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A Preliminary Study in Programming Reading for the Mentally Retarded Learner

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Teaching reading to the mentally retarded assumes a major portion of an institution's educational facilities and personnel. The considerable amount of time and effort that are devoted to this one aspect of the child's training reflect the vital character that reading instruction has for his occupational and psychological adjustment. Any increase in our knowledge of the factors and methods that play a role in the teaching process is desirable and much needed.

Recent developments in psychology suggest some new approaches toward increasing efficiency in the educational procedures used in training the mentally retarded learner (2, 3, 4, 5, 6). These developments center around a number of concepts and methods which have evolved in the field of automated teaching. Briefly, automated teaching refers to a philosophy or theory of teaching and to the various instrumentalities in attaining certain stated goals. Essentially, automated teaching methods embody a number of principles which are quite compatible with the general educational procedures and aims currently in use. Perhaps the major differences between the more conventional methods and automated techniques lie primarily in the preparation of the material to be learned, in the methods of presenting that material to the student, and the specific role of the learner in the training process. Among the several working ideas associated with automated teaching are: 1) the preparation and presentation

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of text materials in discrete programmed steps, 2) the subdivision of course material into ordered progressive units, 3) the active participation of the learner during all phases of the training sequence, and 4) the immediate knowledge of results for the learner for all units of work. In essence the chief goal of this general approach is ". . . an ordered controlled and measurable progression in the learning proficiency and development of the individual student." (1)

The research to be reported grows out of such a philosophy and from the feeling that the principles of automated teaching can be applied with success to the educational procedures utilized with the mentally retarded. The emphasis in this investigation has not been in the design or implementation of certain technical procedures; instead, interest and effort have been focused on what is considered the more immediate problem, viz. that of analyzing reading in order that eventually this subject matter can be programmed and incorporated into some kind of mechanical device—that is, a teaching machine. The aim has been to develop a body of basic information about reading from which can be derived principles of programming and application of student operated teaching devices.

Subjects: The Subjects that were used in the two experiments to be reported were drawn from the general population residing at the Ft. Wayne State School for the Mentally Retarded at Ft. Wayne, Indiana. Some attempt was made to use individuals who were similar on a number of variables: a) *reading achievement level*—no child was included in the studies whose performance on the WRAT (Wide Range Achievement Test) was above the reading level of 2.0, b) *mental age*—only those children whose scores on a recent administration of the Stanford-Binet (Form L) were within ages 3 to 7, c) *chronological age*—no child above the age of 20 was tested; and d) *clinical classification*—only children who were diagnosed as Familial were used.

Apparatus: Two pieces of equipment of a non-automated nature were used in the testing sessions. Both pieces were designed to be operated by the Experimenter and to function as relatively simple discrimination devices. The apparatuses contained a slot in which the Experimenter could place the visual text material, simple door-type bell buttons which could be pressed when making a response, and red lights which serve as simple reinforcers or rewarding stimuli whenever the learner made the correct response. The Subject was

seated in front of a vertical panel; the Experimenter was situated on the other side of this panel controlling the presentation of the material and activating the reinforcers by manipulating a series of mercury switches. The pieces of equipment will be described separately and in some detail since each was designed to be used under different experimental conditions of training.

Apparatus A: The vertical panel contains four 2½ inch square windows with one window centered above a row of three identical windows. It is through these openings that the subject sees the words and/or pictures. Directly below each of the lower windows there is a 7-watt red colored frosted light bulb set flush in the upright panel.

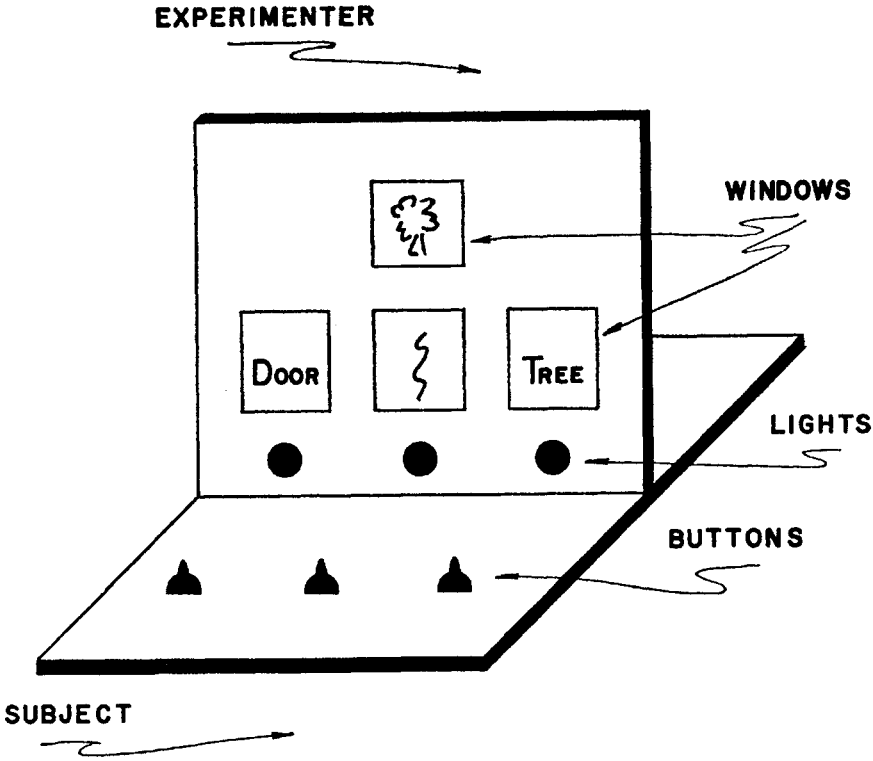

FIGURE I APPARATUS A

These lights are considered red as indicators of appropriate responses and serve as reinforcers. Each light bulb is associated with the window directly above it. The three bell buttons which function as response indicators are set in a line directly below the lights and windows. These controls are imbedded in a smaller horizontal platform. The Experimenter sitting on the opposite side of the partition acts as a human programmer, continually feeding into the apparatus cards containing the material to be learned, controlling which of the lights is to be activated for any particular matching, and recording the errors in the learner's performance.

Apparatus B: This apparatus is a modified version of Apparatus A. It is exceedingly simple in design and operation. As can be

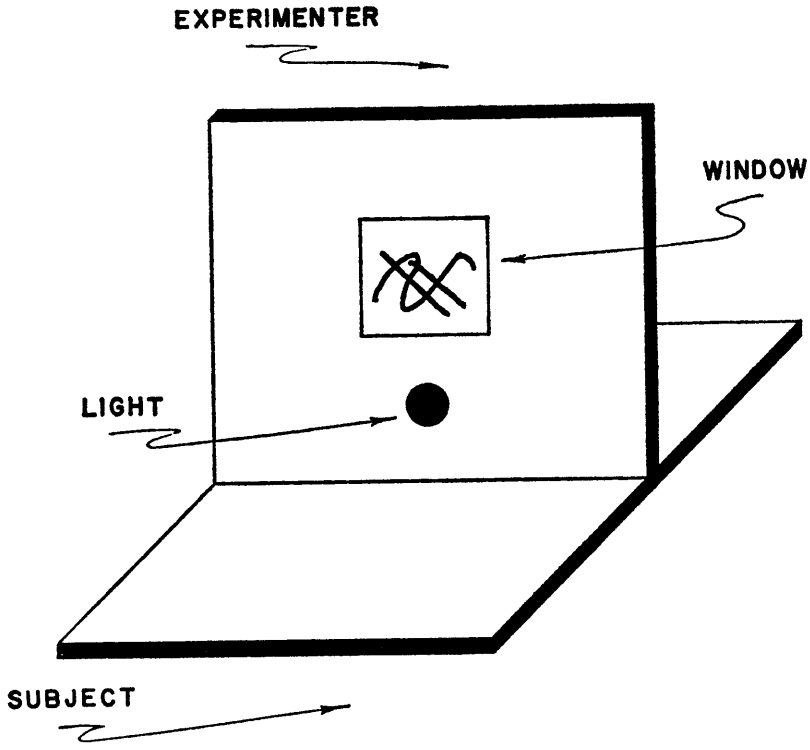

FIGURE 2 APPARATUS B

seen, there is only one window and one light bulb and no response buttons. These design changes were necessary in order to satisfy the requirements established for two of the five conditions of training. As in Apparatus A, there is a vertical panel separating the subject and experimenter. The experimenter manipulates the text material and controls the reinforcing light, while the subject sits before the single opening studying the material. The response in this case is not made by pushing a button but by saying what the stimulus pattern is. If the subject correctly identifies the picture or word, the experimenter flashes the red light.

Program Materials: The program material consisted of a list of 9 relatively simple words and a series of 9 pictures corresponding to the words. The words drawn from Dolch's Basic Reading list of 220 commonest words were as follows: *tree, basket, bell, apple, house, train, door, boat, window.* Selection of the words was made on the basis of a number of criteria: 1) relative length of word—each word contained from 3 to 7 letters, 2) words that could be easily pictured, and 3) words that represented simple object nouns. The corresponding pictures were traced off selected Dolch Picture-Cards and consisted of simple line drawings. The words and pictures were printed and sketched on 2½ inch squares of white paper; these then were pasted on individual 7 x 9 inch cardboard plates which when inserted into the apparatus by the teacher would center a visual pattern in each window.

The nine words and nine pictures were variously combined depending upon the specific conditions of training, e.g. the cards might contain all words, all pictures, or some combination of words and pictures. In any case only 9 cards were used within any one set of conditions.

Procedures: It is assumed that learning to read involves the interplay of sensori-motor and conceptual skills. Any test situation examining the reading process would require that these variables be incorporated into the test design. Furthermore, it is recognized that the method of teaching reading will vary from teacher to teacher and that teachers will differ in how they might begin the reading instruction. For example, with respect to the matching procedures undertaken to establish basic associations, one teacher might have the child match a picture with another picture; another teacher might begin by having the learner match a printed word with other printed words, while

a third teacher might put initial stress upon matching words and pictures. Not only is there variation between teachers but also variation within a teacher's use of these approaches. Differences also crop up in the ways teachers have their learner make responses to basic matching tasks. Sometimes the learner simply points to the appropriate stimulus pattern, other times he may be required to verbally identify the picture or word. Thus we see that the approaches vary and perhaps each in its own way contributes to the reading process and is useful as a means of introducing the mentally retarded learner to the first steps of reading instruction. The fundamental problem, therefore, was to determine whether or not there existed different degrees of effectiveness among these several methods. Consequently, the material was presented in three forms; verbal (the words were spoken by the experimenter), graphic (pictures were presented *in* simple line drawings), and printed (the words were single line capitals). Likewise, the manner of response varied in two ways: verbal reproduction of the appropriate stimulus, and pressing a button.

In order to ascertain whether or not one program was more efficient than some other arrangement, five conditions of training were compared. Each condition used the same materials but in a different relationship. The groups were given alphabetical designations, and represent the basic matching tasks. Table 1 summarizes the groups' characteristics.

TABLE 1

Description of five conditions of training in terms of form of presentation and manner of response.

Condition	Form of Stimulus Presentation		Learner's Response
	standard stimulus	matching stimuli	
A	Picture	Printed Words	Press Button
B	Printed Word	Pictures	Press Button
C	Spoken Word	Printed Words	Press Button
D	Picture	None	Verbal Reprod.
E	Printed Word	None	Verbal Reprod.

Condition A: The training conditions required the subject to match pictures and words, e.g. a picture of a tree would be presented in the top window of Apparatus A while three printed words would be exposed in the lower windows. One of the words would spell Tree. The learner must match the two stimuli and indicate this match by pressing the appropriate bell button located beneath the window that contains the word Tree.

Condition B: This condition involves the same general procedure only now the matching task is reversed, that is, the learner now has to match one of three pictures to a printed word. As in Condition A, the response is made by pressing a button.

Condition C: Again we have the same basic design with the one change; instead of all of the material being visually presented to the learner, the teacher pronounces the standard word twice; the learner has to match the spoken word with one of three printed words that are exposed to him in the row of windows. As in Conditions A and B, the learner indicates his response by pressing the bell button corresponding to the correct word.

Condition D: Using Apparatus B, this group involves a different set of training procedures. In this part of the study the learner is shown a single picture, e.g. a picture of a Tree, to which he must respond by verbally identifying it for the experimenter. He is then given each of the remaining pictures in a random order.

Condition E: Also using Apparatus B, this program utilizes printed words as stimuli. The subject perceives each word and then makes the verbal response. The pronunciation must be essentially correct in order for the experimenter to flash the light thus rewarding the learner's behavior. This activity is reading—at least in its simplest form.

With these five training programs as the basic design, two experiments were conducted. Although the procedures varied somewhat from condition to condition, the same words and pictures were used; the combinations were simply altered whenever the condition warranted it. In both studies, the major concern was to determine whether or not there existed a ranking among the five conditions in terms of learning difficulty.

Experiment I: Thirty-nine children were used, each randomly assigned to one of the five training conditions. No individual was tested on more than one group to which he was initially assigned. Prior to the actual testing, the subject was read a set of instructions that were designed to acquaint him with the "game" and to put him at ease. The experimenter then proceeded to present the cards in random order until 45 successive exposures were given, that is, each of the nine cards was presented five times for a total of 45 separate matchings. More precisely, the procedure was as follows: the learner was shown a card containing the four stimuli, e.g. a picture of a Tree to be matched to the printed word—Tree. He is then given time to study the material and is free to press any one or all of the buttons. If he chooses the correct word, a red light is immediately flashed indicating that this response is correct; if, however, his match is incorrect, no light is flashed and the learner must then continue pressing buttons until he hits upon the correct match. This is called a correction procedure. The "trial" is terminated when the entire 45 card presentations have been made. One trial per day was administered to each learner with the testing continuing until either the criterion of one perfect trial was shown or when 30 days of testing was completed—whichever came first. Whereas in Conditions A, B, and C the learner responded by pressing buttons and was somewhat limited in the number of incorrect responses he could make, Conditions D and E limited the learner to three verbal responses. If after the third attempt the learner was unable to say the appropriate word, the experimenter proceeded to the next card. Learning under all conditions was measured in two ways: a) the average number of errors made in reaching the criterion, and b) the average number of trials to attain the criterion of one errorless trial.

Experiment II: A second group of learners was tested under a modified procedure. This group consisted of five children all of whom were given the five training conditions but each learner received them in a different sequence. In all other respects, the proceedings were identical to those already described for Experiment 1.

TABLE 2

Rank order analysis of five training conditions. Ranking is in the direction of hardest to easiest learning.

Experiment I		Experiment II	
Mean Errors	Mean Trials	Mean Errors	Mean Trials
E	B	E	E
B	E	B	B
A	A	A	A
C	C	C	C
D	D	D	D

Results: In view of the fact that the results of the two experiments turned out to be so similar, it will be sufficient to present them in a single discussion. Both experiments were analyzed in terms of the average number of errors to the learning criterion and the mean number of trials to criterion. The data are presented in simple rank order analysis, for it is felt that a rank order of the five training conditions does reflect somewhat upon the main task of the research, *viz.* when comparing the several methods does a hierarch exist? Table 2 summarizes the results for both experiments. It is demonstrated rather clearly that there does exist some ranking among the different conditions as measured by the two criteria of learning. The consistency with which each training condition holds its relative position in the two studies is of interest. With the exception of only one reversal-between Conditions B and E in Experiment I, the rankings are identical. Task D is the easiest matching to master. Task E (with the one exception already mentioned) is the most difficult. These findings are also illustrated in bar diagram form in figure 3. The mean performance measures are indicated on top of each bar.

It is to be pointed out that not all of the original learners in Experiment I attained the criterion. Of the original group of 39 individuals, 21 reached the criterion, 11 failed to within the prescribed 30 days and therefore were not included in the analysis of results, and 7 persons had to be dropped from the testing because of illness, lack of understanding of the task, etc. If some conditions of training

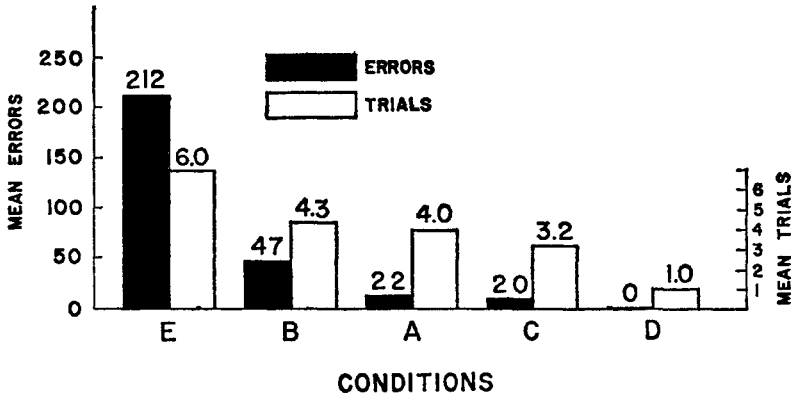

FIGURE 3 MEAN PERFORMANCES OF 5 TRAINING CONDITIONS IN EXPERIMENT 2

were inherently more difficult than others, this fact would show up in the number of persons attaining the criterion for each condition. We might expect fewest learners mastering Condition E and the largest number learning Condition D. The results do not give too clear a picture of this one question, although there is some measure of inter-condition variation in terms of the number of learners reaching the criterion. Three persons learned Condition A, four Condition B, three Condition C, six Condition D, and five Condition E.

The results of the five learners in Experiment II also demonstrated a certain unevenness in their performances over the five conditions. Only two persons reached the criterion on all five problems; one person did so on only one (Condition D—the easiest), and two individuals satisfied the learning criterion on four of the five conditions. As in Experiment I, the number of learners mastering each problem varied demonstrating the intertask difficulty. Condition A was learned by three persons, Condition B by three also, Condition C by 4, Condition D by all five in the study, and Condition E by 4 learners.

Discussion: In a way, the results of the two experiments might not have been totally unexpected, especially those obtained in Conditions D and E. Most teachers would predict that the requirements of Task D would lead to fastest learning for it appears the easiest com-

bination to match, and that the very nature of Condition E would lead to most difficulty. Perceiving, recognizing and appropriately responding to a printed configuration *is* reading, and this is essentially what Condition E demanded. Conditions A, B, and C are placed intermediary in their level of difficulty, although each maintains a position in the ranking that remains quite constant. On an *a priori* basis, one might think that Condition C would be more difficult than either A or B since it involves matching printed stimuli to auditory stimuli. This may seem to be a more difficult matching task, but the results show otherwise. More research needs to be done concerning the relative difficulty of these learning tasks.

Although the present findings are first approximations of the psychological principles being applied, the results do indicate the feasibility of developing basic reading skills in this manner to the mentally retarded learner. Even though the present equipment and programming did not create conditions of high efficiency and economy for both experimenter and learner, there does appear to be some basis for ultimately developing more precise programs and better instrumentalities for increasing the effectiveness of these methods. This line of research has some broad implications for the teacher who is involved in training the exceptional child. The kind of material as that used here and in the manner in which it was included in a training process could be used at the reading readiness level, perhaps for the purpose of developing the learner to a given level of ability before he is more formally exposed to systematic reading education. What is more specifically implied is the notion of sequencing the reading tasks for the learner. All teachers process their learners through some sequence of reading tasks; the question, however, still remains—is the particular programming the best, that is, is it leading to most efficient learning? If the results of this research indicate anything, it may be in giving a hint to the kind of sequence that a teacher might use when she is concerned with establishing basic matching skills. One should not begin with a matching found in Condition E. This is too difficult nor should one spend excess time on Condition D, for this may be too simple. There is of course an optimal transition for the individual learner from method to method. The question remains to determine precisely the nature of this program.

With respect to the mechanical features of programming and

processing the text material, it is felt that automated methods of instruction have real utility for the teacher. This research was not primarily interested in the device itself; yet, even with the rather crude equipment some essential aspects of the teaching machine concept were being examined as well as demonstrating some of the advantages that might be had by the individual teacher under more advanced instrumentation. The learner was presented with specific information; the experimenter was able to examine the learner's performance on each piece of text material as it was presented; the experimenter was able to verify the correctness of a choice when it was correct or provide immediate information on points that were incorrect; the learner was allowed to proceed in a sense, automatically to the next point in the learning sequence especially when the preceding unit was mastered; the experimenter was able to keep a detailed record of the performance of the learner both in terms of errors and correct responses; and, although this one feature was not present in the equipment used, the teaching machine would monitor the programming with infinite patience and without human bias—which in themselves are goals to be achieved.

Summary

Two experiments were conducted with mentally retarded subjects to explore the possibility of establishing a programmed hierarchy of simple stimulus-response associations basic to the reading process. The subjects were required to learn several discrimination tasks each involving the matching of one of three stimuli to a standard stimulus. The materials to be matched were drawn from the Dolch Picture-Word series and were limited to words and pictures representing simple object-nouns. The stimuli were presented in several ways: verbal, graphic, and printed. The responses reflecting the child's performance were classified into two categories: pressing buttons indicating the choice of stimulus, and verbal reproduction of the selected word or picture. Each subject was given one trial a day. The criterion of learning was determined after the child correctly discriminated all exposures. A discrimination consisted of the subject examining the standard stimulus of the particular condition of training, responding to it by selecting the appropriate figure from the array of three choices, making the appropriate response, and finally receiving the reinforcement. These preliminary studies were designed

to determine each child's rate of learning under a specific discrimination series and to measure the number of trials required to produce mastery of the task. By pairing the stimulus forms with the different forms of response, a number of S-R combinations were available for study. The purpose for considering these variations was to judge whether or not one kind of association produced faster and more effective learning than some other association. It was hoped that from this kind of analysis a graded series of discriminations would be empirically derived and eventually integrated into some form of programmed sequence that could be presented to the learner using a teaching machine.

References

1. Corrigan, Robert, "Automated Teaching Methods," *Automated Teaching Bulletin,* Vol. 1, No. 2, (December, 1959), pp. 23-31.
2. Edwards, Ward, Skinner's Teaching Machines, Maintenance Laboratory, Air Force Personnel and Training Research Center. Laboratory note "unpublished draft" ML-LN-51-3, 8 May 1956.
3. Ferster, C. B. and S. M. Sapon, "An Application of Recent Developments in Psychology to the Teaching of German," *Harvard Educational Review,* Vol. 23, No. 1, (Winter, 1958).
4. Galanter, Eugene (editor), *Automatic Teaching: The State of the Art.* John Wiley and Sons, Inc., N. Y. 1959.
5. Hosterak, G. S. and E. E. Ferrier, *Automated Teaching of Sight Vocabulary to the Mentally Retarded Children.* Paper read at the Institute for Research on Exceptional Children, Allerton Park, Montecello, Illinois, 1960.
6. Skinner, B. F., "The Science of Learning and the Art of Teaching," *Harvard Educational Review,* Vol. 23, No. 2, (Spring, 1954).

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