

TRAINING MENTALLY RETARDED ADOLESCENTS TO BRUSH THEIR TEETH¹

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The need for self-care by retarded individuals in behaviors such as brushing teeth led to the development and evaluation of a comprehensive toothbrushing program that included a task analysis and training procedure specific to each component of the task analysis. Eight mentally retarded adolescents, in two groups, individually received acquisition training that included scheduled opportunities for independent performances, verbal instruction, modelling, demonstration, and physical assistance. The first group of four subjects received token plus social reinforcement; the second received only social reinforcement. All eight subjects showed improved toothbrushing behaviors when compared to baseline. Six of the eight subjects correctly performed all toothbrushing steps in two of three consecutive sessions. The study emphasizes the need for systematic program development and evaluation.

DESCRIPTORS: program evaluation, training, toothbrushing, self-care behavior, retardates

The need to teach basic self-care behaviors to mentally retarded persons has made the establishment of such behaviors the objective of an increasing number of training efforts. One class of self-care behaviors that has received attention is toothbrushing. Recent reports have indicated that the need for dental hygiene among retarded individuals is greater than that among nonretarded individuals (Miller, 1965; Nickol, 1973). While various published reports, training

programs, and teaching guides have focused on the training of toothbrushing behaviors, one or more of the following limitations seem to make implementation impractical or difficult: (1) inadequate task analysis or inadequate task description, (2) unspecified or ambiguous information regarding teaching techniques, and (3) inadequate evaluation of program effectiveness in an educational setting.

Few studies dealing with toothbrushing behaviors have been reported in the research literature. Lattal (1969) reported the usefulness of a contingency management procedure in the control of previously established toothbrushing behaviors in eight boys at a summer camp for children. Unfortunately, no task analysis of the target behavior, brushing teeth, into behavioral components and performance sequence was reported. Thus, no information concerning the training of specific behavior components of toothbrushing is available. Abramson and Wunderlich (1972) reported the results of a program used to train nine severely retarded boys to brush their teeth. While the desired behavior, proper brushing of teeth, was divided into 20 components, the lack of operational

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definitions of ambiguous components (*e.g.*, "efficient and quick brushing") minimizes the utility of the program and limits replicability.

Outside the research literature, at least two training programs for teachers and parents of retarded individuals have included extensive task analyses of toothbrushing, provided information about teaching techniques, and provided the user of the programs with some rationale and specific information for collecting data and measuring student success (Anderson, Hodson, Jones, Todd, Walters, and Gregersen, 1972; Baldwin, Fredericks, and Brodsky, 1973). However, neither Baldwin *et al.* (1973) nor Anderson *et al.* (1972) provided information on the extent of student change attributable to actual program application.

In view of the pressing need to provide self-care training for mentally retarded persons and the increasing number of programs to meet those needs, adequate program evaluation seems to rank high as a priority objective in program development. The purpose of the present study was to apply a within-subject experimental design to evaluate the application of a comprehensive toothbrushing program³, which included a detailed task analysis, and a systematic training strategy.

METHOD

Subjects

Eight mentally retarded student-residents (two female, six male) of a state hospital and training school were selected on the basis of available free time. Six of the eight were described as moderately retarded; two (Michael and Charles) as mildly retarded. They ranged in age from 9 to 17 yr (mean = 13.0 yr), had a mean I.Q. of 43.1, measured by standardized tests, and had resided in the institution an average of 2.6 yr. All subjects were ambulatory without relevant

behavior problems but varied organic diagnoses in their medical records.

Trainers

Four female nonretarded adult trainers, ranging in age from 19 to 24 yr, had no experience with either mentally retarded persons or the training procedures described below. The trainer for Michael, Larry, and Russell was a college graduate VISTA volunteer. Tom's trainer was a junior college student who offered her services in order to complete a public service project. The two other trainers for Charles, Jessie, Coleen, and Joyce were available as part of a practicum experience associated with a psychiatric nursing course.

A written program detailing the toothbrushing steps and the training procedures, as summarized below, was presented to the trainers several days before the first baseline session. The trainers were instructed to read and study the program. Two hours of study time were provided, followed by a brief session during which specific questions concerning the program were answered. No other specific instructions were provided.

Task Analysis

A detailed identification and description of the specific behavioral steps and performance sequence, *i.e.*, task analysis, of toothbrushing was performed, yielding the response classification for toothbrushing behaviors presented in Table 1. Production of the task analysis involved: (1) observation of sample videotapes of three "skilled performers" (staff members) brushing their teeth, (2) observation of videotapes of three retarded individuals brushing their teeth, and (3) identification and detailed description of behavioral components of toothbrushing based on repeated observations of the sample videotapes. The three retarded persons viewed on the videotapes were selected because of differing toothbrushing skills assessed informally by their psychiatric aides; *i.e.*, one was designated as "very good", another "poor", and the third

³A revised version of the program described is commercially available and is referenced Horner, R. D., Billions, C., and Lent, J. R. *Toothbrushing*. Seattle: Edmark Associates, *in press*.

Table 1
Description of Toothbrushing Steps

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1. *Pick up and hold the toothbrush.* The student should turn on the water and pick up the toothbrush by the handle.
 2. *Wet the toothbrush.* The student should continue to hold the toothbrush, placing the bristles under the running water for at least 5 sec. Then, the student should turn off the running water and lay the toothbrush down.
 3. *Remove the cap from the toothpaste.* The student should place the tube of toothpaste in his least-preferred hand, unscrew the cap with the thumb and index finger of his preferred hand, and set the cap on the sink.
 4. *Apply the toothpaste to the brush.* The student should pick up the toothbrush by the handle, hold the back part of the bristles against the opening of the toothpaste tube, squeeze the tube, move the tube toward the front bristles as toothpaste flows out on top of the bristles, and lay the toothbrush on the sink with the bristles up.
 5. *Replace the cap on the toothpaste.* The student should pick up the toothpaste cap with the thumb and index finger of the preferred hand, screw the cap on the toothpaste tube, which is held in the least-preferred hand, lay the tube of toothpaste down, and with the preferred hand pick up the toothbrush by the handle.
 6. *Brush the outside surfaces of the teeth.* The student should brush the outside surfaces of the upper and lower teeth on both sides and in the center of the mouth, using either an up and down or back and forth motion, for at least 30 sec.
 7. *Brush the biting surfaces of the teeth.* The student should brush the biting surfaces of the upper and lower teeth on both sides and in the center of the mouth, using a back and forth motion, for at least 30 sec.
 8. *Brush the inside surfaces of the teeth.* The student should brush the inside surfaces of the upper and lower teeth on both sides and in the center of the mouth, using a back and forth motion, for at least 30 sec.
 9. *Fill the cup with water.* The student should lay the toothbrush down, pick up the cup, place it under the faucet, turn on the water, fill the cup, and turn off the water.
 10. *Rinse the mouth.* The student should spit out any excess toothpaste foam, take a sip of water, hold it in the mouth, swish it around in the mouth, and spit it out. If any toothpaste foam should be repeated.
 11. *Wipe the mouth.* The student should pull a tissue from the container (or pick up a hand towel) and dry his mouth.
 12. *Rinse the toothbrush.* The student should pick up the toothbrush by the handle, turn on the water, and place the bristles under the running water until the bristles are free of toothpaste (any toothpaste not removed by the water may be dislodged by drawing the fingers across the bristles), turn off the water, and lay the toothbrush down.
 13. *Rinse the sink.* The student should turn on the water, rub around the inside of the sink with the hand to wash any residue of toothpaste or toothpaste foam down the drain, then turn off the water.
 14. *Put the equipment away.* The student should put the toothpaste and toothbrush in the proper storage place. (If a glass and hand towel are used, these should be placed in the proper place.)
 15. *Discard the disposables.* Any used paper cups and tissues should be placed in a waste receptacle.
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- "average". None of three persons videotaped served as experimental subjects.
- This task analysis represented the objectives and sequence for training and the operational definition of correct responses for recording and reliability purposes. During baseline, responses were considered correct if they conformed to the description of the steps in Table 1, regardless of the sequence or order in which they occurred. During training, responses occurring out of sequence were recorded as incorrect (see below).
- #### Procedures
- The experimental design consisted of a multiple-baseline procedure across individuals, which included Tom, Michael, Larry, and Russell and a systematic replication (Sidman, 1960) involving the four remaining subjects and their trainers. Training of the replication group differed from the original group in the reinforcement procedure applied and the training setting. The setting for training of the first group was a large experimental room containing a single sink and a mirror directly above the sink. Training of the replication group was conducted in the bathroom of the residential living unit of the subjects.

Baseline. The baseline procedure for all subjects involved the following: the trainer placed a toothbrush, tube of toothpaste, disposable cup, and a box of facial tissues near the sink at each session and provided the verbal statement: "[Name], here is everything you need to brush your teeth. I want you to brush your teeth by yourself. Do the very best you can." This procedure was repeated at the start of each baseline session. Sessions were terminated when subjects ceased to engage in behaviors using the toothbrush, toothpaste, cup, tissues, and the sink and responded affirmatively (*i.e.*, nodding head or verbally indicating) to the trainer's question, "Are you finished brushing your teeth?" During baseline, the trainers performed no additional procedures but remained in the experimental room.

All baseline sessions and subsequent training sessions were conducted once daily. The number of baseline sessions for the replication group was reduced due to an observed increase in irrelevant and competing behaviors by Russell in the original group after the tenth baseline session.

Training. Trainers performed four types of procedures during training: (1) *No Help*, (2) *Verbal Instruction*, (3) *Demonstration + Verbal Instruction*, and (4) *Physical Guidance + Instruction*. These four procedures were applied successively to the training of each of the toothbrushing steps. All steps were trained in each session, and sessions were terminated after subjects were given the opportunity to perform the last step. A correct response, defined by the response classification in Table 1, was reinforced by the trainer, and training of the next step in the sequence was initiated by providing the subject the opportunity to perform with *No Help*. As acquisition training progressed, the number of training procedures applied to each step decreased. In this way, training was gradually faded. The four subjects in the first group, Tom, Michael, Larry, and Russell, received tokens plus social reinforcement during training. A paper cup was placed within sight, but outside of

reach, of the student and a token was dropped into the cup after each correct response. Tokens were exchanged for pieces of sugarless gum at a ratio of five to one at the end of each training session. Tokens were accompanied by social praise and pats on the back. The four students in the systematic replication group, Charles, Jessie, Coleen, and Joyce, received only social reinforcement throughout training.

As in baseline, all sessions began with the introductory statement by the trainer prompting the student to initiate toothbrushing. Toothbrushing steps were trained according to the description and sequence outlined in Table 1. For each step, the trainer provided *No Help* for approximately 5 sec, giving the subject an opportunity to perform the step without assistance. If the student failed to initiate a correct response after 5 sec, a nonspecific verbal prompt (*e.g.*, Go ahead or What's next?) was provided. If the student made an inappropriate response (*e.g.*, "making faces" in the mirror, licking the toothpaste tube, *etc.*) or attempted another toothbrushing step, *Verbal Instruction* for that step was provided immediately by the trainer. *Verbal Instruction* for each step consisted of a short imperative statement describing the desired behavior (*e.g.*, Wet the toothbrush). If the subject responded correctly, reinforcement was provided and training of the next step in the sequence was initiated with *No Help*. If the student failed to initiate a correct response in approximately 5 sec, *Verbal Instruction* was repeated. If the student made an inappropriate response (*e.g.*, sucked on the faucet, blew bubbles into the cup of rinse water, *etc.*), attempted another toothbrushing step out of sequence, or initiated no correct response approximately 5 sec after repetition of *Verbal Instruction*, the next training procedure, *Demonstration + Verbal Instruction*, was initiated with that step. *Demonstration + Verbal Instruction* included verbal instruction and simultaneous demonstration of the desired behavior. Demonstration consisted of pointing or directing the subject's responses and modelling the desired behavior. For example, while a

trainer was instructing the subject, "Put the cap on the toothpaste", she might point to the cap and then to the toothpaste tube, followed by moving her hand in a circular motion as if screwing the cap on the tube. If the student performed the step correctly within about 5 sec of *Demonstration + Verbal Instruction*, reinforcement was provided and training of the next step was initiated with *No Help*. No correct response within that time limit resulted in repetition of *Demonstration + Verbal Instruction*. Failure to respond to the repetition or the occurrence of inappropriate behaviors, resulted in the application of the last, or fourth, training procedure, *Physical Guidance + Instruction*. The training method for this procedure consisted of the trainer instructing as well as holding, guiding, or otherwise physically assisting the subject in initiating the desired behavior, but allowing the subject to complete it on his own. Correct completions of the step were reinforced followed by the training of the next step with *No Help*. Failures to complete the step correctly resulted in repetition of *Physical Guidance + Instruction*. If an error in performance or a failure to complete the step occurred after repetition of *Physical Guidance + Instruction*, training of that step ceased and the training of the next step in the sequence was initiated with *No Help*.

Observation and Recording

Correct responses following *No Help*, *Verbal Instruction*, *Demonstration + Verbal Instruction*, and *Physical Guidance + Instruction* were recorded each session by one or two observers on preprinted data forms, and as defined by the response classification of the toothbrushing steps in Table 1. Observers stood about 6 ft (1.8m) behind and 3 ft (0.9m) to the side of the subjects, so as to view them directly from behind and face-on in the mirror above the sinks.

Several procedures were performed to maximize validity and reliability of recording. When two observers were present, they simultaneously but independently scored responses. They were

instructed to record independently correct responses immediately after they occurred. The presence of one of the experimenters in the training setting during each session was designed to minimize biases produced by (1) recording not independent of trainers' behavior, and/or (2) recording dependent on communication between observers. Recording biases produced by observers depending on trainers' behavior, instead of subjects' behavior for scoring responses, was indicated by delays in recording and erasures on the data form. Observers were cautioned about sources of recording bias several times during the experiment.

Reliability of recording was tested by assessing per cent observer agreement calculated by dividing the number of agreements (*i.e.*, correct-correct, incorrect-incorrect) by the number of agreements and disagreements in recording of responses following the *No Help* procedure only. Mean per cent agreements based upon 20 of the 30 baseline sessions and 45 of the total 72 training sessions conducted with Michael, Larry, and Russell were 95%, 97%, and 96% respectively for baseline sessions and 95%, 98%, and 97% respectively for training sessions. Agreement data were collected only once during training for Tom and once during baseline for Charles, Jessie, Coleen, and Joyce. Mean per cent observer agreement computed for these data was 92% and 94% for baseline and training respectively.

RESULTS

Figure 1 shows the number of toothbrushing steps performed by Tom, Michael, Larry, and Russell during baseline and those steps performed correctly with *No Help* (requiring no intervention) during training. An arbitrary training criterion, all steps performed correctly two of three consecutive sessions, was reached by Michael in 30 sessions, by Larry in 24, and by Russell in 18.

Figure 2 presents acquisition performance with *No Help* for the four subjects in the rep-

lication group. Baseline performance was higher for Charles, Jessie, Coleen, and Joyce than for the initial group. Criterion of two of

three consecutive sessions of correct performance of all steps was achieved in 20 training sessions by Charles and Joyce, and by Coleen in 21

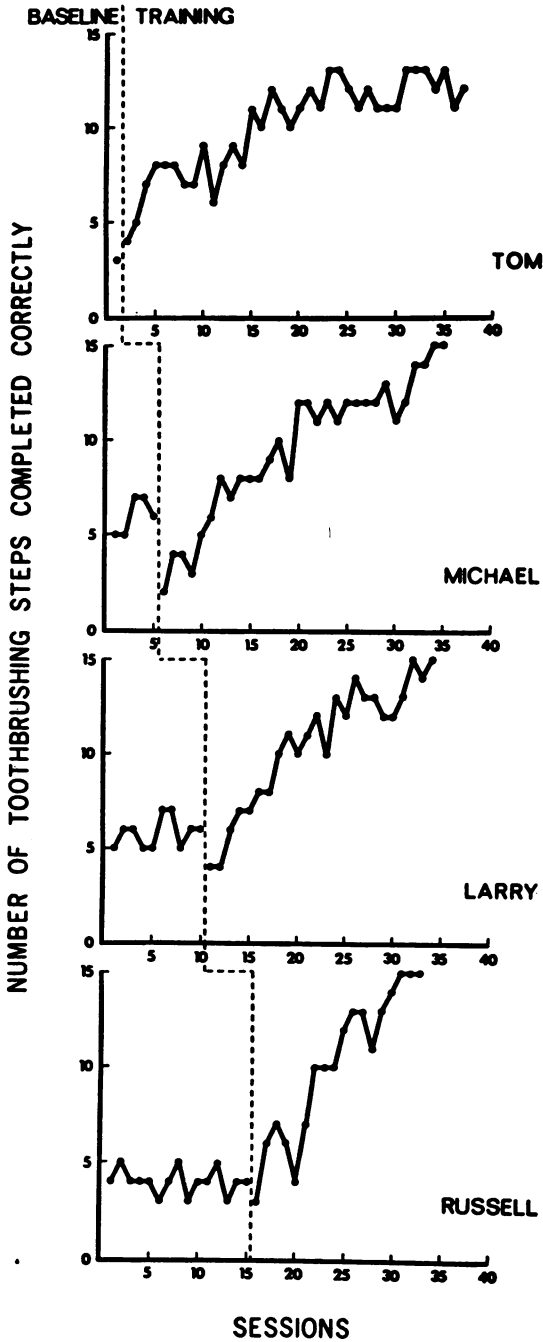


Fig. 1. The number of toothbrushing steps performed correctly by the four subjects in the first group. The broken line through the individual graphs indicates termination of baseline and the beginning of training for each subject.

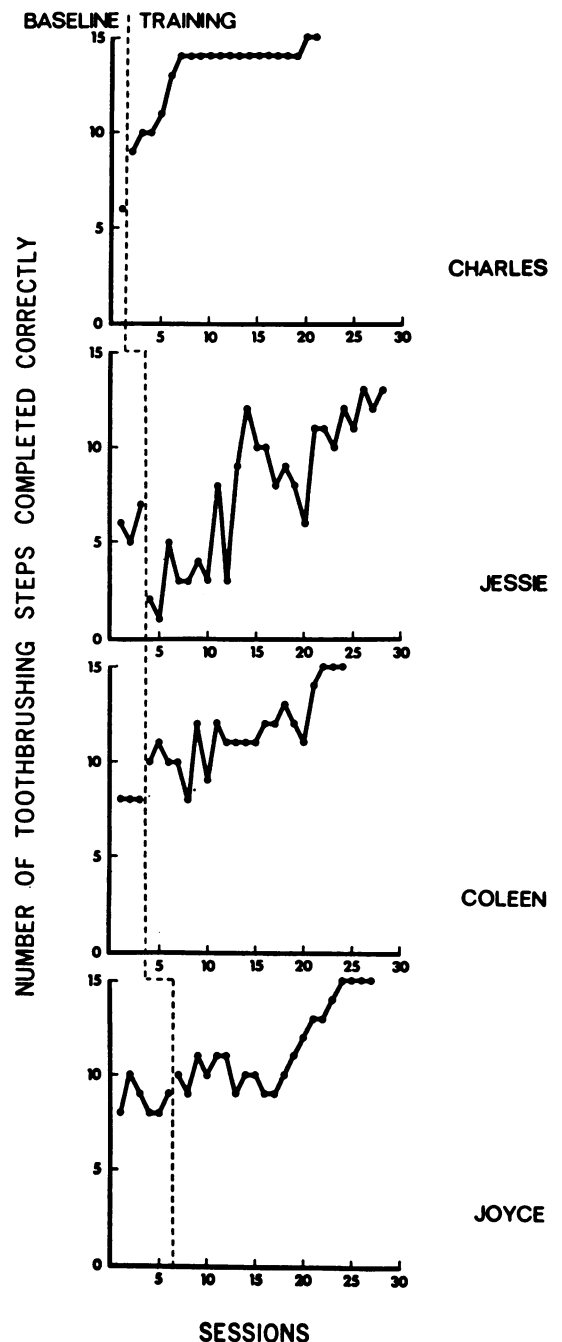


Fig. 2. The number of toothbrushing steps performed correctly by the four subjects in the replication group. The broken line through the individual graphs indicates termination of baseline and the beginning of training for each subject.

training sessions. Jessie had not reached criterion performance after 25 training sessions when training was terminated due to the departure of his trainer. While Jessie was unable to master all the steps with *No Help*, only *Verbal Instruction* was necessary to produce correct performance of the two steps not mastered with *No Help* in the last training session.

Table 2 indicates the gradual reduction of the four training procedures for the first group for four sample sessions. For example, during Session 1, Michael performed two steps without intervention (*i.e.*, *No Help*), 13 steps required at least *Verbal Instruction*, five steps required at least *Demonstration + Verbal Instruction*, and four steps required *Physical Guidance + Instruction*. Over the course of training, less training intervention became necessary as subjects performed more steps correctly without

help from the trainer. Interobserver reliability was not evaluated for these data.

DISCUSSION

The toothbrushing program produced high performance levels in the first group of subjects and in the systematic replication group, which received social reinforcement only. Six of the eight subjects in the two groups achieved a high criterion performance standard in 18 to 30 training sessions. The remaining two subjects, Tom and Jessie, made considerable gains over their baseline performance. While not reaching the stringent performance requirements set in this study, the standard of toothbrushing behaviors acquired by Tom and Jessie would more than likely be indistinguishable from that of their noninstitutionalized normal peers. These results cannot be attributed simply to practice or the

Table 2

Number of toothbrushing steps and types of training procedures applied in Sessions 1, 5, 10, 15, and 20.

Subject	Training Session	Training Procedure			
		No Help	Verbal Instruction	Demonstration and Verbal Instruction	Physical Guidance and Instruction
TOM	1	4	11	8	7
	5	8	7	6	6
	10	6	9	6	6
	15	10	5	1	1
	20	12	3	2	1
MICHAEL	1	2	13	5	4
	5	5	10	7	4
	10	8	7	5	5
	15	12	3	3	3
	20	12	3	1	1
LARRY	1	4	11	8	4
	5	7	8	5	4
	10	10	5	3	1
	15	12	3	2	1
	20	12	3	1	0
RUSSELL	1	3	12	8	5
	5	4	11	6	5
	10	12	3	1	0
	15	13	2	1	1
	18	15	0	0	0

*Russell's training terminated after Session 18.

passage of time because the multiple baseline-procedure effectively demonstrated that the subjects' performances did not alter appreciably until training was initiated.

Performances during the first few training sessions for Michael, Larry, and Russell in the first group, and Jessie in the replication group, indicate difficulties with the training of skill components in a predetermined sequence. The numbers of steps performed correctly by these subjects during the initial training sessions were fewer than during baseline. This drop was largely due to the fact that during baseline, these subjects performed some steps correctly according to the response classification, but not in the order prescribed in the training program. Such responses were scored as correct during baseline sessions, before training was initiated, but were treated as incorrect responses during training. The drop in performance below baseline levels in the initial training sessions is, thus, attributable to the "undoing" of sequences of correct responses established during baseline.

The advantage of training toothbrushing using the same predetermined sequence of steps for all subjects is that the trainer is not required to determine the sequence of steps individually for each subject. From a practical standpoint, this is an important consideration because trainers of retarded individuals are often limited in the amount of time available for training. It is also more parsimonious to communicate a written program with a set sequence of task components. Nonetheless, it can be questioned whether these advantages outweigh the disadvantages of undoing any sequence of correct responses established during baseline. One could speculate that Michael, Larry, and Russell might have achieved the performance criterion several sessions earlier had it not been for the training requirement of a set sequence of correct responses different from the performance sequence in baseline. Although this was not done in the present study, the sequence in which the 15 steps of the program was trained could have been determined from the baseline performance of each subject. In a

task such as toothbrushing, sequence of components in a task analysis is largely determined by the task. Applying the toothpaste to the brush as one component, for example, must appear after the toothpaste cap is removed. Sequence is also partially determined by the function of the component; *e.g.*, rinsing of the sink should appear after the brushing behaviors. Given restrictions of the task and the function of the component, the sequence of components can be established by the subject and maintained throughout training.

A limitation of the present study is its emphasis on demonstrating acquisition of toothbrushing behaviors. The durability and generalizability of the newly acquired behaviors trained in the specific training situation are of relevant interest. Limited inferences concerning the generality of the produced effects can be gleaned from the results reported for the systematic replication in the present study. Unfortunately, follow-up data on subjects' performances are unavailable.

In summary, the present results constitute the kind of evaluation information that is generally unavailable for other published programs or guides for the training of mentally retarded individuals. With an increase in such programs for self-care training of mentally retarded individuals, the need for valid, reliable evaluation information becomes more pressing. Funding agencies, professionals, and consumers are demanding evaluation and accountability from those developing educational programs and products, often asking questions that the developer has difficulty answering without enormous expenditures of time and resources. The contribution of single-subject designs and the functional analysis of behavior to evaluation problems would seem to hold promise for supplementing, or even supplanting, more traditional evaluation tools.

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