JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1984, 17, 57–69 NUMBER 1 (SPRING 1984)

TRAINING AND GENERALIZATION OF REACH-GRASP BEHAVIOR IN BLIND, RETARDED YOUNG CHILDREN

VIVIAN I. CORREA, CLAIRE L. POULSON, AND CHARLES L. SALZBERG

VANDERBILT UNIVERSITY AND UTAH STATE UNIVERSITY

The effects of a graduated prompting treatment procedure were analyzed in three phases of an experiment on the training and generalization of reaching-grasp responding in 2- to 4-year-old blind, severely or profoundly retarded children. In Phase 1, we used a multiple-baseline across-subjects design to investigate the effectiveness of the treatment on midline reach-grasp responding. In Phase 2, we used a reversal design to investigate the effects of repeated implementations and withdrawals of the treatment. In both phases, generalization to right and left positions was measured. In Phase 3, in a multiple-baseline across-responses design, the treatment was implemented in right and left positions. Also in Phase 3, shift of stimulus control from toy-sound to verbal instructions was measured. The results showed that (a) the graduated prompting procedure was effective in training reach-grasp responding in all three children; (b) for one child, the effects were durable over repeated applications of the treatment procedure, but were not maintained during withdrawals; (c) for another child, the treatment procedure was effective in teaching reach-grasp responding in all three positions; and (d) for the same child, training of reach-grasp responding generalized to toys presented without sound, given only the verbal instruction.

DESCRIPTORS: blind, prompting, manual exploration, severely handicapped, preschool children

In infants and young children, the acquisition of fine motor skills, such as reaching, touching, and grasping objects, is critical for the development of exploratory behavior. If a young child is blind and severely or profoundly mentally retarded, the effects of these handicaps on the development of such exploratory behavior can be severely limiting.

The single handicap of blindness can severely impede normal development. Warren (1977) states that in young, blind children there is:

> prolonged and excessive use of the mouth for exploration to the detriment of the use of the hands; failure to engage in mutual exploration of two hands and failure to maintain the hands in a midline posture; excessive stereotypic behavior such as rocking, head banging, and arm waving; very late or absent creeping; and delayed walking. (p. 79).

Like the young blind child, the young severely or profoundly retarded child has significant delays in exploratory behavior. Moreover, the additive effects of blindness and mental retardation further impair a young child's abilities to learn. The inability of a young, blind, severely or profoundly retarded child to reach out to objects in the environment or to move freely, coupled with the increased risk of developing stereotypic behavior patterns (Guess, 1966) can seriously impair the child's awareness of external stimulation and thus, independent exploration of the environment.

Because of the reported high incidence of visual handicaps among the mentally retarded (Ellis, 1979), and because of the lack of separate research on intervention strategies with the young, blind

This research was supported in part by Grant HD-00973 from the National Institute of Child Health and Human Development. Sincere appreciation is due to Everett Hill for support and expertise in the area of the blind; to Alfred Baumeister for guidance and support; to research assistants Beth Coppersmith, Bettie Richardson, Yvonne Houze, and Marilyn Stone; to the parents, children, and program teachers; Linda Maggart for manuscript preparations.

Inquiries or requests for reprints should be sent to Vivian I. Correa, who is now at the College of Education, Box 4560, Texas Tech University, Lubbock, Texas 79409.

severely or profoundly mentally retarded child, it is critical to provide an informed research base for intervention with these children.

Authors of educational programs for the young, blind child recommend a variety of sensory stimulation activities (Barry, 1973; Carolan, 1973; Fowler, 1976; Fraiberg, 1977; Mori & Olive, 1978; Sokolow & Urwin, 1976). For example, Sokolow and Urwin (1976) recommend a "play mobile" to stimulate hand movement of blind infants. Fraiberg (1977) recommends an "interesting space," such as toys on a lap tray and a cradle gym, to develop manual exploration. Unfortunately, there is little empirical evaluation of the effectiveness of these intervention strategies.

There is much more information on intervention with the young severely or profoundly mentally retarded child. That literature has emphasized the use of behavioral intervention strategies and documentation of child behavior change. Filler and Kasari (1981) demonstrated the effectiveness of parent intervention on the acquisition by severely retarded infants of six developmental tasks: visual tracking, auditory localization, rolling, reaching, weight-bearing puppy prone, and weight-bearing sitting. In their study, two parents were instructed to use a prompting and social praise procedure to increase three motor skills in each infant. The procedures were effective in a single-subject, multiple-baseline design across responses of each child. The procedure outlined by Filler and Kasari supports the use of a prompting hierarchy in which a teacher advances to increasing levels of instructional assistance, depending on the learner's ability to respond to the task.

Our research investigated the effects of a graduated prompting treatment procedure on the development of reach-grasp responding in three young, blind, severely or profoundly retarded children. The experiment was conducted in three experimental phases with three experimental designs. In the first phase, a multiple-baseline across-children design was used to answer the question: Does the graduated prompting procedure enhance the development of reaching and grasping noisemaking toys in three young handicapped children?

In the second phase, a single-subject reversal design was used to answer the question: Will the treatment procedure produce durable effects over time when it is first applied; that is, will correct responding be maintained when treatment is withdrawn? Furthermore, in the second phase vibration was added to the social reinforcement event to enhance its reinforcement value. The additional effectiveness of vibration was assessed.

In the third phase, a within-subject, multiple-baseline design across three responses was used to answer the question: Can the graduated prompting treatment procedure be used to produce responses at the right and left sides of a lap tray, as well as at the midline? Furthermore, in the third phase generalization was tested to determine whether there would be a shift of stimulus control from toy sound to a verbal instruction.

METHOD

Participants

Three blind, severely or profoundly retarded, nonambulatory boys between 2.3 years and 4.3 years of age participated in the study. Each of the boys attended different day programs 4 to 5 days a week, 6 hours a day, where all received seizure medication throughout the study. They were chosen because they were blind, severely delayed in development, and they did not reach out and explore objects in their environments.

The first child, Ernie, was 2.4 years old at the beginning of the study. Medical diagnosis included cortical blindness, cerbral palsy, and seizure disorder. The Griffiths Mental Deficiency Scales (Griffiths, 1976) showed an overall developmental age of 3.6 months, with the range of subscores from 2.9 months to 4.6 months. Informal assessment with the Functional Vision Inventory (Langley, 1980) showed that Ernie had some light perception, but only in the upper right quadrant of his right eye.

The second child, Jason, was the oldest (4.3 years), and he functioned at a higher developmental level than the other boys. Medical diagnosis included cerebral cortical atrophy, congenital blindness, optic atrophy, cortical blindness, seizure disorder, severe motor delay, and failure to thrive. The Griffiths Scales indicated an overall developmental age of 4.5 months, with a range of subscores from 3.0 months to 5.5 months. The results of the Functional Vision Inventory indicated that Jason had no light perception at all. Jason continuously swayed his head during the sessions. These head movements were somewhat stereotypic, and resulted in his resting his head on the lap tray for an average of 5 times during a session. Because of the frequency of this behavior, the experimenter provided social praise contingent on "head up" behavior before approximately every third trial.

The third child, Cory, was the youngest (2.3 years) and most severely delayed. His records included diagnoses of congential blindness, hydrocephaly, severe motor delay, and seizure disorder. The Griffiths developmental evaluation suggested he was functioning at the 2.8-month level, with a range of scores from 0.4 months to 4.2 months. The Functional Vision Inventory showed some pupillary reactions to a penlight, but no tracking of a light or brightly colored object in any field of vision. Prior to each session, the experimenter gave Cory his morning juice in a bottle, and performed his routine range of motion warm-up exercises. Cory did the exercises because he had mixed body tone (i.e., floppiness and spasticity), and because the sessions were usually his first activity of the day. Each day, prior to the session, Cory engaged in arm extensions, leg extensions, log rolling, and head control lifting. It was hoped that these exercises would facilitate body control and movement in general, and reaching/grasping in particular. Cory sometimes bit or sucked his hands. When this occurred during sessions, the experimenter removed Cory's hands from his mouth before a new trial began, or before proceeding to a higher level of prompting.

Setting and Apparatus

Training was conducted at each child's center-based or public school program in rooms adjacent to his classroom. With the exception of program visitors, only the child and experimenter were present. The experimental rooms contained several tables, chairs, and a variety of educational and play materials. A VHS-video cassette recorder (Model #HR 4100AU) was used during sessions in which interobserver agreement was obtained.

Ernie was placed in an adapted wooden chair (0.91 m high × 0.36 m wide × 0.31 m deep) with a padded vinyl post (0.15 m high) between his legs to keep him stable and prevent him from slipping. Jason had an adapted wooden booster chair (0.91 m high × 0.36 m wide × 0.61 m deep), which allowed him to sit straddled over a padded vinyl roll to stabilize his trunk. Velcro and cotton straps were tied around his trunk to prevent him from slipping to the sides. Cory was placed in a Collier "Bobby Mac" standard infant high chair. Because of his severe lack of head and trunk control, rolled terry cloth towels were placed on Cory's sides to support body stability.

Each child had a lap tray. Ernie's was made of wood (1.3 m × 1.3 m) and had side molding 0.04 m high to prevent toys from falling off. Jason's lap tray was the same in size and was also made of wood. The standard Collier "Bobby Mac" lap tray was used on Cory's infant high chair (0.31 m × 0.41 m) to accommodate his limited arm and hand extension. Three small squares (0.05 m × 0.05 m) in the midline, right, and left of the center of each of the lap tray tops were designated with red plastic tape. The centers of these open squares were judged to be within arm's reach of all three children and were in a straight line. These stimulus presentation areas were used to ensure the consistent placement of toys by the experimenter, who sat next to and on the right side of the child, thereby permitting convenient hand-on-hand guidance.

Three noisemaking toys, no larger than 0.15 m × 0.15 m × 0.15 m were used for training. Ernie and Jason were provided with a rubber squeak toy, a bell, and a tin box with paper clips inside. Cory's toys were a rubber squeak toy, a bell, and a felt squeak toy. According to teachers, toys selected for the study were toys the children had never played with.

In addition, during the final condition of Phase 2, the effects of contingent vibration as a possible reinforcer for Cory's reach-grasp responding was investigated. A commercial vibrator, Body Massage by Windermere (Model #MS-31555) was used. The vibrator was placed in the high chair next to Cory's left side. An extension cord attached to the vibrator, with an Leviton on-off switch (Model #S5-120V), was placed near the experimenter so the vibrator could be turned on and off easily and quickly.

Response Definition and Procedure

The first author conducted experimental sessions daily during midmorning and midafternoon. Most sessions lasted approximately 20 minutes and consisted of three blocks of nine trials conducted in a randomized order at the midline, right, and left presentation areas. If the child became fussy or cried over 2 minutes, the session was terminated for the day. This occurred only four times, and only with Cory.

During most trials, the experimenter presented one of the three noisemaking toys in one of the three presentation areas on the lap tray. The experimenter squeezed, shook, or rang the toy for about 3 seconds. The experimenter recorded on a data sheet the occurrence and nonoccurrence of the reach-grasp response.

The dependent measure, reaching/grasping (one response), was the percentage of trials the child extended his arm in a reach that resulted in the child's touching the toy simultaneously with his thumb and at least one other digit of the same hand for a duration of at least 2 seconds or twice by the end of a 10-second trial. A correct reach-grasp response is defined in relation to the graduated prompting procedure described later.

The actual response topographies emitted by each child in meeting the reach-grasp definition were distinctive. Cory's reach-grasp met the minimum criteria for inclusion under the above definition. Ernie's and Jason's, however, were more sophisticated. Both routinely exceeded those minimum criteria by enclosing the toy with their fingers and lifting it off the tray. Because of Jason's severe motor impairment, he was only able to reach-grasp with his left hand.

The independent variable was the graduated prompting procedure. Table 1 outlines the graduated prompting treatment procedure for reach-grasp responding to noisemaking toys. In a typical trial, the experimenter sounded the noisemaking toy and waited until the child responded or until 10 seconds had passed, whichever occurred first.

As shown in the first column of Table 1, the graduated guidance procedure consisted of criterion trials and three levels of prompt trials. A criterion trial was one in which the experimenter provided no assistance to the child following activation of the toy sound, as described under Step 1 of Column 2. A prompt trial was one in which the experimenter provided one of three levels of assistance to the child in a gradual progression of steps, as shown in Table 1, Column 2, from lesser to greater levels of assistance. The greatest level of assistance, shown as Step 4, consisted of direct physical guidance of the child's hand by the experimenter.

Column 3 of Table 1 shows the child's response by level of assistance received. If the child emitted a reach-grasp response on a criterion trial under the Step 1 procedure, he emitted an independent response to the toy sound, and the response was counted as correct. If the child did not emit a correct response within a criterion trial, then his response to a prompt trial was measured. A reach-grasp response to any of the three kinds of prompt trials was an assisted response, and was not counted as a correct response. Prompt trials occurred only during the graduated guidance treatment procedure, and only if the child failed to emit a reach-grasp response within 10 seconds of the toy sound.

Not shown in Table 1 were probe trials delivered to Jason in which the instruction "Get the toy" was substituted for the toy sound. Probe trials differed from criterion trials only in that the sole discriminative stimulus for reaching-grasping was a vocal instruction.

Throughout the study and during all three kinds of trials (criterion, prompt, and probe) the children received social praise and the naturally occurring

Table 1
Graduated Prompting Treatment Procedure for Reach-Grasp Responding to Noisemaking Toys

Type of trial	Experimental procedures at graduated assistance steps	Child's response by level of assistance
Criterion	Step 1—No assistance. Present toy, produce toy sound. If reach-grasp occurs, reinforce. If no response in 10 seconds, go to next step.	Level 1—Independent response (correct response)
Prompt	Step 2—Give verbal prompt: "(Name), get the toy, it's in front of you." Produce toy sound. If reach-grasp occurs, reinforce. If no response in 10 seconds, go to next step.	Level 2—Prompted response (assisted response)
Prompt	Step 3—Take child's hand and place on object for 5 seconds, return hand to original position. Produce toy sound. If reach-grasp occurs, reinforce. If no response in 10 seconds, go to next step.	Level 3—Prompted response (assisted response)
Prompt	Step 4—Take child's hand and give direct physical guidance in reach-grasp behavior. Produce toy sound. If reach-grasp occurs, reinforce. If no refusal, end trial and begin at Level 1. (There were no refusals.)	Level 4—Hand-on-hand guided response (assisted response)

opportunity to manipulate the toy contingently on reaching and grasping. Social praise consisted of statements such as, "Good boy, you got the toy!" paired with hugs, pats, and kisses. Once the child reached and grasped the toy, he was allowed to play with it for 30–40 seconds.

In the data analysis, the percentage of correct responses was derived by dividing the number of correct responses by the number of criterion trials presented per block of nine criterion trials. Also, for Jason, the percentage of correct responses to voiced instruction probe trials was obtained by dividing the number of correct probe responses by the number of probe trials presented per block of nine probe trials. No graduated promping trials were used in Jason's probe procedure.

Experimental Conditions

Figure 1 provides an overview of the experimental conditions experienced by each child in the three phases of the experiment. The kinds of trials experienced by each child in each experimental condition are listed.

If a child received criterion trials at midline, left, and right positions of the lap tray, he received 9 trials of each kind per session, resulting in 27 trials per session. During one-third of all experimental sessions the block of nine midline trials was presented first, the block of right trials second, and the block of left trials third. The order in which a child experienced each kind of block of trials in a session was randomized.

The order of presentation of toys was controlled so that no toy was presented on more than two consecutive trials, and so that each toy appeared in each lap tray position and in each experimental condition approximately the same number of times. During over one-third of his sessions, Jason received an additional 27 voice-alone probe trials per session, following the 27 criterion trials.

During treatment conditions all children received graduated prompt trials at the midline position only, and, for Jason, eventually, at the left and right position as well. The number of prompt trials received depended on a child's response to the previous criterion trial; thus, the number of prompt trials per criterion trial could vary between zero and three.

Baseline. As shown in Figure 1, during baseline conditions for Cory and Ernie, only criterion trials occurred. The experimenter sounded one of the toys, placed it in one of the three positions on the lap tray, and waited up to 10 seconds for a reach-grasp response to the toy. If the child did not respond, another criterion trial was presented with a different toy. If the child did respond during any

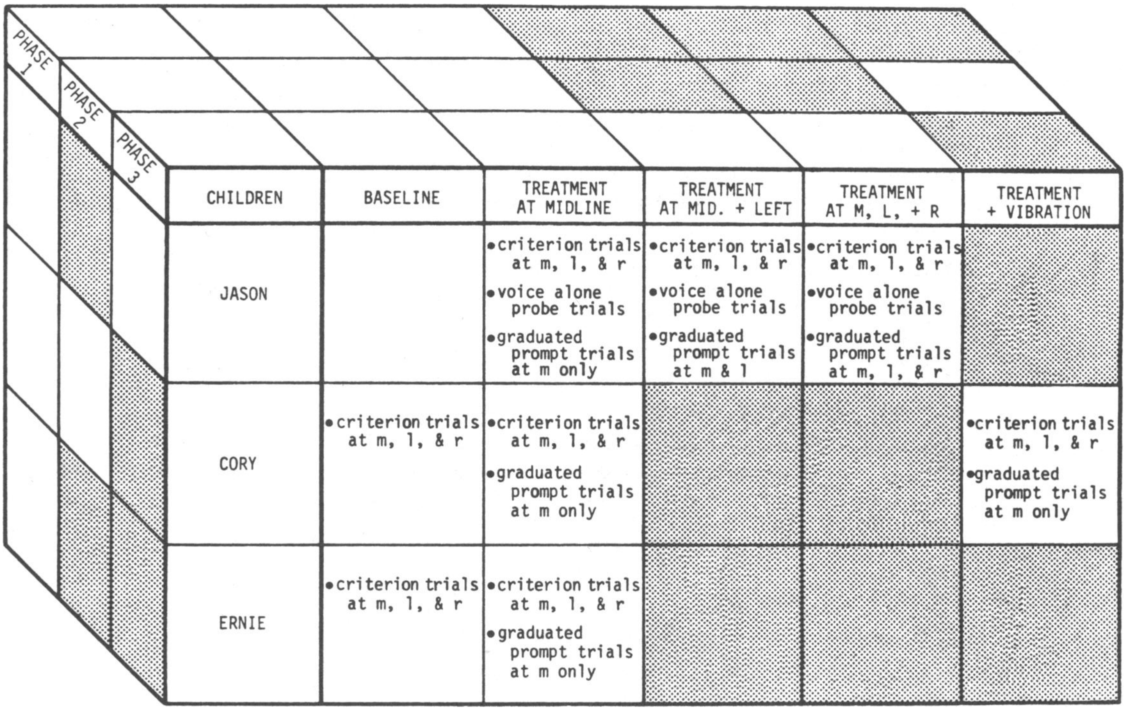

Figure 1. Experimental conditions for each child and for each phase and types of trials during each experimental condition.

criterion trial, the experimenter praised the child and allowed him to manipulate the toy for 30–40 seconds.

For Jason, baseline conditions also consisted of criterion trials at the midline, left, and right positions. Additionally, at the end of every second or third session, he received probe trials in which toys used in training were silently placed in each of the three lap tray positions, and the instruction "Jason, find the toy" was substituted for the toy sound. If Jason did not search for and grasp the toy, a new trial was begun. If he grasped the toy, he was praised and allowed to play with the toy for 30–40 seconds.

Treatment at midline. As shown in Figure 1, all three children received the graduated prompting treatment procedure, with treatment only in the midline position of the lap tray. Table 1 reviews the graduated guidance procedure listed in Figure 1. The procedure consisted of three levels of prompting to be used if a child did not reach-grasp independently on a criterion trial at midline. During treatment, criterion trials were presented at left and right positions as well, but these served only to measure generalization from treatment at the midline position. As shown in Figure 1, Jason continued to receive voiced instruction alone (no toy sound) probe trials during treatment as a measure of stimulus generalization.

Treatment at midline and left and right. As shown in Figure 1, for Jason only, the graduated prompting treatment procedure was eventally used to teach reaching/grasping to the left and right positions on the lap tray as well as to midline. All procedures were identical to those during treatment at midline. When treatment was implenented for a new position, it continued to be available for the previously taught positions. Most treatment sessions for Jason were approximately 18 minutes long.

Treatment and vibration. As shown in Figure 1, only Cory received the treatment and vibration condition. This condition differed from treatment at midline only in that contingent vibration accompanied social reinforcement during criterion trials. Only social reinforcement was provided during prompt trials. Whenever Cory emitted a correct reach-grasp response, the experimenter provided social praise and turned on the switch on an extension cord attached to the vibrator on Cory's left side. Vibration was provided for 30–40 seconds.

Experimental Design

Three experimental designs were used in the three phases of the experiment. Phase 1 was a multiple-baseline across-children design. As shown in Figure 1, Jason, Cory, and Ernie participated in Phase 1. As shown across the top of Figure 1, the experimental conditions were baseline and treatment at midline. Not shown in Figure 1, treatment began with Ernie, was extended to Jason after 16 blocks of nine baseline trials at midline, and to Cory after 24 blocks of nine baseline trials at midline.

Phase 2 began after Cory had experienced 24 baseline and 22 treatment-at-midline blocks during Phase 1. Phase 2 was designed to see if Cory's small treatment gains would be maintained in the absence of the treatment procedure, and if the addition of vibration to the social reinforcement event would promote further gains. Phase 2 was a repeated reversal design. As shown in Figure 1, Cory was the only child in Phase 2, and he experienced baseline, treatment at midline, and treatment and vibration experimental conditions. Not shown in Figure 1, Cory experienced a return to baseline conditions following each of two applications of the treatment condition, and as the final condition, he experienced treatment and vibration.

Phase 3 began after Jason had experienced 16 baseline and 30 treatment-at-midline blocks during Phase 1. Phase 3 was designed to see if the graduated prompting treatment procedure was powerful enough to produce reaching-grasping at the right and left sides of a lap tray, as well as at midline. Also in Phase 3 it was asked whether a shift of stimulus control from toy sound to voiced instruction alone would occur. Thus, Phase 3 consisted of a multiple-baseline across lap-tray positions. As shown in Figure 1, Jason was the only child in Phase 3, and he experienced baseline, treatment at midline, treatment at midline and left, and treatment at midline, left, and right. As in Phase 1, he continued to receive voice-alone probe trials measuring shift of stimulus control in all three positions. Not shown in Figure 1, Jason experienced treatment first at midline, next at midline and left, and finally, at midline and right.

Interobserver Agreement

During the sessions, the experimenter recorded on a data sheet the occurrence and nonoccurrence of the reach-grasp responses. The experimenter videotaped approximately half of the sessions. An independent observer recorded on a data sheet the child's reach-grasp responding from the videotapes at a location other than the school site. Observers were one undergraduate and two graduate students, who had had previous course work in behavior analysis and data collection. Training required approximately 30 minutes with each observer to obtain interobserver agreement at an 80% criterion. Interobserver agreement was assessed by a point-by-point comparison. Percent agreement was calculated by dividing the total number of agreements by the number of agreements plus disagreements and multiplying by 100. Throughout all three phases interobserver agreement was 93% to 100% for all three children for both occurrence and nonoccurrence of the reach-grasp response. Agreement was calculated both ways because there were long baselines with 0% responding. Interobserver agreement was calculated on 46% of all 240 blocks of baseline trials and 42% of all 218 blocks of treatment trials reported in the three phases of the experiment.

RESULTS

Figure 2 illustrates the percentage of trials in blocks of nine trials, in which each of the three children independently reached and grasped a noisemaking toy across experimental conditions during Phase 1. Prior to training, none of the chil-

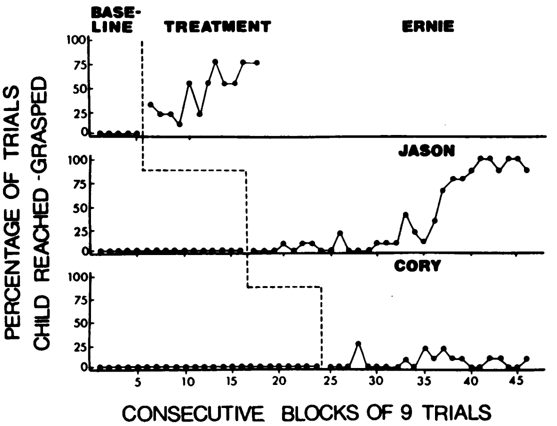

Figure 2. Percentage of trials, in blocks of nine trials, in which Ernie, Jason, and Cory reached and grasped a noise-making toy, within 10 seconds after the toy sound, without assistance, in the midline position, during baseline and treatment conditions.

dren independently reached and grasped a toy within 10 seconds. When the graduated prompting treatment procedure was introduced, reaching-grasping increased above baseline levels for each of the three children.

Trials with reaching and grasping increased up to 22% for Cory, 77% for Ernie, and 100% for Jason. Ernie and Jason showed clear and significant improvement in independent reaching/grasping in response to toy sound. Cory showed smaller gains during the treatment condition.

No generalization from training at midline was observed in the right and left positions by any of the three children. Not a single response occurred to right and left positions during Phase 1.

Figure 3 illustrates the percentage of trials in which Cory independently reached and grasped a noisemaking toy in Phase 2 across six experimental conditions. Data blocks 1–46 were obtained during Phase 1 and included in Phase 2. Independent reaching and grasping toys did not occur in any of the baseline blocks of trials.

During the graduated prompting treatment procedure, Cory's percentage of reaching-grasping responses increased over 0% for the first time but not until the fourth block of trials. During the first treatment condition, reaching and grasping reached 22%, with a mean of 7% across the 22 blocks.

During the second baseline condition, when the treatment procedure was withdrawn, Cory's performance immediately dropped to 0% responding. A return to the graduated prompting treatment procedure during block 44 was associated with reaching-grasping responses during up to 33% of the blocks of trials.

Although Cory's performance during treatment showed positive change over the baseline conditions, it was not clear whether the reinforcement procedure could be made stronger for Cory's independent reach-grasp responding than for prompted reaching/grasping. To assess that possibility, a third 0% responding baseline was obtained; and in the final condition, Cory received the graduated prompting treatment procedure, and contingent vibratory stimulation was added to the social reinforcement component during criterion trials. The mean percentage of trials in which reach-grasp responding occurred reached a high of 33% only once during the last 10 blocks of trials in Phase 2.

Figure 4 illustrates the percentage of trials in which Jason reached and grasped a toy across the midline, right, and left positions on the lap tray during the baseline and graduated prompting treatment conditions of Phase 3. Data blocks 1–46 at midline were obtained during Phase 1 and included in Phase 3. During all three baselines, Jason reached/grasped in response to the noisemaking toys during only four blocks, 31 and 35 in the right position and 36 and 38 in the left. The mean percentage of reach-grasp responding during the baseline condition was 0% in midline, 1% in right, and less than 1% in the left position.

The systematic introduction of the graduated prompting treatment procedure across the midline, right, and left positions was associated with improvement in reaching and grasping in response to toy sounds. Percentages of increase over baseline for the midline, right, and left were 63%, 42%, and 76%, respectively.

There was a savings over time in the number of trials to criterion performance of the treatment

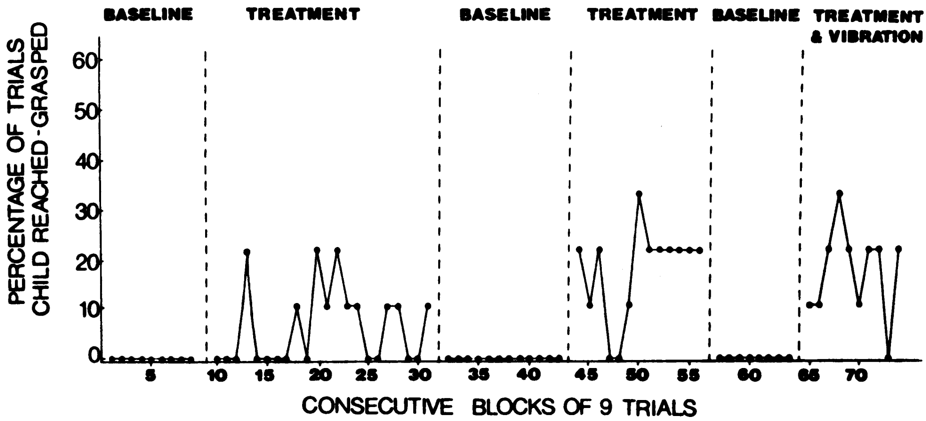

Figure 3. Percentage of trials, in blocks of nine trials, in which Cory reached and grasped a noisemaking toy within 10 seconds after the toy sound, without assistance, in the midline position, for all experimental conditions. The first 46 blocks of trials are the same data shown for Cory in Figure 2. The first 15 blocks of trials under baseline shown for Cory in Figure 2 have been omitted in Figure 3 to narrow the figure.

procedure. Jason required 25 blocks of treatment to reach 100% correct responding in the midline, or the first-trained position; 20 blocks to reach a high of 88% in the right, or second-trained position; and only 8 blocks to reach 100% in the left, or third-trained position.

Figure 5 illustrates generalized effects of the graduated prompting treatment procedure to a new situation in which toys were presented silently and the experimenter merely told Jason to find the toy. During baseline, Jason never reached and grasped toys presented silently following a verbal instruc-

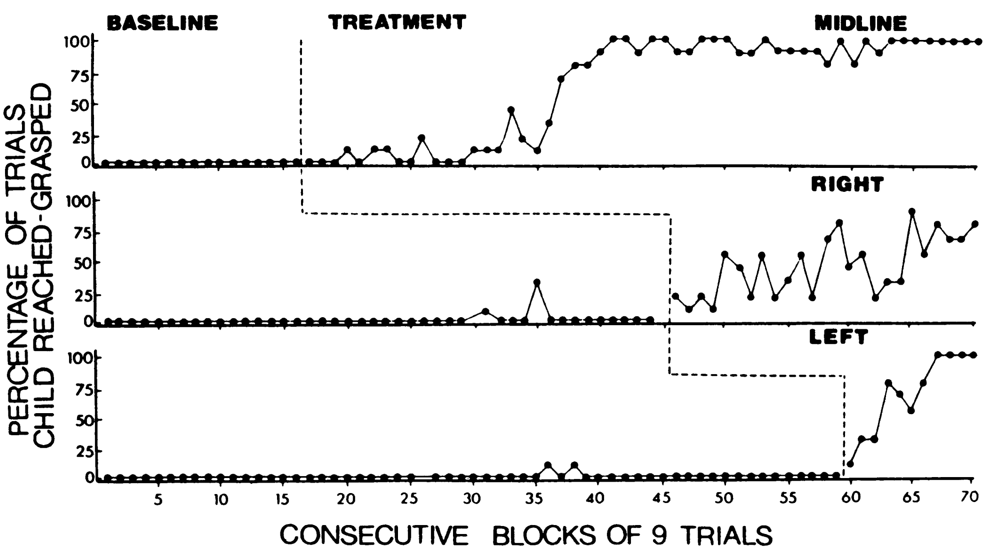

Figure 4. Percentage of trials, per block of nine trails, in which Jason reached and grasped a toy within 10 seconds after toy sound, without assistance, in baseline and treatment conditions, across the midline, right, and left positions of the lap tray. The first 46 blocks of trials at midline are the same data shown for Jason in Figure 2.

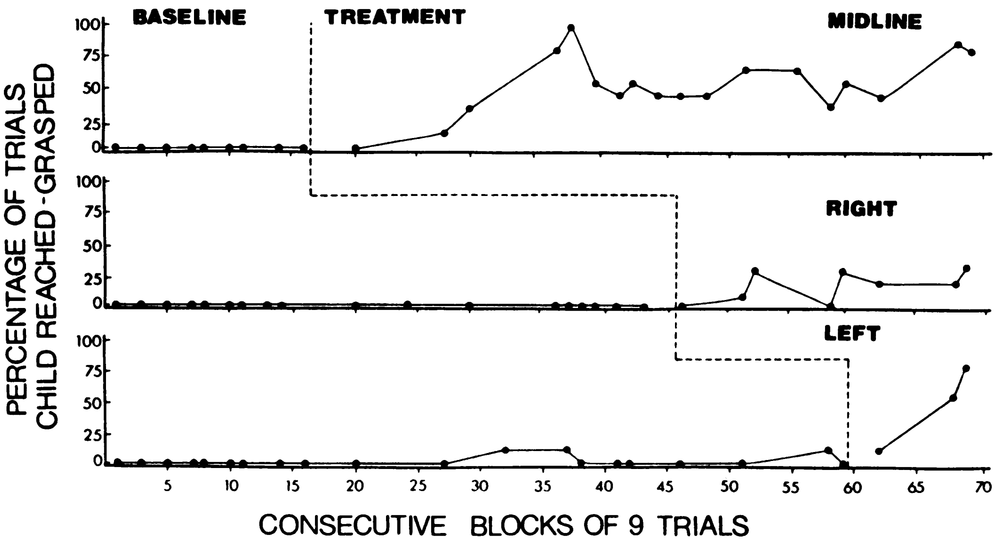

Figure 5. Percentage of generalization trials, per block of nine trials, in which Jason reached and grasped a toy within 10 seconds after verbal instruction, without assistance, in baseline and treatment conditions, across the midline, right, and left positions of the lap tray.

tion in the midline or right position. He did reach and grasp toys in three blocks on the left position (blocks, 32, 37, 58) during baseline. For these three blocks only 11% correct responding was demonstrated.

The introduction of the graduated prompting treatment procedure with toy sound available at the midline, right, and left positions, as shown in Figure 4, was accompanied by an increase in reaching/grasping during voice-alone probe trials as shown in Figure 5. During probe trials Jason reached and grasped toys during up to 100% of trials at midline, 33% of the trials on the right, and 77% on the left, only after the graduated prompting treatment procedure was implemented in those positions in the presence of toy sounds.

In summary, it was clear that by teaching Jason to reach and grasp toys that made sound, in the midline, right, and left positions, he could, without additional training, perform reaching and grasping responses in all three positions when verbal instruction was the only prompt for responding. Shift of stimulus control from toy sound to voiced instruction occurred in Phase 3.

DISCUSSION

This experiment provided support for the effectiveness of a graduated prompting treatment procedures in training motor skills with severely or profoundly retarded individual (Filler & Kasari, 1981; Gold, 1972; Lent & McLean, 1976), by extending the procedures to children who are also blind. Such children are frequently inactive and unresponsive to external stimulation, and they often engage in stereotypic behavior. Teaching them to reach-grasp objects appears to be a prerequisite to exploring their environments more routinely and more independently.

In Phase 1 of this experiment, functional relations between the reaching and grasping response and the graduated prompting treatment procedure were demonstrated across three young, blind severely or profoundly retarded children who, during baseline conditions, never reached/grasped. To answer further questions about the effectiveness of the treatment for individual children, two of the children from Phase 1 participated in additional experimental sessions under Phases 2 and 3.

A reversal design in Phase 2 demonstrated that the graduated prompting treatment procedure reliably produced reaching-grasping in Cory. Because termination of the treatment during return to baseline in Phase 2 consistently resulted in total and instant cessation of reaching/grasping by Cory, reaching-grasping does not seem to be a skill that will be maintained by naturally occurring contingencies once treatment is withdrawn.

Nevertheless, Cory's was a singular case. The fact that he stopped reaching-grasping so abruptly with the introduction of the return to baseline conditions confirms our observations that Cory's reaching-grasping on criterion trials occurred only following previous prompt trials in which hand-on-hand guidance was provided. During baseline conditions, no such prompting was provided, and Cory did not reach-grasp independently. During treatment Cory did reach-grasp independently during up to 33% of the criterion trials.

Because Cory did not show increasing levels of reaching-grasping during the two treatment conditions, we decided to provide differential reinforcement for reaching-grasping independently. During treatment for all the children, social reinforcement was available for responding during prompt as well as criterion trials. We did not want to stop providing social reinforcement during Cory's prompt trials, so we attempted to identify another potential reinforcer to deliver along with social praise contingently upon correct responding to criterion trials.

Among the variety of potential reinforcers, food and juice were eliminated because they were too difficult to administer to Cory. He had a severe tongue thrust, excessive drooling, and he frequently mouthed his hands. Because Cory laughed whenever vibration was administered, and because it has been shown to be an effective reinforcer for some severely or profoundly retarded individuals by Bailey and Meyerson (1969) and Ohwaki, Brahlek, and Slayton (1973), we decided to try it with Cory during the final condition of Phase 2. In fact, vibration contingent on independent reaching-grasping had no effect on Cory's level of reaching/grasping, and, thus, despite his laughter, it was not a reinforcer for his reach-grasp response. Although we were not entirely satisfied by the small but reliable gains in Cory's reaching-grasping, his teachers told us they viewed his gains as large and significant, and certainly as prerequisite to further gains they hoped to achieve with him.

For Cory, as well as for Ernie and Jason, reaching and grasping was enhanced by the graduated prompting treatment procedure and the midline position only. No generalized effects were demonstrated across the right and left positions of the lap tray by any of the three children.

Phase 3 showed that the graduated prompting treatment procedure was effective for teaching reaching-grasping to Jason, not only in the midline, but also in the right and left positions. During treatment, Jason's reaching-grasping responses stabilized at 100% of trials in the midline and left positions. Because Jason had no functional use of his right hand, reaching for toys on the right required him to cross his midline with his left arm and extend his left hand to grasp the toys. Although he never reached 100% correct responding on the right, the degree of proficiency (up to 88% correct) he attained represented socially significant gains over his baseline performance.

Although Jason had not shown spontaneous response generalization across lap tray positions, he did show spontaneous stimulus generalization. Jason's performance on voiced instruction probes demonstrated a successful shift of stimulus control from reaching-grasping in response to toy sounds, to reaching and grasping in response to verbal instructions. This achievement would allow teachers to prompt Jason's reach-grasp behavior from the other side of a classroom, while they were working with other students.

Jason's newly learned midline reach-grasp response to voiced instructions generalized without special training to right and left positions, but only following the successful implementation of the graduated prompting treatment procedure with toy sound activated in the right and left lap tray positions. Jason's ability to search his lap tray in all positions during generalization probe trials following treatment on nonprobe trials indicated a more sophisticated level of exploration than that of the other two children. These skills should be useful to him outside the training sessions. Data on children's generalization of reach-grasp responding in a variety of nontreatment environments would be desirable. Implementation of the graduated prompting treatment procedure in the classroom was easily taught to the teachers at the end of the experiment.

Graduated prompting was shown to be an effective procedure for a new population of severely or profoundly retarded children: the blind, nursery-aged child. It was implemented without the use of extraordinary reinforcers. Social praise, hugs, pats, kisses, and naturally occurring toy manipulation were available throughout all baseline conditions as well as during all criterion and prompt trials of the graduated prompting treatment procedure. Contrived vibratory stimulation, delivered contingently on Cory's independent reaching-grasping, was not shown to be a reinforcer; it did not enhance the value of the ongoing social reinforcement procedure for Cory's reaching-grasping.

The graduated prompting treatment procedure may be ideal for nonretarded blind infants and preschoolers. The need for such a program was indicated by Fraiberg (1977) whose descriptive research delineated the kinds of developmental delays shown by blind infants. Responding to sound as a discriminative stimulus for reaching-grasping noisemaking objects was tested by Fraiberg and found to be significantly delayed in blind children. Fraiberg described this skill as a prerequisite to object-concept development.

Furthermore, according to Fraiberg, the ability to reach and grasp following the onset of sounds may later serve as a "lure" for the blind child's gross motor movements of creeping and walking. If it is true that a blind child reaches an impasse in development because he or she does not understand the association beween sounds and objects, development can be enhanced through the use of these procedures.

Further study of the specific technology used in this research is needed: replication with more children; a component analysis of the graduated prompting treatment procedure; generalization to different environments; and the maintenance of the treatment effects.

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Received September 27, 1982
Final acceptance June 13, 1983