DOCUMENT RESUME

ED 113 883 EC 080 123

AUTHOR Levy, Sidney M.
TITLE The Development of Work Skill Training Procedures for the Assembly of Printed Circuit Boards by the Severely Handicapped.
INSTITUTION American Association for the Education of the Severely/Profoundly Handicapped.
PUB DATE Sep 75
NOTE 12p.
JOURNAL CIT AAESPH Review; v1 i1 p1-10 Sep 1975

EDRS PRICE MF-$0.76 HC-$1.58 Plus Postage
DESCRIPTORS Adults; *Custodial Mentally Handicapped; Exceptional Child Research; *Job Skills; Mentally Handicapped; Program Effectiveness; Research Reviews (Publications); Severely Handicapped; *Skill Development; *Training Techniques; *Vocational Education

ABSTRACT

Research studies in which severely retarded adults have been trained to perform complex industrial tasks are reviewed. It is explained that results demonstrate that retarded workers can learn to insert electronic components into a printed or etched circuit board. Reported is a pilot study which is investigating two adult retardates' ability to assemble a large number of parts using a match-to-sample training procedure. (CL)

ED113883

REVIEW

The American Association for the Education of the Severely/Profoundly Handicapped

THE DEVELOPMENT OF WORK SKILL TRAINING PROCEDURES FOR THE ASSEMBLY OF PRINTED CIRCUIT BOARDS BY THE SEVERELY HANDICAPPED

Sidney M. Levy

Children's Research Center
University of Illinois at Urbana-Champaign
51 Gerty Drive
Champaign, Illinois 61820

September, 1975

Issue One: Volume 1

In our society, what a person does and how much he earns determines his value and the level of respect he holds with its other members. Historically, the retarded have not participated in the labor market because they were thought incapable of making a significant contribution to it. They have been perceived as a surplus, along with the aged, hardcore unemployed and others, (Farber, 1968) without the training or skills necessary to fill existing jobs. Consequently, the retarded constitute one of the largest segments of the unemployed population with a great deal of energy and money spent on their maintenance. Gold (1972) states, "Some of the energies presently used for maintenance of this unproductive portion of the population should be directed toward training the retarded to somehow effectively compete in the labor market with other members of the surplus population who are not additionally stigmatized by the label 'retarded'."

Gold has clearly demonstrated that moderately and severely retarded individuals are capable of performing much more complex work than has ever been thought possible (1969, 1972). Even with the establishment of this new knowledge, very little is being done to train the retarded to do complex work or to give them the skills necessary for remunerative employment.

A program designed to develop training procedures for giving retarded individuals skills to assemble complex industrial tasks has been conducted at Children's Research Center, University of Illinois since 1968. Many of the procedures developed are being successfully employed by agencies serving the retarded. Most of the work tasks currently available to the retarded, however, are of a highly simplified and repetitive nature and do not require sophisticated training techniques. Studies to develop training procedures for complex work tasks which are or could be available as real subcontracts for rehabilitation agencies are currently being undertaken. The tasks being used are electronic printed or etched circuit boards (P.C. boards). P.C. boards were selected because of their apparent complexity and feasibility as a source of work for this population. Preliminary studies by Merwin (1973, 1974) indicate the potential for moederately and severely retarded persons to perform this type of work.

In her studies Merwin investigated the effects of pretraining upon the training and transfer of P.C. board assembly utilizing a match-to-sample training procedure. The initial study used 45 adult residents of a state institution. Their mean IQ was 55 (range 23 to 92).

Learning to assemble a circuit board is considered to be primarily a discrimination task. Form, size and color of the individual components, as well as their position on the board are the relevant dimensions to be learned. Consistent with the Attention Theory of Zeaman and House (1963), the purpose of the pretraining was to help direct the subjects' attention to those relevant dimensions. It was believed that prior knowledge of the relevant dimensions might enhance the learning and transfer of the discrimination skills required in assembling the boards.

Conditions of visual discrimination pretraining were varied for three groups using a multiple-choice visual discrimination apparatus (Scott, 1970). After completing the pretraining all subjects were trained on the assembly of two similar P.C. boards.

In pretraining one group (Group I) was asked to solve match-to-sample problems containing multi-dimensional junk stimuli (e.g., pictures of a dog, tree, etc.). The purpose of the junk stimuli problems was to familiarize the subjects with match-to-sample type problems, and was not intended to systematically direct attention to the color and form dimensions. After pretraining they began training on the board itself. The second group (Group II) was asked to solve junk stimuli problems. After learning the junk problems they were presented with problems involving electronic components as stimuli, and finally sets of problems of P.C. boards with increasing numbers of components. When they were able to discriminate pictures of boards containing 12 different components, training on the actual boards was begun. The purpose of the problems containing the components was to direct the subjects' attention to the color and form dimensions. The P.C. board problems included the dimension of position as well as color and form.

The final group (Group III) first received problems consisting of geometric form stimuli which differed in color and form. After learning the geometric form problems the subjects were presented with the component problems followed by the circuit board problems. The intention of the geometric form problems was to make the dimensions of color and form more salient.

Thirty-nine of the 45 subjects (88.6%) learned to assemble both the training and transfer P.C. boards each to a criterion of five consecutive correctly assembled boards. The mean number of trails to criterion across both boards was 16.5 and the mean total time for pretraining,

training and transfer was 170 minutes. The effects of pretraining on task assembly training were inconsistent. In accordance with the theoretical assumptions of the pretraining, Group III (geometric forms) had superior performance in training and transfer as predicted. Since Group II received identical pretraining, except for the junk stimuli problems in place of the geometric form problems, it was predicted that their performance would be close to Group III. Group II had the poorest performance, with Group I (junk stimuli only) falling between Group II and III. Although differences between groups occurred, the differences did not reach statistical significance.

Suggested interpretations are that the geometric forms pretraining had a slight effect on assembly acquisition, that experience with match-to-sample problems is facilitative in learning the circuit board task, or there was no pretraining effect at all, and direct training on the board would have been as facilitative. Since there was no control group that received only direct training, the latter question could not be addressed.

A significant transfer effect on the second board was obtained for all groups. Whether this was due to pretraining effects, to the training on the first board, or to the combination of the two has not been resolved.

In her next study Merwin attempted to resolve the unanswered questions. The second study used 60 institutionalized adults. Their mean IQ was 39.66 with a range of 10 to 77. As with the first study the type and amount of pretraining were varied between groups. The first group received only direct assembly training on a 12 component circuit board.

Following criterion they were presented with a second board with different components in different positions (transfer). The second group was given matching pretraining in the form of match-to-sample slide problems (components and circuit boards) which was followed by training and transfer. The third group received the matching pretraining (the slide problems), followed by placement pretraining and finally training and transfer on the two boards. Placement pretraining consisted of manipulation and insertion of six of one type of component in a board. By using identical components, color and form dimensions were held constant with only position allowed to vary.

Forty-eight out of the sixty subjects (80%) reach criterion on both boards. The data failed to show a significant pretraining effect. It appears the direct training on the task is as effective and efficient as the forms of pretraining employed in the study. As in the first study, a strong transfer effect was found for all three groups. Since most P.C. boards are similar with regard to the relevant dimensions (color, form, position) for the discrimination necessary for assembly, the generalizability of the transfer effect to most other P.C. boards seems probable. The mean total time for all three groups to reach criterion was 246 minutes.

The training techniques generated from the previous studies indicate that retarded workers can learn to insert electronic components into a P.C. board. The P.C. boards that are assembled in the electronics industry usually contain many more components than subjects in the prior studies were required to do. The assembly of the boards also entails additional steps such as bending the component leads, cutting and crimping the leads, riveting some parts, and in some cases soldering the components in place. The Merwin studies provide sufficient encouragement to investigate whether retarded workers can do these other steps and how many components they can assemble. Pilot work addressing these questions has been started using a circuit board consisting of 45 components.

The P.C. board task being used is one that is currently produced by an electronics company in the midwest. The components include resistors, capacitors, and diodes which must be bent, inserted in a specific place on the board and in a specific position, and cut and crimped. In addition to the insertion components, there are parts that must be mounted and riveted into place, and others that require mounting with small bolts and nuts.

Two subjects from a sheltered workshop in Champaign, Illinois have been selected to pilot our procedures. One is a 28 year old female with an IQ of 35 and the other is a 25 year old male with an IQ of 48. Both subjects were chosen because they were described by their supervisors as functioning in the trainable range with no gross motor or sensory problems and as being cooperative individuals. It was decided that individuals with those characteristics would best serve to answer the initial questions being asked in the pilot work.

A question being investigated is, can they learn to assemble a large number of parts using the match-to-sample training procedure? The initial task consists of the insertion of 32 pre-bent components into their appropriate positions on the board. In this task they are also required to insert the parts with the markings on the components in identical positions as found on the sample. Some parts have letters, or numbers, or both facing in a specific direction. Some of the other components have color bandings. If a part is inserted upside down, it is considered an error and the subject must correct it. In actuality, many components can be assembled with either lead in either hole. Because the markings on some of the components must be able to be read or have specific polarities, how they are positioned is critical.

At the present time, the male subject has reached our criterion of five consecutive insertions of all 32 components (five boards) without error or assistance. The total amount of trials needed to reach criterion was 19, which took seven training sessions, one per day. The toal time to criterion was 141 minutes averaging seven minutes and 44 seconds per trial. The subject was run 19 trials past criterion to determine the validity of our criterion, consistency, and also to get a feel for production. In the 19 trials, which consisted of 608 insertions, he made four errors. The mean time per trial was five minutes and 32 seconds, decreasing over trials, and at this time is still going down.

An interesting incident took place with this subject during the post criterion trials. On the table where the subject was engaged in the task was a correctly assembled circuit board with all 45 components. After completing his work the subject, who is almost nonverbal, pointed to the completed board. He was told that he would soon learn to assemble the rest of the board in addition to the parts he already knew. The subject then proceeded to point to the new parts on the complete board and show the experimenter where they went on his board. He already knew the rest of the assembly without ever having been directed toward it.

Another interesting event occurred during the post criterion period. While assembling a board he got out of sequence and had six parts in wrong places. He seemed to know something was wrong and expressed concern. The experimenter said "That isn't correct, Francis, fix it." Using the sample board as a guide he proceeded to correct the mistakes.

The second subject has not yet reached criterion. She has had 22 trials to date and her number of errors has gone down from approximately 18 per trial to two on her last three trials. The time per trial has also decreased from over 20 minutes initially to about 12 minutes currently. Her problem is in attending to the writing or color coding on the parts. If reminded to attend she will insert the part correctly, if not the part will go on correctly or incorrectly depending on how it was picked up.

Two experiments and work with two pilot subjects have been discussed. These data strongly suggest that additional investigation is warranted. Current plans include: 1) The running of additional subjects to verify the findings to date; 2) The development of training procedures for lead bending, small tool usage, and soldering; 3) Doing the circuit board used in the present pilot work as a remunerative subcontract; 4) Obtaining several other subcontracts and training workers in order to validate the training procedures; and 5) To create an electronics factory for the purpose of documenting and marketing the skill competencies of the severely handicapped.

The severely handicapped should be granted the right to full participation in society. An important area of participation is work. Determining their true capabilities in this area and giving them the means for reaching those capabilities is providing an option previously not available. Whether or not they will be able to exercise that option remains to be seen. Today's society will have to undergo major modifications for the full integration of the handicapped to occur. Helping them to develop sophisticated manual work skills may be the most effective means to accomplishing that goal.

References

Farber, B. Mental Retardation: Its Social Concept and Social Consequences. New York: Houghton Mifflin Company, 1968.

Gold, M.W. The acquisition of a complex assembly task by retarded adolescents. Final Report, May, 1969, University of Illinois at Urbana-Champaign.

Gold, M.W. Stimulus factors in skill training of the retarded on a complex assembly task: Acquisition, transfer and retention. American Journal of Mental Deficiency, 1972, 76, 517-562.

Merwin, M.R. The use of match-to-sample techniques to train retarded adolescents and adults to assemble electronic circuit boards. Unpublished Master's Thesis, University of Illinois, 1973.

Merwin, M.R. The effect of pretraining upon the training and transfer of circuit board assembly skills of retarded adults. Unpublished Doctoral Thesis, University of Illinois, 1974.

Scott, K.G. A multiple-choice audio-visual discrimination apparatus with quick interchange display and response panels. Journal of Experimental Child Psychology, 1970, 9, 43-50.

Zeaman, D., & House, B.J. The role of attention in retardate discrimination learning. In N.R. Ellis (Ed.) Handbook of Mental Deficiency. New York: McGraw-Hill Book Co., 1963, pp. 159-223.