Although several demonstrations are available that severely retarded persons can learn difficult vocational tasks, little effort has been made to determine whether this learning occurs as a result of the reported training procedures. Therefore, a severely retarded woman learned to assemble a saw chain when teaching procedures involving differential reinforcement, modeling and physical priming were used. The use of a multiple baseline design across task segments allowed for the interpretation that the procedures were functionally related to the trainee's gains.

Evaluation of a Procedure for Teaching Saw Chain Assembly to a Severely Retarded Woman

Candace T. O'Neill
G. Thomas Bellamy

Acquisition and performance of vocational tasks by severely and profoundly retarded persons have been reported with increasing frequency during the last two decades. It now seems clear that to label a person "retarded," even "severely retarded," implies no necessary restriction on the individual's potential to learn a variety of work behaviors (Bellamy, Peterson, & Close, 1975; Clarke & Hermelin, 1955; Crosson, 1966; Gold, 1976; Hunter & Bellamy, 1976; Karan, Eisner, & Endres, 1974; Martin & Flexer, Note 1).

The demonstrational emphasis of much of this literature motivated the present research. Acquisition of vocational skills by severely retarded adults has been reported often, but little effort has been made to determine whether those gains are actually the result of reported teaching procedures. For example, none of the studies cited utilized experimental designs which rule out the possibility that learning resulted simply from extended exposure to the task or trainer. Therefore, the purpose of this research was to ask if the learning of a difficult vocational task was functionally related to the defined training procedures.

Specifically, a case study in vocational training will be presented to illustrate the ability of a severely retarded woman to learn to assemble saw chain, a task potentially available to sheltered workshops. In the study the relationship between training procedures and task acquisition was assessed in a multiple baseline design across task segments.

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Method

Trainee

The trainee was a 30-year old woman labeled either severely or profoundly retarded on the basis of several standardized intelligence tests administered over the last 10 years. At the time of the research she had been a participant in a community vocational training program for fourteen months. Prior to that, the trainee had resided in a state institution for nine years with neither vocational nor educational programming. She had no functional expressive language, but followed some simple verbal directions and imitated some movements.

The Work Task

The task involved assembly of 11 small parts to form a repeating segment of saw chain, the cutting portion of chain saw blades. Each of the components measured approximately 1.5 × .5 cm. Assembly involved stacking the components in three levels, with each piece requiring correct rotation on both horizontal and vertical axes. Stacking was done on a masonite strip with grooves which held the bottom set of components in a straight line. Assembly of the product involved performing in sequence a chain of behaviors which was defined in 47 steps, or discriminated operants. At the com-

pletion of training the subject was expected to complete the task without assistance. This involved moving a place marker in front of each parts bin in turn, picking up a component from the bin and placing it correctly on the chain assembly.

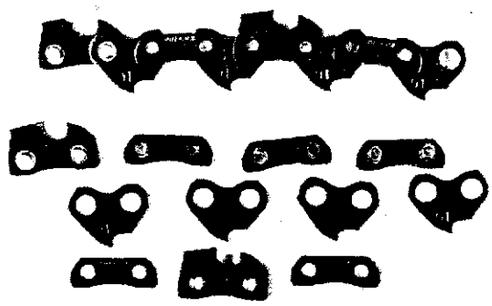

FIGURE 1. SAW CHAIN MATERIAL USED FOR ASSEMBLY.

Training Materials

In addition to the task itself, training involved the use of a parts bin apparatus, in which parts were stored separately in the order of assembly. The apparatus consisted of a row of 11 3-inch (7.6cm.) square compartments. In front of each compartment was a small platform on which the trainee moved a wooden block to mark her place in the assembly. Small edibles and later pennies which could be exchanged for edibles were delivered contingent upon task-related behaviors during training.

Data Collection

Correct responses for each discriminated operant in the task were recorded during probes which occurred after every 20 minutes of training. During probes the trainee responded to the discriminative stimulus defined for each step in the task. This was accomplished by letting her continue without interruption when a step was completed correctly and by having the trainer complete the step after incorrect responses (thereby creating the discriminative stimulus for the next step). During probe trials the trainer made comments like, "You are really trying hard," *etc.*, while the trainee was manipulating task components, regardless of whether responses were correct.

A response was scored as correct if the trainee responded to the discriminative stimulus without prompts or cues of any kind, performed the movement correctly, and made all necessary rotational discriminations. Any other response or failure to respond within 10 seconds was scored as incorrect. Observer agreement was checked during the first five probes and every eighth probe thereafter. During these 16 probes performance was scored simultaneously by the trainer and a second individual with vocational training experience.

Training Procedures

Training was conducted on one task segment at a time to allow measurement of progress within a multiple baseline design. Training continued on each segment until the trainee performed all steps in the segment correctly on three consecutive probes.

The trainee was seated in front of the task with the trainer either sitting beside or standing behind her. Early training sessions began when the trainee attended to the task for a few seconds. The trainer then modeled the first step, asked the trainee to perform the step, and provided differential consequences for correct and incorrect imitative responses. Correct responses were followed by compliments, physical contact, and small edibles. Incorrect responses were terminated by the trainer as soon as they occurred. The trainer returned the task to the last correctly completed step and, using more complete modeling or physical priming, assisted the trainee through a correct performance of the step. The trainer then returned the task once more to the last correctly completed step and repeated the procedure, providing much less physical or modeling assistance.

Each step was introduced in sequence via this modeling and priming procedure. After a step was performed correctly, the trainer no longer provided the modeling cue prior to the trainee's response. The trainee was expected to perform the step without prompts of any kind from the trainer, the relevant discriminative stimuli being provided by the task itself. Differential consequences for correct and incorrect responses were then provided as described above.

These procedures were modified during the training periods between probe trials 30 to 70 when the data indicated lack of progress. These modifications were based on the trainer's hypothesis that correction procedures might be functioning as reinforcers for error responses. First, an attempt was made to maximize the difference between consequences for correct and incorrect responses. Incorrect responses were followed by a firm "No" before the correction procedure. When this had

little effect, it was hypothesized that the physical contact involved in priming correct responses might be a strong reinforcer. These were deleted, but with little effect. Finally, an attempt was made to eliminate corrections altogether. This involved attempting to anticipate incorrect responses and provide necessary verbal or physical assistance before an error was made. When the trainee began to emit the correct response, the assistance was gradually removed by providing it earlier in the behavior chain (Bellamy, Inman, & Schwarz, 1976) or making it less and less specific. This procedure continued throughout the remainder of training.

Results

Observer Agreement

Agreement between observers was computed by dividing the total number of agreements by the agreements plus disagreements on the 47 discriminated operants in the task. Agreement ranged from 98–100 percent. It is possible that this represents an overestimate, in that complete independence of observers was not achieved. Progression through the task during probes required the trainer (first observer) to complete a step performed incorrectly by the subject in order to assess responding to the subsequent step. Therefore, the second observer was aware when the trainer considered a step incorrect. After the two initial probes, however, the second observer reported no instances when she felt the trainer had intervened inappropriately.

Task Acquisition

Acquisition data are presented in Figure 2. During the three probes before instruction, the subject made one correct response on Segment 1 (attending to the task) and no correct responses on either Segments 2 or 3.

Training on Segment 1 was conducted during 28

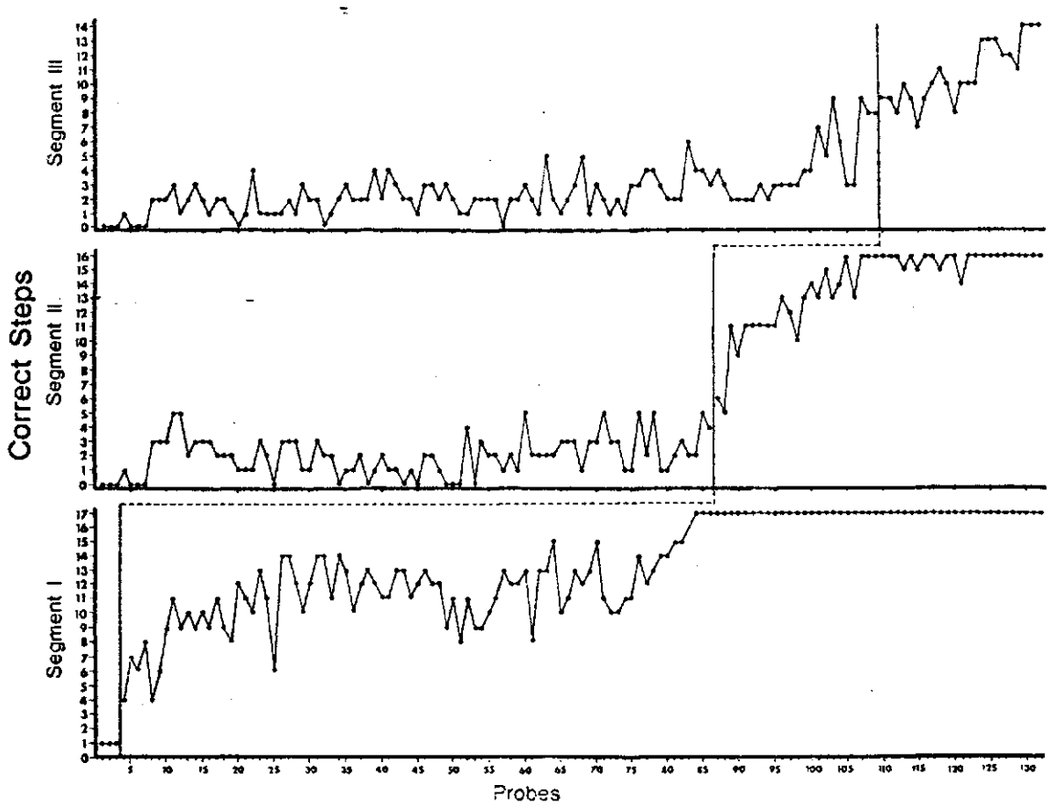

FIGURE 2. NUMBER OF STEPS COMPLETED CORRECTLY DURING UNASSISTED PROBES CONDUCTED BEFORE AND AFTER TRAINING (VERTICAL INTERVENTION LINE) ON EACH TASK SEGMENT.

hours and 40 minutes over a two month period. A total of 82 probes were taken during this time, with performance on Segment 1 increasing from 4 correct responses on probe 4 to a criterion of 3 consecutive correct responses on probes 83 to 85. Correct responding on the remainder of the task ranged from 0-5 on Segment 2 and 0-6 on Segment 3. Inspection of Figure 3 reveals that little apparent progress was made during probes 30-70, the period in which several procedural modifications were made.

Training on Segment 2 required a total of 7 hours and 40 minutes during eight days of training. During the 23 probes taken during this time, the subject's correct responses to Segment 1 remained perfect; those to Segment 2 increased from 6 and 5 on probe trials 86 and 87 to a criterion of 3 consecutive correct trials on probes 107–109; correct responses on Segment 3 ranged from 0–9.

Training on Segment 3 was completed during 8 hours of instruction over nine days. During the 24 probes taken during this period, the subject maintained correct responding to all steps on Segment 1 and ranged from 14–16 correct on Segment 2. Correct responding on Segment 3 increased from 9 on probe 110 to the criterion level on probe 131 to 133.

Discussion

The subject learned to perform all three segments of the task independently after the training procedures were implemented. This result provides evidence for the existence of a functional relationship between the vocational training procedures and the trainee's skill acquisition. Because a multiple baseline design was used, attribution of skill acquisition to simple repeated exposure to a task or trainer, which has not been ruled out in most previous literature, could be seriously doubted in the present study. The trainee appears to have acquired each segment of the task as a function of beginning systematic instruction.

The results also provide a clear demonstration that a severely retarded person can learn the skills required to perform a complex vocational task. This is consistent with several other reports of the potential vocational competence of severely retarded persons (Bellamy, Peterson, & Close, 1975; Clarke & Hermelin, 1955; Crosson, 1966; Gold, 1976; Martin, & Flexer, 1975). Spanning two decades, these reports have illustrated that, with systematic training, severely handicapped adults could participate in remunerative work activity. However, their impact on vocational service programs seems to have been considerably less significant than the positive results might suggest. In spite of their apparent vocational potential, severely retarded adults frequently receive no work opportunities (Rowitz, O'Connor, & Boroskin, 1975), or else participate only in programs designed for adults whose "productive capacity is inconsequential" (Federal Register, 1974; Commission on Accreditation of Rehabilitation Facilities, 1976).

Therefore, the question arises as to what researchers should now do to decrease this apparent gap between research and service programs. One approach is to continue reporting practical procedures for teaching vocational tasks which may be available to sheltered vocational programs. By illustrating the abilities of severely retarded adults to perform these tasks, an increased willingness to include these individuals in vocational programs may be fostered.

A second task for applied researchers appears to be the development of training procedures which are increasingly efficient, thereby reducing the cost of including severely retarded persons in sheltered vocational programs. Related to this issue is the apparent increase in efficiency of training on successive task segments in the present study. Acquisition of segment 1 required 28 hours, 40 minutes, while segments 2 and 3 required only 7 hours, 40 minutes and 8 hours respectively. A possible explanation for this dramatic reduction in training time is that the subject acquired behaviors which facilitated performance in the training setting, including sustained attention to the task and consistent responding to verbal, physical and gestural cues used by the trainer. Another potential explanation is the possibility of an increase in the trainer's skills in obtaining and reinforcing correct responses. A third possible explanation for the reduction in training time during Segments 2 and 3 seems particularly important. Training may have become more efficient because the trainee developed generalized skills or "operations" (Becker, Englemann, & Thomas, 1975), which resulted in the correct performance of some untaught steps which were similar to those taught previously. For example, steps 7, 11, 15, 19, 23, 27, and 31 all involved obtaining one part from the bin behind the marker immediately after the marker had been moved. After training on a few of these steps in the first two segments, the trainee also began responding correctly to the steps which had not been taught. That is, the trainee had developed an operation of following a particular stimulus characteristic (the marker in front of a parts bin) with the response of reaching into that bin to obtain one

part. This would suggest that generalization had occurred across the irrelevant dimensions of location of the bin and particular type of part.

This generalization poses a set of particularly interesting questions for future research on vocational training. Can a set of generalized skills, or operations, be identified which are applicable across several tasks typically found in sheltered workshops? Will pre-training on these skills increase a severely retarded individual's overall success in community vocational programs? And finally, can these operations be used as a basis for task selection and assignment decisions within workshops?

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Authors: **CANDACE T. O'NEILL** is Program Coordinator of Olympus, a division of Northwest Center for the Retarded, Seattle, WA. **G. THOMAS BELLAMY**, Ph.D. is Director, Specialized Training Program, University of Oregon, Eugene, Oregon, 97403.