THE STUDY

The Pilot Study

An associative learning task was chosen for the pilot study because associative learning is perhaps the most commonly used type of learning in the public schools. Early in their school experiences children learn that certain symbols go together to make a word. They learn to associate these printed symbols, or the verbalization of them, to the object to which the word refers. The entire reading process takes place by means of such association. Examples of associative learning experiences are: (1) associating the positions of musical notes on a staff with certain tones; (2) linking various historical events with specified periods of time; (3) paralleling the numerical and monetary systems; (4) learning that different configurations of the same chemical symbols denote various compounds; and (5) learning the geography of the New England states in connection with the colonial period of history.

The associative learning task for the pilot study was learning pairs of pictures which were paired together on five-inch

by eight-inch cards. The subjects were given these instructions:

> Here are a number of cards. Each card has two pictures on it. Look at both pictures on each card carefully. Then, I will show you a set of cards like this. (The Examiner shows the Subject a sample card with only the first picture of the pair on it.) You are to tell me what was the other picture on each of these cards.

A series of paired pictures was presented to the subjects at the rate of one every three seconds, then, the first picture of each pair was presented singly at the rate of one every five seconds. The longer time interval on the second series was to give the subject time to respond. The intertrial intervals were ten seconds in length. This procedure was continued until each subject correctly associated the first and second pictures of each of the twelve pairs.

A review of the literature on paired associative studies of verbal learning revealed that all studies but one used either paired nouns, paired adjectives, or nonsense syllables.[20] The writer rejected the idea of using printed words in the paired associative learning task because of these disadvantages: (1) subject variation in the amount of time needed to recognize words; (2) the variation in reading ability among school children; (3) certain words might arouse sufficient affect so that the learning process would be inhibited; and (4) the task might arouse negative feelings if the subject had had unpleasant experiences in reading. In addition,

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[20] B. S. Eisman, "Paired Associate Learning, Generalization, and Retention as a Function of Intelligence," American Journal of Mental Deficiency, LXII (1958), pp. 481-489.

many of the studies reviewed used words of one or more than one syllable in the same list. When more than one syllable was used, this might have presented a variable in the difficulty of learning lists.

For the present study, pictures rather than words were used for the paired-associative task in order to avoid the disadvantages that were just reviewed. In addition, certain other criteria were set up for the selection of the pictures. The criteria were: (1) the pictures must be simple, outline drawings of common objects; (2) the words represented by the pictures must be one-syllable nouns; (3) the pictures must be immediately recognizable; (4) the pictures must be readily and consistently identifiable; that is, if a picture of a horse was sometimes called "pony" and sometimes "horse," the picture was eliminated; and (5) pictures must not be obviously potentially affect arousing, for example, a picture of a gun or of a snake. In order to insure immediate recognition and consistent identification, the pictures were shown to groups of seventy-five kindergarten children and forty fourth-grade children. Pictures which did not meet the above criteria were eliminated.

An important part of the pilot study was the determination of the length of the test, that is, the number of pairs to be in a series. The length desired was the minimum number of pairs which would differentiate between various grade levels with respect to learning rate and retention. Lists of eight, twelve, sixteen, twenty, and twenty-four pairs were tested.

A list of twelve pairs was first given to groups of twelve first, twelve fourth, and twelve eighth graders. Using chi-square as the test of significance, the twelve-pair list was found to discriminate between the three groups with respect to learning rate and retention. The differences were significant at the .05 per cent level of confidence.

The list was then lengthened to sixteen, twenty, and twenty-four pairs in order to see what effect test length had on learning and retention. Forty subjects were tested with the sixteen-pair list, forty subjects with the twenty-pair list, and thirty subjects with the twenty-four-pair list. None of the three increased test lengths was found to be more discriminative than the twelve-pair list. An eight-pair list was then tried on thirty subjects to see if a shorter list would be as discriminative as the twelve-pair list. It was found not to be. Apparently, the task was so easy for all grade levels that it did not discriminate between them. Eisman used eight pairs and criticized her study in that her lists may not have been long enough to be discriminative.[21] The twelve-pair list proved to be of optimum length for easy administration and discriminability in the pilot study.

During the testing to determine test length, serial effects were noted in the learning curves of some groups. That is, the first and last pairs of the list tended to be learned first, with

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[21]Eisman, op. cit.

the middle pairs being learned last. This was evidence of the well-known phenomenon which takes place when items are learned serially. It was known that if the learning curves could be flattened so that the end-pairs of the lists were not learned more quickly than the middle pairs, the serial effects would be controlled and a random presentation of the lists would be unnecessary. Therefore, one hundred twelve students were then tested using various arrangements of the pairs until the learning curves became flat with certain arrangements. It was desired to keep the arrangement of the pairs constant, since certain random orders might be more difficult to learn than others; and an additional variable would then be introduced. A random presentation of pairs could not be kept constant from subject to subject since the subjects would vary with respect to the number of trials needed to reach the learning criterion.

The Subjects

The subjects used in this study were one hundred twenty boys and girls selected from the total enrolment of one hundred seventy-eight boys and girls in first grade classes in Lindsay, Oklahoma, Public Elementary School. Lindsay is a typical Oklahoma community made up of citizens whose income resources are: agriculture, business, petroleum production, and petroleum refinement.

The subjects ranged in chronological age from seventy months to eighty-three months. No child participated in the study who had been retained because of failure in school.

All subjects were considered by teachers as normal in regard to their sensory reception. None of the children used in the study were known to have visual disabilities, hearing impairments, or speech defects.

The Goodenough Draw-A-Man Test was administered by the writer to the total first-grade population for the purpose of obtaining intelligence quotient scores for each first-grade child. Seventy per cent of the first-grade children scored in the average range of intelligence (90 to 110 I.Q.). One hundred twenty of these children were used as subjects for this investigation.

The subjects were randomly divided into four equal groups of thirty each for the experimental tasks. Each child served as a subject in only one of the experimental groups.

All responses made by each subject were recorded. The number of trials required to meet the criterion of learning were totaled for each subject. Criterion of learning was defined as one correct repetition of the twelve-paired associates. The number of errors made by each child was recorded on his individual subject sheet.

The Test Instrument

Test materials consisted of two booklets. Each booklet contained sixteen five-inch by eight-inch cardboard cards bound together by a flexible plastic spiral band. Booklet One contained thirteen cards on each of which there was one pair of outline pictures and three blank cards serving as front, back, and blank page between sample card and stimuli cards. One pair served as a

sample card; the other twelve pairs were the stimuli cards. Booklet Two contained thirteen cards on each of which appeared the first picture of the stimulus pair. The first picture card served as a sample card for instructional purposes and the other twelve pictures as test cards. Three blank cards were included in this booklet, also.

The construction of the associative learning test, the selection of the pictures, and the arrangement of the pairs in the test series have been discussed under the preceding heading The Pilot Study. The criteria for selection of the pictures for the test series are again listed: The pictures were simple outline drawings of common objects; the words represented by the pictures were one-syllable nouns; the pictures were immediately recognizable; the pictures were consistently identifiable; and the pictures were not obviously potentially affect arousing.

The examiner was provided with individual record sheets for each subject on which appeared the name of the subject, the method of stimuli presentation used, the record of each response made by the subject, and the total number of trials for reaching the criterion of learning, also, the total number of errors made by the subject in reaching that criterion of mastery.

The examiner had a stop watch available as an aid in the timing of the presentation of the stimuli, the timing of the inter-trial period, and the timing of the response period.

The Procedure

Each subject was tested individually in a small, comfortable, quiet, well-ventilated, and well-lighted room adjacent to the principal's office. Each subject was brought by an office girl as directed to the experimental room. The Subject was asked to sit to the left of the Examiner at a right angle to the Examiner at the end of a small table.

The following instructions were given to each subject in Group I:

> Here are a number of cards. Each card has two pictures on it. Look at both pictures on each card carefully. (The Examiner shows the Subject Booklet Two then, and says:) Then I will show you another set of cards like these. (The Examiner shows the Subject the sample card with only the first picture of the stimulus pair.) You are to tell me what picture was with this first picture. What you are supposed to do is remember which two pictures go together. Now as you see the two pictures together try to remember what two pictures were together.

The twelve paired pictures were presented to each subject visually at the rate of one every three seconds. Then, Booklet Two was opened and the first picture of each pair was presented singly at the rate of one every five seconds. The Examiner recorded each oral response made by the Subject. A second trial was then given following the same procedure and additional trials until the Subject was able to make the twelve correct responses. Intertrial intervals were ten seconds in length. Between trials, the Examiner said:

> Now we shall look at the pictures again. Try to remember what two pictures were together.

If the Subject questioned the Examiner about the test, she added:

> We shall keep looking at the pairs of pictures until you remember all of them.

Each subject in Group II was given the same instructions except an additional sentence was added to the instructions. The Examiner said:

> Look at both pictures on each card carefully. (The following sentence was added.) As you look at the pictures, you will also hear me say the names of the pictures.

The same procedure was followed except for the addition of the auditory stimulus each time as the pair of pictures appeared.

Each subject in Group III was given the same instructions as those in Group I except for this modification.

> Look at both pictures on each card carefully. As you look at the pictures, say the name of the pictures aloud each time.

The same procedure was followed as used in Groups I and II except for the changed method of stimuli presentation; the combined visual and vocalization method was employed.

The following instructions were given to each subject in Group IV:

> (The Examiner opens the Booklet One to the sample card and says to the subject:) Here are a number of cards. Each card has two pictures on it. Look at both pictures on each card carefully. Then take your finger and trace around the outline of each picture and say aloud the names of the pictures as you trace them. (The Examiner takes the index finger of the Subject's right hand, unless he indicates that he writes with his left hand, and guides his finger around the outline of the first pair of pictures. If the Subject

> hesitates to trace, the Examiner guides his finger until he grasps the idea of tracing each picture.) (The Examiner shows the Subject the sample card in Booklet Two with only the first picture of the stimulus pair.) You are to tell me what picture was with the first picture. What you are supposed to do is remember which two pictures go together. Now as you see the two pictures together try to remember what two pictures were together.

The same procedure was followed except for the modification of the method; the visual and kinaesthetic method was used. The necessary number of trials was continued for each subject until he reached the criterion set for learning, one correct repetition of all twelve responses.

The Obtained Data

The following data were obtained for each of the one hundred twenty subjects participating in the study: name of child, chronological age, intelligence quotient, experimental method used, response to each test item, total number of trials required by subject for mastery, and total number of errors made by each subject in reaching the criterion of learning.

CHAPTER IV

THE RESULTS

Four groups of thirty first-grade children with intelligence quotients ranging from 90 I.Q. to 110 I.Q. participated in a paired-associative learing test, each group receiving a different method of stimuli presentation. The purpose of the investigation was to determine if there was a statistically significant difference between the four groups in the rate of learning; also, if there was a statistically significant difference between the four groups in the number of errors in reaching the criterion of learning. In this study the required level of statistical significance was set at .05.

The statistical technique chosen for treatment of the data was a nonparametric statistic, the Kruskal-Wallis One-Way Analysis of Variance. The scores obtained through the testing procedures on the four variables of stimuli presentation yielded for each of the one hundred twenty subjects: number of trials required to reach criterion of learning and number of errors made in reaching the criterion of learning. To apply the Kruskal-Wallis technique it was necessary to change all data: number of trials and number of errors to rank scores. The number of trials required by a subject to reach the criterion of learning was translated to a rank number for that subject, e.g., the

subject with the least number of trials was given rank one and the subject with the largest number of trials was given rank one hundred twenty. N equaled the total number of independent observations in the k (number of samples).

The first null hypothesis tested was that there is no statistically significant difference in the number of trials required to meet the criterion of learning in a paired-associative learning test of average first-grade children who received stimuli presentation on the variables of visual stimulation, combined visual and auditory stimulation, combined visual and vocalized stimulation, and combined visual and kinaesthetic stimulation. The paired-associative test was administered to the one hundred twenty subjects in the four groups.

Since four independent groups were under study, a test for k independent samples was required. Since the number of trials required for learning scores was considered to represent at least an ordinal measurement of the rate of learning of the subjects, the Kruskal-Wallis test was appropriate.

The formula for the Kruskal-Wallis One-Way Analysis of Variance follows:

$$H = \frac{\frac{12}{N(N+1)} \sum_{j}^{k} \frac{Rj^2}{nj} - 3(N+1)}{1 - \frac{\sum T}{N3 - N}}$$[22]

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[22] Sidney Siegel, Nonparametric Statistics for the Behavioral Sciences, (New York: McGraw Hill Book Co., Inc., 1956), p. 192.

TABLE 1

NUMBER OF TRIALS IN REACHING CRITERION OF LEARNING OF SUBJECTS IN FOUR GROUPS OF STIMULI PRESENTATION

Visual Stimulus Group	Visual-Auditory Stimulus Group	Visual-Vocalized Stimulus Group	Visual-Kinaesthetic Stimulus Group
5	3	4	6
8	9	14	6
4	9	6	5
3	7	9	4
5	13	5	6
6	13	14	6
5	12	8	5
8	14	4	15
6	9	4	6
6	10	8	13
7	12	4	14
10	12	7	5
8	6	11	9
4	7	13	4
5	6	5	5
12	9	4	5
9	6	13	10
9	7	15	6
15	4	4	10
10	6	3	5
6	8	8	5
6	7	5	8
9	6	8	9
10	5	9	10
8	8	3	10
10	4	3	13
8	6	8	6
8	6	4	4
8	6	6	13
8	7	9	12
226	237	218	239
M= 7.53	M=7.90	M=7.26	M=7.96

TABLE 2

TRIAL RANKS IN REACHING CRITERION OF LEARNING OF SUBJECTS IN FOUR GROUPS OF STIMULI PRESENTATION

Visual Stimulus Group	Visual-Auditory Stimulus Group	Visual-Vocalized Stimulus Group	Visual-Kinaesthetic Stimulus Group
27.0	3.0	12.5	45.5
71.5	85.5	115.5	45.5
12.5	85.5	45.5	27.0
3.0	60.0	85.5	12.5
27.0	110.0	27.0	45.5
45.5	110.0	115.5	45.5
27.0	104.0	71.5	27.0
71.5	115.5	12.5	119.0
45.5	85.5	12.5	45.5
45.5	96.0	71.5	110.0
60.0	104.0	12.5	115.5
96.0	104.0	60.0	27.0
71.5	45.5	101.0	85.5
12.5	60.0	110.0	12.5
27.0	45.5	27.0	27.0
104.0	85.5	12.5	27.0
85.5	45.5	110.0	96.0
85.5	60.0	119.0	45.5
119.0	12.5	12.5	96.0
96.0	45.5	3.0	27.0
45.5	71.5	71.5	27.0
45.5	60.0	27.0	71.5
85.5	45.5	71.5	85.5
96.0	27.0	85.5	96.0
71.5	71.5	3.0	96.0
96.0	12.5	3.0	110.0
71.5	45.5	71.5	45.5
71.5	45.5	12.5	12.5
71.5	45.5	45.5	110.0
71.5	60.0	85.5	104.0
1859.0	1937.5	1613.5	1840.0
R1	R2	R3	R4

TABLE 3

NUMBER OF ERRORS IN REACHING CRITERION OF LEARNING OF SUBJECTS IN FOUR GROUPS OF STIMULI PRESENTATION

Visual Stimulus Group	Visual-Auditory Stimulus Group	Visual-Vocalized Stimulus Group	Visual-Kinaesthetic Stimulus Group
18	12	13	24
28	38	80	25
13	67	24	28
9	23	22	13
12	72	17	16
20	56	47	33
11	85	30	23
18	79	13	102
26	77	15	28
30	56	29	91
30	89	18	96
40	54	24	10
30	22	25	60
22	32	62	14
13	25	17	29
55	45	16	14
87	23	54	61
46	33	108	29
47	18	15	62
57	26	12	32
20	30	25	27
22	30	14	40
42	32	36	66
53	17	50	82
46	50	7	76
46	17	4	80
35	26	19	37
35	23	17	18
36	20	24	117
46	19	48	102
993	1196	895	1435
M=33.1	M=39.9	M=29.8	M=47.8

TABLE 4

ERROR RANKS IN REACHING CRITERION OF LEARNING OF SUBJECTS IN FOUR GROUPS OF STIMULI PRESENTATION

Visual Stimulus Group	Visual-Auditory Stimulus Group	Visual-Vocalized Stimulus Group	Visual-Kinaesthetic Stimulus Group
29.0	8.0	12.0	45.5
56.0	78.0	109.5	49.0
12.0	104.0	45.5	56.0
3.0	41.5	37.5	12.0
8.0	105.0	24.0	20.5
34.5	97.0	88.5	70.5
6.0	112.0	63.5	41.5
29.0	108.0	12.0	117.5
52.0	107.0	18.5	56.0
63.5	97.0	59.0	115.0
63.5	114.0	29.0	116.0
79.5	94.5	45.5	4.5
63.5	37.5	73.0	100.0
37.5	68.0	102.5	16.0
12.0	49.0	24.0	59.0
96.0	82.0	20.5	16.0
113.0	41.5	94.5	101.0
85.0	70.5	119.0	59.0
99.0	29.0	18.5	102.5
88.5	52.0	8.0	68.0
34.5	63.5	49.0	54.0
37.5	63.5	16.0	79.5
81.0	68.0	75.5	97.0
93.0	24.0	91.5	111.0
85.0	91.5	2.0	106.0
85.0	24.0	1.0	109.5
73.0	52.0	32.5	77.0
73.0	41.5	24.0	29.0
75.5	34.5	45.5	120.0
85.0	32.5	90.0	117.5
1753.0	1990.5	1431.5	2126.0
R1	R2	R3	R4

H is distributed approximately as chi square with degrees of freedom equaling k-1. N = 120, the total number of subjects. n_1 = 30, the number of first-grade subjects who received visual stimuli. n_2 = 30, the number of first-grade subjects who received visual-auditory stimuli. n_3 = 30, the number of first-grade subjects who received the visual stimuli and vocalized the stimuli. n_4 = 30, the number of first-grade students who received the combined visual-kinaesthetic stimuli.

The significance level chosen was .05. Thus, the probability associated with the occurrence under H_o of values as large as an observed H is determined by reference to the Table of Critical Values of Chi Square.[23]

Table 1 shows the number of trials required by each of the subjects in reaching the criterion of learning. Ranks assigned to these scores are shown in Table 2. The one hundred twenty scores were ranked in a single series as is required by this particular statistical test. The least number of trials required by a subject in reaching the criterion of learning was three, and that subject was given the rank of three. Ordinarily, the subject in question would receive the rank of one, but since there were five subjects who tied in requiring the same least number of trials, the average rank for the five subjects is the rank assigned to all five of their scores. The largest number of trials required for reaching the criterion of learning was fifteen. Again, there were three tied scores of fifteen;

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[23] Ibid., p. 249.

therefore, three subjects were assigned the average rank of one hundred nineteen.

With the data in Table 2, the value of H was computed:

$$H = \frac{\frac{12}{120\ (121)}\ (115{,}196.03 \quad 125{,}130.20 \quad 86{,}779.40 \quad 112{,}853.33) - 3(121)}{1 - \frac{2832}{1{,}727{,}880}}$$

$H = .53$

$df = 3$

$p\ .05 = 7.82$

Reference to the Table of Critical Values of Chi Square indicates that an H value of .53 with three degrees of freedom has the probability of occurrence under H_o of $p < .05$. Since the probability is smaller than the previously set level of significance $a = .05$, the null hypothesis is accepted. There is no statistically significant difference in the number of trials required to meet the criterion of learning in a paired-associative learning test given to average first-grade children who received stimuli presentations on four variables: visual stimuli, visual-auditory stimuli, visual-vocalized stimuli, and visual-kinaesthetic stimuli.

Data for testing the second hypothesis, which compared the error ranks of one hundred twenty first-grade children on the four variables of stimuli presentation are given in Table 3 and Table 4.

The value of H was computed:

$$H = \frac{\frac{12}{120\ (121)}\left(\frac{102,433.63}{68,306.40} + \frac{1,320,696.75}{150,662.53}\right) - 3\ (121)}{1 - \frac{246}{1,727,880}}$$

$$H = 950.78$$
$$df = 3$$
$$p \text{ at } .05 = 7.82$$

Reference to the statistical table giving the Critical Values of Chi Square indicates that an H of 950.78 with three degrees of freedom has the probability of occurrence under H_0 of $p > .05$. Since this probability is greater than the previously set level of significance, the decision is to reject H_0, the null hypothesis. There is a statistically significant difference in the number of errors made in reaching the criterion of learning on a paired-associative learning test given to average first-grade children who received stimuli presentations on four variables: visual stimuli, visual-auditory stimuli, visual-vocalized stimuli, and visual-kinaesthetic stimuli.

The rejection of the second null hypothesis necessitates further analysis of the data. The following null sub-hypotheses are proposed:

1. There is no statistically significant difference in the number of errors made in reaching the criterion of learning on a paired-associative learning task by average first grade children who received stimuli presentation on the variables of visual stimulation and combined visual and auditory stimulation.

2. There is no statistically significant difference in the number of errors made in reaching the criterion of learning on a paired-associative learning task by average first-grade children

who received stimuli presentation on the variables of visual stimulation and combined visual and vocalized stimulation.

3. There is no statistically significant difference in the number of errors made in reaching the criterion of learning on a paired-associative learning task by average first-grade children who received stimuli presentation on the variables of visual stimulation and combined visual and kinaesthetic stimulation.

4. There is no statistically significant difference in the number of errors made in reaching the criterion of learning on a paired-associative learning task by average first-grade children who received stimuli presentation on the variables of combined visual and auditory stimulation and combined visual and vocalized stimulation.

5. There is no statistically significant difference in the number of errors made in reaching the criterion of learning on a paired-associative learning task by average first-grade children who received stimuli presentation on the variables of combined visual and auditory stimulation and combined visual and kinaesthetic stimulation.

6. There is no statistically significant difference in the number of errors made in reaching the criterion of learning on a paired-associative learning task by average first-grade children who received stimuli presentation on the variables of combined visual and vocalized stimulation and combined visual and kinaesthetic stimulation.

The nonparametric statistical test, the Mann-Whitney U Test was chosen for testing the six proposed null hypotheses. The formula

for the Mann-Whitney U Test follows:

$$U = n_1 n_2 + \frac{n_1 (n_1 + 1)}{2} - R_1$$

$$z = \frac{U - \frac{n_1 n_2}{2}}{\sqrt{\frac{n_1 n_2}{N (N - 1)} \frac{N^3 - N}{12} - \Sigma T}}$$

TABLE 5

COMPARISON OF VISUAL STIMULUS SUBJECTS AND VISUAL-AUDITORY STIMULUS SUBJECTS ON ERRORS

Group	N	Total Errors	M	Total Ranks	z value	p
Visual	30	993	33.1	853.5	.91	.1814
Visual-Auditory	30	1196	39.9	980.5		

The data in Table 5 produced a z value of .91 with a probability of .1814. Using the previously set criterion of significance of .05, the z value is smaller than an .05 value; therefore, the null hypothesis is sustained. There is no statistically significant difference in the number of errors made in reaching the criterion of learning on the variables of visual stimulation and combined visual and auditory stimulation.

A z value of 1.34 with a probability of .0901 was obtained from the data in Table 6. The z value is smaller than the value which is necessary to meet the criterion of the .05 level of significance. The second null sub-hypothesis is sustained. There is no statistically significant difference in the number of errors made in reaching the

criterion of learning on the variables of visual stimulation and combined visual and vocalized stimulation.

TABLE 6

COMPARISON OF VISUAL STIMULUS SUBJECTS AND VISUAL-VOCALIZED STIMULUS SUBJECTS ON ERRORS

Group	N	Total Errors	M	Total Ranks	z value	p
Visual	30	993	33.1	1006.0	1.34	.0901
Visual-Vocalized	30	895	29.8	827.5		

TABLE 7

COMPARISON OF VISUAL STIMULUS SUBJECTS AND VISUAL-KINAESTHETIC STIMULUS SUBJECTS ON ERRORS

Group	N	Total Errors	M	Total Ranks	z value	p
Visual	30	993	33.1	819.5	1.41	.0793
Visual-Kinaesthetic	30	1435	47.8	1010.5		

Comparison of the visual stimuli group with the visual and kinaesthetic stimuli group as shown in Table 7, yielded a z value of 1.41 with a probability of .07. The z value is smaller than the value required for the .05 level of significance; therefore, the third null sub-hypothesis is sustained. There is no statistically significant difference in the number of errors made in reaching the criterion of learning on the variables of visual stimulation and combined visual and kinaesthetic stimulation.

TABLE 8

COMPARISON OF VISUAL-AUDITORY STIMULUS SUBJECTS AND VISUAL-VOCALIZED STIMULUS SUBJECTS ON ERRORS

Group	N	Total Errors	M	Total Ranks	z value	p
Visual-Auditory	30	1196	39.9	1078.8	2.41	.0080
Visual-Vocalized	30	895	29.8	752		

Table 8 shows a z value of 2.41 with a probability of .008. This value is larger than the value required for the .05 level of significance; therefore, the fourth null sub-hypothesis is rejected. There is a statistically significant difference in the number of errors made in reaching the criterion of learning on the variables of combined visual and auditory stimulation and combined visual and vocalized stimulation. The visual-vocalized method of stimuli presentation produced fewer errors.

TABLE 9

COMPARISON OF VISUAL-AUDITORY STIMULUS SUBJECTS AND VISUAL-KINAESTHETIC STIMULUS SUBJECTS ON ERRORS

Group	N	Total Errors	M	Total Ranks	z value	p
Visual-Auditory	30	1196	39.9	864.0	.75	.2266
Visual-Kinaesthetic	30	1435	47.8	965.0		

A z value of .75 was obtained from data given in Table 9. The z value is smaller than the value required for the .05 criterion;

therefore, the fifth null sub-hypothesis is accepted. There is no statistically significant difference in the number of errors made in reaching the criterion of learning on the variables of combined visual and auditory stimulation and combined visual and kinaesthetic stimulation.

TABLE 10

COMPARISON OF VISUAL-VOCALIZED STIMULUS SUBJECTS AND VISUAL-KINAESTHETIC STIMULUS SUBJECTS ON ERRORS

Group	N	Total Errors	M	Total Ranks	z value	p
Visual-Vocalized	30	895	29.8	744.0	2.53	.0057
Visual-Kinaesthetic	30	1435	47.8	1085.0		

The data in Table 10 produced a z value of 2.53 with a probability of .0057. This value is greater than the value required for the .05 level of significance. Therefore, the sixth null sub-hypothesis is rejected. There is a statistically significant difference in the number of errors made in reaching the criterion of learning on the variables of combined visual and vocalized stimulation and combined visual and kinaesthetic stimulation. The visual-vocalized method produced fewer errors.

Summary of Results

In summary, there was no statistically significant difference in the number of trials required to meet the criterion of learning by the subjects on the four stimuli variables. A statistically significant

difference was found in the number of errors made in reaching the criterion of learning by the subjects on the four stimuli variables. Further analysis showed that a statistically significant difference was found in the number of errors made by the subjects who received the combined visual and auditory stimulation and the subjects who received the combined visual and vocalized stimulation. Also, a statistically significant difference was found in the number of errors made by the subjects who received the combined visual and vocalized stimulation and the subjects who received the combined visual and kinaesthetic stimulation. In both instances the visual-vocalized method proved to be more effective than either the visual-auditory method or the visual-kinaesthetic method. A smaller number of errors resulted when the visual-vocalized method was used. Other comparisons of the various independent samples yielded no significant differences.

CHAPTER V

CONCLUSIONS AND SUMMARY

Varied approaches have been employed by educators in presenting learning materials. Some have favored single sensory stimulation, while others have recommended multi-sensory stimulation. The literature on this subject which was reviewed in Chapter One presented no conclusive evidence as to which approach was more effective in the presentation of materials for learning--single sensory or multi-sensory stimulation. Quantz concluded that eye and ear together had little advantage over either separately. Finzi pointed out that visual stimulation alone was superior to articulatory stimulation or combined auditory and articulatory stimulation. Kemsies' results sustained the single auditory approach. Schuyten, likewise, concluded that auditory presentation was superior to visual and auditory. Graunke's recent study showed that the visual approach was equal to or superior to the combined visual-auditory presentation. The multi-sensory approach was supported by studies made by Munsterberg and Bigham, Cohn, A. Von Sybel, Smedley, Pohlmann, Henmon, Backus and Beasley, and O'Neill. Fernald proposed the

combined approach including the kinaesthetic factor and gave many case studies to support her theory.[24]

This study was instigated primarily to investigate the differences, if any, in the rate of learning and in the number of errors made in reaching the criterion of learning by average first-grade children on four variables of stimuli presentation: visual, visual-auditory, visual-vocalized, and visual-kinaesthetic. Also, it was hoped that further knowledge might be gained in determining which of the methods compared was more effective in the facilitation of learning.

The subjects of this study were one hundred twenty boys and girls between the ages of seventy and eighty-three months, who had intelligence quotient scores between 90 and 110 on the Goodenough Draw-A-Man Test, and who were enroled in the first-grade classes of the Lindsay, Oklahoma Public Schools.

Each subject participated in one of the four experimental groups. He was given the twelve-pair associative learning task by one of the stimuli presentation methods until he reached the criterion of learning which was one correct repetition of the twelve-paired associates. The number of trials necessary to reach criterion and the number of errors made were recorded for each subject.

Results of the study sustained the first hypothesis: There is no statistically significant difference in the number of trials required to meet the criterion of learning in a paired-associative

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[24]Supra, Chap. I, 3 - 10.

learning task of average first-grade children who received stimuli presentation on the variables of visual stimulation, combined visual and auditory stimulation, combined visual and vocalized stimulation, and combined visual and kinaesthetic stimulation.

The second hypothesis was rejected. A significant difference was found in the number of errors made in reaching the criterion of learning on a paired-associative learning task by average first-grade children who received stimuli presentation on the variables of visual stimulation, combined visual and auditory stimulation, combined visual and vocalized stimulation, and combined visual and kinaesthetic stimulation.

In order to make further analysis of the data on errors, six null sub-hypotheses were proposed stating that there was no significant difference in the number of errors made in any of two independent samples, six comparisons being possible.

The results showed that no significant difference was found in the number of errors made between the following groups: visual and visual-auditory, visual and visual-vocalized, visual and visual-kinaesthetic, visual-auditory and visual-kinaesthetic. A significant difference in the number of errors made was found between these two sets of groups: visual-auditory and visual-vocalized, visual-vocalized and visual-kinaesthetic.

What are some of the implications of these findings?

1. The selection of one particular method of stimuli presentation over the others does not enhance learning. Any one of the four methods proves to be equally effective.

2. There is a difference in the number of errors made by the subjects in reaching the criterion of learning on the four variables of stimuli presentation.

3. A statistically significant difference is found in the number of errors made between the visual-auditory stimulus group and the visual-vocalized stimulus group.

4. A statistically significant difference is found in the number of errors made between the visual-vocalized stimulus group and the visual-kinaesthetic stimulus group.

The evidence in this study does not point to a preferred method of stimuli presentation as far as number of trials required for learning. Any one of the four methods seem to be equally effective in this respect. Graunke pointed out that the evidence of his study was scanty and contradictory; however, he concluded that the visual method of presentation was equal to or superior to the combined visual and auditory presentation of stimuli. Quantz's findings were likewise inconclusive. The results of Finzi's study showed preference for visual stimuli presentation as compared with auditory and articulatory stimulation or articulatory stimulation alone. The studies of Kemsies and Schuyten both pointed to the superiority of auditory presentation over visual presentation or visual-auditory presentation.

The findings of this investigation do not support the superiority of multi-sensory stimulation over single sensory stimulation. Therefore, they contradict the results of studies made by Cohn, Munsterberg and Bigham, A. Von Sybel, Smedley, Pohlmann, and Henmon.

The last three researchers named gave preference to the visual-auditory method of stimuli presentation.

The errors made by the subjects in reaching criterion of learning were not recorded or discussed in any of the studies reviewed. Therefore, it is impossible to relate the information found about errors in this study to earlier studies. The author feels that, in this respect, earlier studies were weak because consideration of errors is an important factor in the problem of learning.

As we consider these findings, it may be important to recognize that the data was gathered during the first five weeks of the school term.

The subjects, who were first-graders, were engaged at the time of testing in reading readiness work. Also, results may have been influenced by the fact that some of the children in first grade had had kindergarten training. In most kindergartens, considerable time is given to reading readiness experiences which facilitate visual and auditory discrimination.

As the author observed the first-graders functioning on the paired-associative learning task, it seemed that the vocalization of the stimulus required the subject to give greater attention to the stimulus. Perhaps integration in the perceptual processes are facilitated when the subject vocalizes the stimulus.

The addition of the kinaesthetic process, that of tracing the outline of the picture, required more time for the subject on each

stimulus pair. The author believes that fatigue occurred in many instances. The repeated trials with the multiple stimuli presentation seemed to produce fatigue. It was most interesting to the examiner that although the largest average number of errors was made by the visual-kinaesthetic group, there was a wide margin between the average number of errors made by the visual-kinaesthetic group and the visual-auditory group; whereas, the average number of trials made by the visual-kinaesthetic group and the visual-auditory group differed by only a slight margin of .06 of one point. It may be that the addition of stimulus clues, when the material to be learned is simple and clear-cut, is a retarding rather than an enhancing factor in the learning process. Likewise, where material to be learned is more complex, additional clues may facilitate the learning process.

Further research might prove fruitful with a repeat of the study as designed herein with average first-grade children in their eighth or ninth month of school experience. Also, more study should be done with children of average intelligence using the kinaesthetic method. The research reported has dealt largely with the use of the kinaesthetic method where the learning process of the children had broken down.

In conclusion, the finding in this study supports the earlier literature that there is no conclusive evidence that either the single sensory stimuli presentation or the multi-sensory stimuli presentation is a preferred approach. The results of this study give evidence that there is a statistically significant difference in the

number of errors made between the visual-auditory and visual-vocalized and visual-kinaesthetic methods. Results would support our present method of reading instruction: a basic sight reading program for first-graders with much of the initial work in reading instruction utilizing the visual vocalized method or oral reading emphasis.

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APPENDIX

INDIVIDUAL RECORD SHEET

Name _____ Age _____

I. Q. _____ Teacher _____

Pairs		Number of Trials																				
Stimulus	Response	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
bread	(clock)																						
tree	(shoe)																						
kite	(fish)																						
coat	(sun)																						
duck	(saw)																						
bird	(lamp)																						
hat	(cup)																						
comb	(drum)																						
leaf	(house)																						
chair	(dress)																						
box	(pig)																						
car	(fork)																						