



Pergamon

Research in Developmental Disabilities
24 (2003) 58–74

Research
in
Developmental
Disabilities

Generalized imitation and the mand: inducing first instances of speech in young children with autism

Denise E. Ross*, R. Douglas Greer

*Teachers College, Columbia University, Health and Behavior Studies,
Box 223 525 W. 120th Street, New York, NY 10027, USA*

Received 20 March 2002; received in revised form 13 June 2002; accepted 14 October 2002

Abstract

It has been suggested that the use of a generalized motor imitation sequence before a vocal model may be an effective procedure for teaching nonvocal children with autism to speak. However, the tactic has rarely been empirically demonstrated. The purpose of this experiment was to test the effects of presenting a rapid generalized motor imitation sequence before an opportunity to imitate on the vocal speech of nonvocal children with autism. Participants emitted no vocal imitations during a mand training baseline. During the intervention, a rapid motor imitation sequence was presented before an opportunity to imitate a model's vocalizations. The teacher's presentation of the rapid motor imitation sequence was then faded by presenting an opportunity to vocally imitate without the sequence followed by an opportunity to independently mand. Results of the intervention phase indicated that all of the participants began to vocalize with the generalized motor imitation sequence and that mands were maintained during a follow-up phase and 3-month follow-up probes.

© 2002 Elsevier Science Ltd. All rights reserved.

Keywords: generalized imitation; mand; autism

1. Introduction

The failure to develop vocal speech can be a challenging characteristic of autism. Research suggests that nearly one-half of persons with autism do not have

* Corresponding author. Tel.: +1-212-678-8328; fax: +1-212-678-4034.

E-mail address: dross@exchange.tc.columbia.edu (D.E. Ross).

vocal speech (Rutter, 1978) and that few will attain it without intervention (Rutter, 1985). Because first instances of speech from nonvocal children with autism can be difficult to obtain, educators often facilitate the process by prompting and reinforcing imitative vocal behavior.

Shaping is one common tactic used to obtain imitative vocalizations from nonvocal children with autism (Harris, 1975). First, children are taught to imitate the gross and fine motor actions of an adult model. Next, any vocal sound is reinforced to increase vocalizations. Then, successive approximations to the vocalizations of a model are reinforced until a child's vocalizations reliably match those of the model. Lastly, an instructor differentially reinforces new vocalizations until they match those of a model. In this way, shaping procedures establish vocal imitation repertoires in nonvocal children with autism. Lovaas, Koegel, Simmons, and Long (1973) found that a shaping procedure resulted in increased vocal speech for nonvocal children with developmental disabilities. Sloane, Johnston, and Harris (1968) also found that nonvocal children with autism learned to emit vocal speech as a result of shaping.

Time delay is another common procedure that has been used to increase the imitative vocalizations of children with autism (e.g., Charlop, Schriebman, & Thibodeau, 1985; Halle, Marshall, & Spradlin, 1979; Matson, Sevin, Box, Francis, & Sevin, 1994). Instruction occurs during meal times or in other environments where functional speech can occur. The teacher vocalizes and then waits a predetermined number of seconds for the child to imitate the vocalization. When the child imitates the vocalization, the environmental stimulus to which the vocalization corresponds is given to the child. After the child can reliably imitate a vocalization, the model is faded, and the teacher simply waits a predetermined number of seconds for the child to emit the targeted word or sound before delivering the environmental stimulus as a reinforcer. Halle et al. (1979) found that the use of 15-s time delay resulted in speech in three children with mental retardation and promoted generalization across meals. Ingenmey and Van Houten (1991) demonstrated that a 10-s time delay procedure effectively increased the spontaneous speech of a child with autism during motor activities such as drawing or playing with a toy.

Prompting and reinforcing imitative vocal speech is also a common first step in teaching children to independently request items (i.e., mand). For example, Williams and Greer (1993) described a mand training procedure that began with a teacher reinforcing a student's vocal imitation of a model by providing contingent access to a targeted reinforcing stimulus (i.e., stimulus-specific contingent reinforcement) for which the student was under deprivation (i.e., an establishing operation). When the teacher's vocalizations were reliably imitated, independent mands were taught by displaying two or more reinforcing items under relevant conditions of deprivation, waiting a predetermined number of seconds, and then delivering the requested item contingent upon the student speaking the targeted word.

Using this procedure, Williams and Greer (1993) found that adolescents with developmental disabilities emitted more vocal speech during mand training than

during a linguistic curriculum procedure. Drash, High, and Tudor (1999) also found that children with autism readily acquired vocal imitation skills when mand training procedures were used. Many functional communication training (FCT) packages also use mand training procedures to establish communicative responses that replace aberrant behavior (Brown et al., 2000; Drasgow, Halle, & Ostrosky, 1998; Fisher, Thompson, & Kuhn, 1998).

Although mand training can be an effective procedure for teaching vocal speech to individuals with autism, establishing a vocal imitation repertoire remains an important first step. For students who do not already have vocal imitation skills, additional interventions such as shaping or time delay may be necessary to facilitate the acquisition of vocal imitation. However, shaping can be a relatively inefficient procedure. Time delay may be ineffective in some cases because it does not directly teach imitative vocal speech. Thus, a need exists for interventions that efficiently establish a vocal imitation repertoire to facilitate vocal training for children with autism.

Some research suggests that a generalized motor imitation sequence, a series of rapid motor imitations that occur immediately before a vocal model, may facilitate imitative vocal speech (Baer, Peterson, & Sherman, 1967; Sloane et al., 1968). During this procedure, an instructor rapidly models several motor actions which the child imitates and then immediately presents an opportunity to imitate a vocalization. If a participant imitates the vocalization, reinforcement is delivered, and the procedure begins again. When the individual can reliably imitate vocalizations, the motor imitation sequence is faded.

The generalized imitation procedure has been described in research studies, but has never been formally evaluated in research for its efficacy in establishing vocal imitation skills for nonvocal children with autism (Baer et al., 1967; Sloane et al., 1968). While numerous studies on generalized imitation have been conducted over the past 35 years, they primarily evaluated differences between vocal and nonvocal response classes rather than the benefit for inducing speech in nonvocal children with autism (Garcia, Baer, & Firestone, 1971; Harris, 1975; Young, Krantz, McClannahan, & Poulson, 1994). Research findings on generalized imitation showed that teaching motor imitations did not automatically result in vocal imitation of words by participants. In fact, shaping procedures were usually necessary to obtain words. Thus, efficient procedures for teaching vocal imitation of words without lengthy shaping procedures are needed.

Mand training procedures may be helpful in establishing vocal imitation following generalized imitation sequences. Because the mand specifies its own reinforcer and occurs under relevant conditions of deprivation (Skinner, 1957) as well as other establishing operations (Michael, 1982), powerful motivational contingencies can be established that result in functional communication for children with autism. For instance, Brown et al. (2000) found that establishing operations contributed to the effectiveness of a mand training procedure for children with developmental delays. Drasgow et al. (1998) found that the presence of inaccessible preferred items was a significant component of mand training for children with autism. Bowman, Fisher, Thompson, and Piazza (1997) found that a

listener's compliance with the appropriate mands of children with developmental disabilities increased mands and decreased aberrant behaviors. Although the contributions of mand training have been widely demonstrated, no studies on generalized imitation used mand training procedures.

The purpose of the present study was to test the effect of a generalized imitation tactic and mand training procedures on the acquisition of vocal speech by nonvocal children with autism. Specifically, generalized imitation as an antecedent procedure was used to establish vocal imitation skills during the initial stages of mand training. Thus, the objectives of this study were to formally evaluate the effects of a rapid generalized motor imitation antecedent and to extend the tactic to a mand training procedure.

2. Method

Five elementary-school aged children who met the criteria for a diagnosis of autism based on the DSM-IV participated in this study. Students A, B and C began the study and Students D and E entered at a later time. Each child was independently tested by a district psychologist prior to enrolling in the school in which the study occurred. The participants were evaluated using one or more of the following assessments: the *Leiter International Performance Scale* (Leiter, 1979), the *Vineland Adaptive Behavior Scales* (Sparrow, Balla, & Cicchetti, 1984), the *Preschool Inventory of Repertoires for Kindergarten* (PIRK) (Greer, McCorkle, & Twyman, 1996), the *Merrill-Palmer Scale of Mental Tests* (Stutsman, 1948), the *Mullen Scales of Early Learning* (Mullen, 1984), the *Bayley Scales of Infant Development* (Bayley, 1969), and the *Childhood Autism Rating Scale* (CARS) (Schopler, Reichler, & Renner, 1988). All five children were chosen as participants because they did not have spontaneous vocal speech, did not imitate vocal speech, and did not have a generalized imitation repertoire as determined by the above assessments, teacher and parental reports, and experimenter conducted pre-base-line assessments. Specific information on each participant is displayed in [Table 1](#).

2.1. Setting

The experiment was conducted at a large public school for regular and special education students from kindergarten to twelfth grade (regular education) or 21 years of age (special education). Each participant attended a self-contained kindergarten/first grade as part of an autism unit within the school that utilized instructional tactics from applied behavior analysis. Classroom staff included one teacher, three teacher's assistants, and two student teachers.

2.2. Dependent variables

The dependent variables in this study included three types of responses. *Vocal imitations* were defined as vocal speech with a close or identical approximation to

Table 1
Profile of participants

Student	Age	Standardized assessment data ^a	Targeted reinforcers and forms ^b
A	6.9	Leiter MA = 4.9–6.5	Ball, book, box (bah), chip (ch), juice, music, toy
B	6.6	Merrill-Palmer MA = 1.1 Vineland Communication: 1.0 year Daily living: 1.3 years Socialization: 1.0 year Motor skills: 1.1 years	Ballcard (ball-car), batman (bat-man), book (bu), candy, chip, coke, mama, popcorn, toy
C	5.5	Mullen Receptive language: 10 months Expressive language: 9 months Bayley MA = 18 CARS Severe autism Vineland Communication: 1.0 year Daily living: skills 2.0 years	Candy, chip, juice, popcorn (pop-corn), pretzel, soda
D	7.6	Rosetti Receptive-expressive language: 6–9 months	Baby doll (baby), cake, cheese doodle (chee doo do), chip, popcorn (pa-cor), pretzel (pe-zo), raisin (ra-si)
E	7.8	Vineland Communication, daily living skills, and socialization: 10 month–2.3 years CARS Moderate autism	Candy (a-dee), cheese doodle (ch doo do), chip (ch -p), juice (j), soda (s-o-da)

^a All participants were assessed during the academic year immediately prior to the study.

^b Modified pronunciations of targeted stimuli are enclosed in parentheses.

the speech of a model. A correct response was scored when the participant said the exact word or an acceptable approximation to the teacher's model within 5 s after the teacher presented the vocal model. An incorrect response was scored if the participant did not say the word within 5 s of the model, did not imitate the model at all, or emitted other verbalizations before the target word. *Mands* were defined as vocal requests emitted without a model. A correct mand was scored if the participant said the name of an item with no other verbalizations within 5 s of the teacher showing the participant the item. An incorrect mand was scored if the participant did not emit the correct word within 5 s of the presentation of the item, spoke the word but refused the item, or emitted other verbalizations before

emitting the target word. *Generalized vocal imitations* were vocal responses that followed a rapid number of non-vocal motor imitations and that were an exact imitation of or a close approximation to the speech of a model. A correct response was scored if the participant imitated each motor imitation and then emitted a close approximation or identical imitation of the teacher's vocal model. An incorrect response was scored if the participant did not imitate each motor action, did not imitate the teacher's vocal model within 5 s of the presentation, emitted other verbalizations before emitting the target word, or did not imitate the teacher's vocal model at all. [Table 1](#) displays the vocalization forms targeted for each participant.

2.3. *Data collection and interobserver agreement*

Frequency data on correct responses and incorrect responses during opportunities to respond were collected. Each opportunity, or trial, consisted of the antecedent procedure (verbal model only, rapid motor model, or mand probe), the response, and the consequence. The teacher, the experimenter, one student teacher, and a teacher's assistant collected data during 30-min sessions conducted once per day. A second observer collected data with the instructor during reliability checks. Correct and incorrect responses were recorded via paper and pencil for each opportunity to respond. Interobserver agreement was calculated for correct responses during approximately 20% of treatment sessions. Interobserver agreement was calculated for each session by dividing the total number of agreements for the presentation of opportunities to respond by the number of agreements plus disagreements and multiplying by 100%.

Mean interobserver agreement for opportunities to respond and correct responses for Student A's instructional sessions was 99% (range, 97–100%). Mean interobserver agreement for opportunities to respond and correct responses for Student B's instructional sessions was 98% (range, 90–100%). Mean interobserver agreement for opportunities to respond for Student C's instructional sessions was 96% (range, 89–100%). Mean agreement for Student C's correct responses was 94% (range, 90–100%). Mean interobserver agreement for opportunities to respond and correct responses for Student D's instructional sessions was 100%. Student E's interobserver agreement was 100% for opportunities to respond and correct responses.

2.4. *Design and procedure*

Two different multiple baseline across subjects designs were used to assess the effects of the rapid motor imitation sequence on vocal verbal behavior. A delayed multiple baseline across subjects design (Heward, 1978 as cited in Cooper, Heron, & Heward, 1987) with 3-month follow-up probes was used for Students A, B, and C. A multiple baseline across subjects design (Baer, Wolf, & Risley, 1968) was used for Students D and E. No follow-up probes were conducted for Students D and E because they entered the study after Students A, B, and C.

2.5. *Pre-baseline procedures*

Prior to baseline, the PIRK (Greer et al., 1996), a curriculum-based assessment, and standardized assessments were used to confirm teacher and parental reports about the participants' lack of vocal speech (see Table 1). Multiple opportunities to emit mands and imitative words were given to each participant. The participants did not emit any vocal speech nor did they achieve the 80% mastery criteria for instructional control probes. Subsequently, instructional programs were implemented to teach the participants to: (a) sit still for 2 s; (b) make eye contact for 1 s; (c) follow five interspersed one-step directions; and (d) imitate 10 motor actions.

Motor imitations were individually trained through physical prompts that were gradually faded to lesser prompts until a participant could independently perform ten large motor actions (i.e., clapping hands or touching the head) and small motor actions (i.e., touching the nose or eyes) with 90% accuracy for three consecutive instructional sessions. During subsequent generalized motor imitation training, the teacher randomly interspersed motor actions and thinned reinforcement until a participant could imitate trained and untrained motor actions on an individualized variable schedule of reinforcement. Reinforcers identified during pre-baseline procedures were used for motor imitation training. Participants received approximately 10–20 trials per instructional program daily until criteria were achieved. The duration of pre-baseline procedures for Students A, B, and C was 8, 16, and 12 months, respectively. The duration of pre-baseline procedures for Students D and E was 22 and 12 months, respectively.

2.6. *Mand training baseline*

Although all participants received mand training during baseline, the procedures for Students A, B, and C differed slightly from those used with Students D and E. Students A, B, and C received gestural-to-mand training during baseline whereas Students D and E received echoic-to-mand training during baseline. During all sessions, the teacher sat facing the participant at a table. Consumable items were on a tray and non-consumable items such as toys were on or near the table. Twenty opportunities to respond were presented during each session. One to five sessions occurred daily.

During gestural-to-mand training, the teacher chose an item from an array of items, presented it to the participant, and waited 5 s for the participant to request the item by pointing to it. Contingent upon the participant pointing to the reinforcer, the teacher said the word for the item (e.g., "cookie" if the item was cookie), waited approximately 2 s for the participant to imitate the word, then delivered the reinforcer to the participant. After the participant consumed or manipulated the reinforcer, the teacher presented a second trial in the same manner. If the participant did not imitate the teacher twice consecutively, the teacher continued to present opportunities to respond using the gestural-to-mand training sequence as described earlier. If the participant imitated the teacher twice

consecutively, the gestural mand component was faded and echoic-to-mand training occurred as described below.

During echoic-to-mand training, the teacher chose an item from an array of known reinforcers. The item was presented to the participant and the teacher said the name of the item (e.g., “cookie” for a small piece of a cookie). The teacher waited 5 s for the child to imitate the word. If the child responded with the targeted word form (e.g., “cooka” for cookie), the teacher gave the participant a small piece of the food reinforcer or 5 s to interact with a nonfood reinforcer. The teacher did not praise correct responses but periodically said, “You can have it” or “Sure.” If the child did not say the word within 5 s or gave an unacceptable form of the word, the reinforcer was not delivered. If the participant said a word other than the target word (e.g., “juice” when a cookie was presented), the teacher gave the participant the requested item and not the targeted item. If the child emitted two consecutive incorrect responses during vocal imitation probes, the teacher broke the word into smaller parts/syllables or switched to a successive approximation for the target word (e.g., “chee-doo-dle” for cheese doodle).

If the participant said the word, the teacher gave the participant the nonfood item for 5 s or an edible item until it was consumed. The next trial was presented using the same procedure. If the participant did not say the word or emitted an incorrect response, the teacher did not deliver the item. The teacher repeated the procedure for the next trial. If the participant emitted two consecutive incorrect independent mands, the teacher began the vocal imitation training procedure as described earlier.

2.7. Treatment

The training sequence for the treatment procedure is presented in Fig. 1. As in baseline, all targeted reinforcers were on the table on a plastic tray. Before each session of vocal training, the teacher chose a word and an appropriate form from the participant’s reinforcer list. The first form of each word to be taught was the word itself with no approximations. However, if the participant could not say the word, it was modified by dividing it into syllables or by accepting a close approximation of the word. For example, “popcorn” became “pa-cor” for Student D. Phonetic forms of targeted words were selected based on agreement between two or more instructors. In most cases, the participants were able to emit the word itself as the initial form. One word was targeted for each instructional session. An instructional session ended when a participant received a minimum of 10 total opportunities to respond across response types. Approximately one to six different items were targeted for instruction during each 30-min session. However, the number of trials in each daily session varied across sessions and participants. Instruction typically continued until a participant indicated satiation for the targeted item by pushing the item away, refusing to consume it, or reaching for a new item.

First, the teacher gained the participant’s attention by saying, “Look at me” or the participant’s name. The teacher said, “Do this,” and modeled one large motor

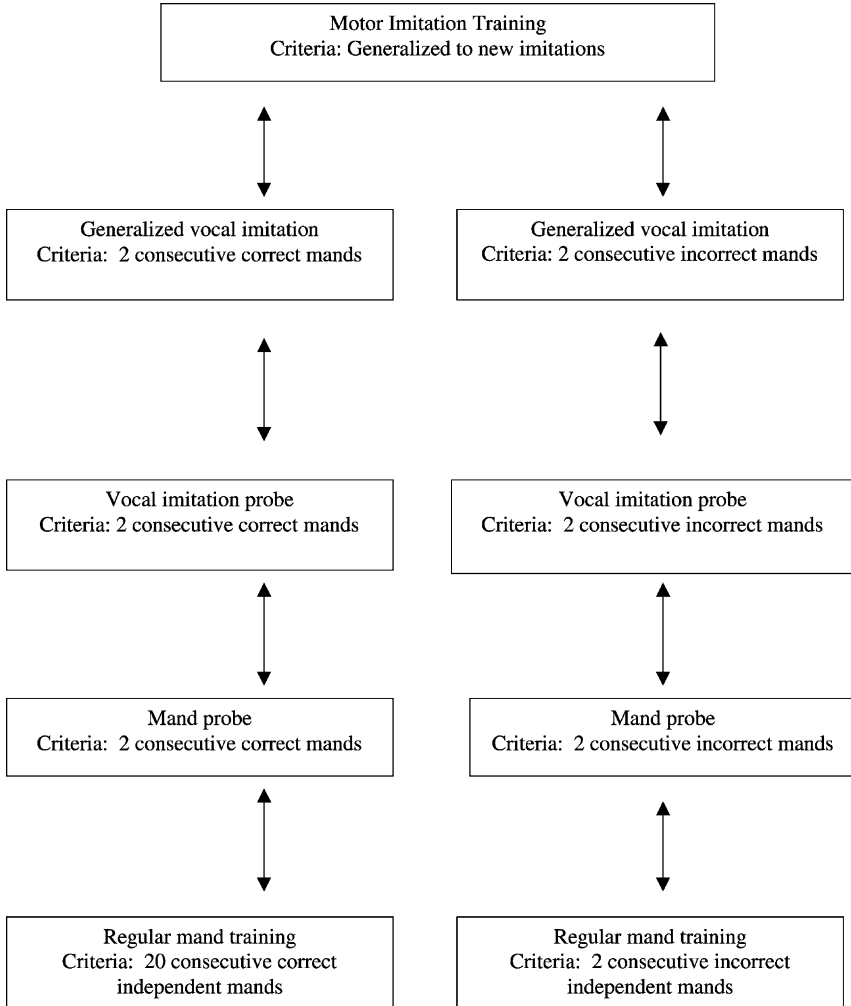


Fig. 1. Training sequence for generalized vocal imitations, vocal imitations, and mands during treatment.

action such as clapping hands. If the participant imitated the action, the teacher said, “Do this,” and immediately modeled another large motor action such as touching the head. If the participant imitated that action, the teacher modeled two to three small motor actions such as touching the nose, mouth, and teeth in the same manner. Immediately after the final small motor action, the teacher said a targeted word alone (i.e., “cookie”) and waited 5 s for the participant to respond. If the participant said the word, the teacher immediately gave the participant a piece of the targeted food item to consume or the targeted toy for 5 s. If the participant did not imitate an action at any point, the teacher began the entire sequence again. After two consecutive incorrect responses, the teacher changed

the reinforcer or added more actions to the motor antecedent sequence. The procedure was repeated for one more trial.

If the participant emitted a correct response for two consecutive words, the teacher immediately began vocal imitation probes in the same session. The teacher presented the targeted reinforcer to the participant and modeled the targeted word. She waited 5 s for the participant to imitate her vocalization. If the participant made a non-targeted utterance before saying the targeted word or did not say anything, the teacher gave the participant a second opportunity and then, after two consecutive incorrect responses, returned to generalized vocal imitation training. If the participant emitted a correct response to a vocal model, the teacher delivered the item. After 5 s or after the participant had consumed the item, the teacher presented the item again by repeating the vocal imitation training procedure. If the participant made two consecutive correct vocal imitation responses, the teacher began mand probes.

During mand probes, the item was presented to the participant by holding it up. The teacher did not say anything and waited 5 s. If the participant requested the item by saying the targeted word, the item was immediately delivered to the participant for 5 s or until it was consumed. No verbal praise was given. If the participant said nothing or did not say the targeted word for two consecutive correct trials, the teacher returned to vocal imitation training. If the participant did not emit vocal imitations, generalized vocal imitation training was reinitiated. The teacher continued the session until a total of at least ten opportunities to respond (e.g., across generalized vocal imitations, vocal imitation probes, and mands) had been given.

Treatment ended when the targeted words occurred without the generalized imitation antecedent procedure. For example, a child who only needed the generalized imitation procedure for the first two trials of an instructional session while all remaining responses were vocal imitations or mands was ready to move to the follow-up condition.

2.8. Follow-up

Follow-up sessions were identical to baseline sessions with the exception of the number of trials, which varied across sessions and participants. No new mands were targeted.

2.9. Three-month follow-up probes

Probes were conducted with Students A, B, and C 90 days after the study was completed. The participants' teacher recorded the number of correct mands and vocal imitations emitted for 5 consecutive days. Each probe session was the duration of a child's classroom instructional time, which was approximately 2 hr. The teacher sat facing the participant and administered routine instruction (e.g., compliance, counting, reading, etc.). Following an instructional trial, the participant was given an opportunity to independently mand a reinforcer. The teacher recorded the response on a data collection sheet. These data were

summarized for the probe sessions. Probes were conducted on items trained during the study and on items for which the participant had received training during the 3-month period after the follow-up phase.

3. Results

Fig. 2 shows the percentage of correct responses emitted per session during baseline, treatment, follow-up, and 3-month follow-up probes for Students A, B, and C. The percentage of correct responses emitted per session was calculated by dividing the number of correct responses emitted during each session by the

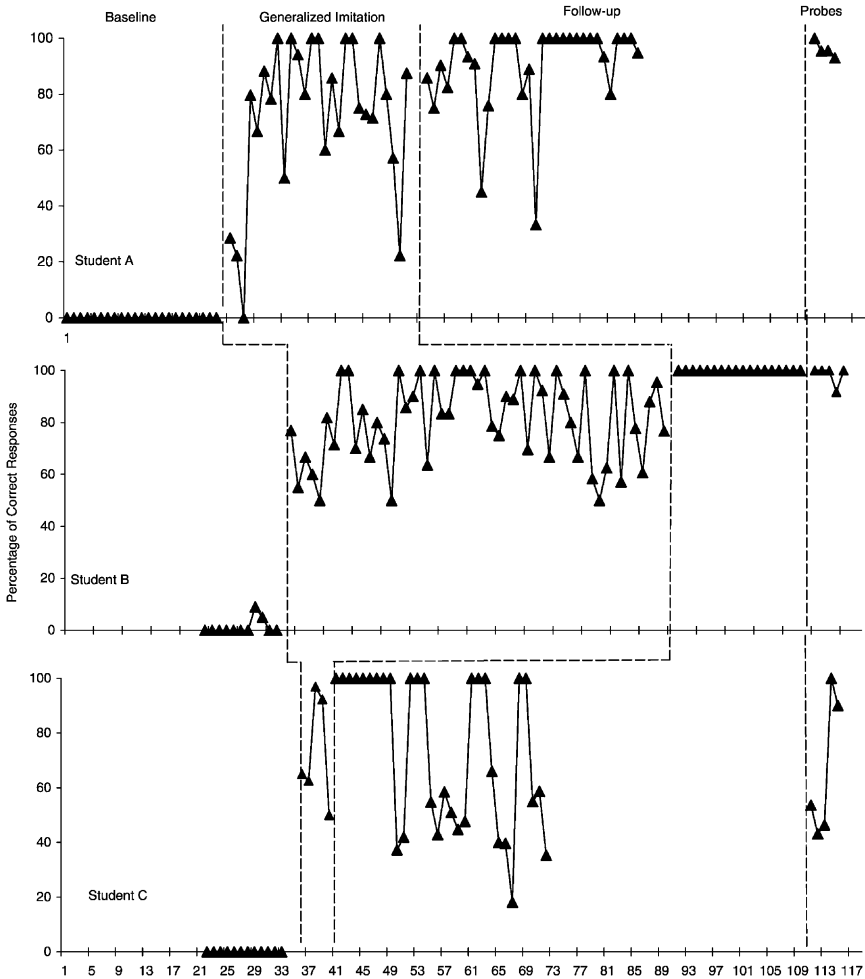


Fig. 2. Percentage of correctly emitted mands across generalized vocal imitations, vocal imitation probes, and mands for Students A, B, and C.

number of opportunities to respond per session and multiplying by 100. The following results describe the mean number of correct responses per session given the mean number of opportunities to respond per session.

During baseline, Student A emitted 0 correct responses given 660 total opportunities to respond. Student B emitted a mean of .20 correct responses per session (two mands total) given 140 total opportunities to respond. Student C emitted 0 correct responses given 240 total opportunities to respond. During treatment, Student A’s mean number of correct responses increased to 8 (range, 0–21) given a mean of 11 opportunities to respond per session (range, 2–49). Student B’s mean number of correct responses increased to 11 (range, 2–28) given a mean of 14 opportunities to respond (range, 2–36) per session. Student C’s mean number of correct responses increased to 12 (range, 5–31) given a mean of 15 opportunities to respond per session (range, 4–32).

During follow-up, Student A emitted a mean of 13 correct responses (range, 2–64) given a mean of 14 opportunities to respond per session (range, 2–76).

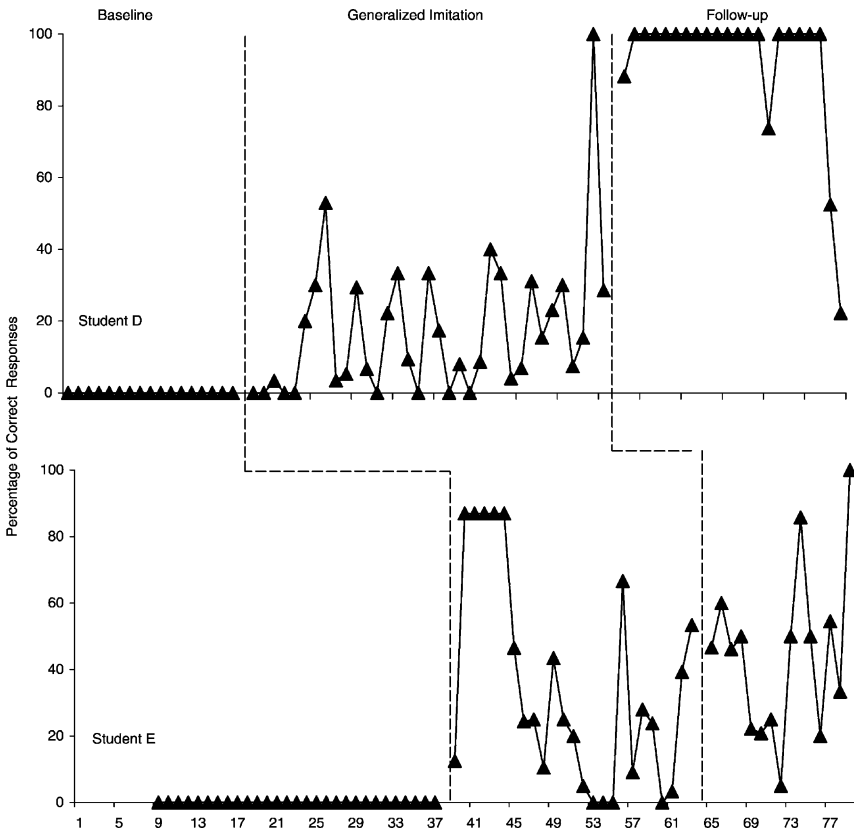


Fig. 3. Percentage of correctly emitted mands across generalized vocal imitations, vocal imitation probes, and mands for Students D and E.

Student B emitted a mean of 12 correct responses (range, 2–34) given a mean of 12 opportunities to respond per session (range, 2–34). Student C emitted a mean of 13 correct responses (range, 3–32) given a mean of 14 opportunities to respond per session (range, 3–69).

During 3-month probes, Student A emitted a mean of 62 correct responses (range, 5–93) given a mean of 65 opportunities to respond per session (range, 5–100). Student B emitted a mean of 30 correct responses (range, 33–46) given a mean of 30 opportunities to respond per session (range, 33–46) across 4 days of probes. Student C emitted a mean of 29 correct responses (range, 18–52) given a mean of 52 opportunities to respond per session (range, 18–97).

Fig. 3 shows the percentage of correct responses emitted per session during baseline, treatment, and follow-up by Students D and E. During baseline, Student D emitted 0 correct responses given a total of 340 opportunities to respond.

Table 2

Percentage of correct responses emitted during treatment, follow-up, and probe sessions

Student and response type	Treatment	Follow-up	3-month probe
Student A			
Total opportunities to respond	306	513	260
Total responses	227	495	247
Generalized vocal imitation	17	–	–
Vocal imitation	68	92	–
Independent mands	15	8	100
Student B			
Total opportunities to respond	743	241	76
Total responses	594	239	66
Generalized vocal imitation	11	–	–
Vocal imitation	54	7	–
Independent mands	33	93	100
Student C			
Total opportunities to respond	77	631	46
Total responses	63	528	44
Generalized vocal imitation	18	–	–
Vocal imitation	76	52	–
Independent mand	6	48	100
Student D			
Total opportunities to respond	616	483	
Total responses	339	443	
Generalized vocal imitation	12	–	
Vocal imitation	26	8	
Independent mands	62	92	
Student E			
Total opportunities to respond	639	189	
Total responses	392	68	
Generalized vocal imitation	44	–	
Vocal imitation	56	33	
Independent mands	0	0	

Student E emitted 0 correct responses given a total of 600 opportunities to respond. During treatment, Student D's mean number of correct responses increased to 6 (range, 2–45) given seven mean opportunities to respond per session (range, 2–45). Student E's mean number of correct responses increased to 16 (range, 0–48) given 28 mean opportunities to respond per session (range, 8–69). During follow-up, Student D emitted a mean of 11 correct responses (range, 4–38) given 11 mean opportunities to respond per session (range, 10–40). Student E emitted a mean of four correct responses given 10 opportunities to respond per session (range, 4–20).

Table 2 presents the percentage of correct responses by type (generalized vocal imitations, vocal imitations, and mands) during treatment, follow-up, and the 3-month probe (Students A, B, and C only) for all participants. Student A emitted more vocal imitations during treatment than both Students B and C. Similarly, Student E emitted more vocal imitations during treatment than Student D. This trend continued during subsequent phases. During the follow-up phase, Students A, B, and C emitted both vocal imitations and mands although Students A and C emitted more vocal imitations than mands. For Student D, independent mands were high and vocal imitations were low during follow-up. As in the treatment phase, Student E emitted only vocal imitations and did not emit any independent mands. During the 3-month probe, Student A continued to emit a large number of vocal imitations while Students B and C emitted only independent mands. Student C emitted a number of incorrect responses during the 3-month probe by typically responding with a single response to many different stimuli.

4. Discussion

This study formally evaluated generalized motor imitation as a tactic to mediate vocal speech in nonvocal children with autism. A mand training procedure that had been effective for children with developmental disabilities (Drash et al., 1999; Williams & Greer, 1993) was unsuccessful with five nonvocal children with autism during baseline. However, the rapid imitation of modeled motor behaviors during treatment resulted in generalized vocal imitations for all participants. Vocal imitation of words and subsequent mands were taught by using a fading procedure in which an opportunity to respond without the rapid imitation of modeled motor behaviors was immediately followed by an opportunity to respond with no vocal model. A follow-up phase and 3-month probes indicated that four of the five participants continued to emit mands.

A main objective of this study was to implement the generalized imitation tactic to obtain words and initial vocalizations without relying on repetitive shaping procedures. Initial vocalizations were identical imitations or close approximations to words and did not require shaping procedures. Only Student E required shaping for all of the words that he emitted. Words containing multiple syllables were frequently difficult for all participants and, consequently, were divided into smaller parts. Additionally, the experimenters and teachers periodically needed to establish

agreement on the “best” form of a word that a participant could emit (i.e., *bu* instead of *book* for Student B).

Another goal of this study was to extend the tactic to a mand training procedure. A fading procedure within each instructional session was used to effectively transfer stimulus control from the generalized imitation tactic to a vocal imitation probe model to a nonverbal antecedent. Although not tested, the presentation of the targeted reinforcer under each antecedent condition along with the use of establishing operations and stimulus-specific reinforcement may have facilitated the transfer of stimulus control. This suggests that the mand training procedures were important for the acquisition of speech. Future studies could evaluate the contribution of the mand procedure by presenting participants with opportunities to name targeted items following the generalized imitation antecedent without using establishing operations and stimulus-specific reinforcement.

The procedures contained several limitations. First, the number of opportunities to respond per session during treatment was an inconsistent variable and, if controlled, may have allowed for better analysis of the data. The number of training trials varied widely across instructional sessions because we frequently presented trials until satiation was indicated to bring the participants into contact with the mand contingency and to strengthen the likelihood of future occurrences of vocal verbal behavior. Different target reinforcers also were used for each session. Additionally, Student C’s mand acquisition rate was higher than that of Students A and B and, therefore, resulted in a shorter treatment phase.

Second, motor imitation training was extensive and took multiple school years for most participants. A delayed multiple baseline was used for Students A, B, and C because each participant’s motor imitation training began during the preceding student’s baseline. However, with the exception of Student B’s two mands, there were no apparent differences in their baseline data when compared to that of Students D and E who began motor imitation training at the same time.

Third, the relative contribution of the various treatment components was not evaluated. There are many potential explanations for the results that should be tested in future studies. For example, most participants (except Student E) emitted initial words (e.g., *candy*) that were close to the model instead of sounds (e.g., “ah”). The emission of words as first vocalizations eliminated the need for shaping procedures, but it also suggests that the participants may have had prior vocal speech under stimulus controls that were unknown to the experimenters. It is possible that the procedure simply facilitated the transfer of stimulus control.

Another explanation may be that vocal imitations were suppressed during baseline by the reinforcement history established during the pre-baseline procedure’s motor imitation training. Reinforcement in the form of praise was withheld during baseline. When reinforcement for responding was re-instated during treatment, vocal speech may have emerged due to resumption of reinforcement and not because of the generalized motor imitation antecedent. Future studies could test this possibility by including praise in baseline.

A third explanation may be that the momentum of motor imitation (a high-probability behavior) increased the likelihood of vocal imitation (a low-probability

behavior) (Nevin, 1996). If high-probability behaviors were important, any high-probability behavior would evoke speech. To test this possibility, the imitation antecedent could be replaced by a series of instructions (e.g., “stand up,” “sit down,” “touch your nose”) prior to the vocal model.

In summary, the use of rapid imitations of modeled motor behaviors before an opportunity to respond increased the operant mands of four nonvocal children with autism more than mand training alone. Despite the need to know much more about this procedure, it was successful with children for whom a previously existing tactic was not—all of who were above 5 years of age. Additionally, informal investigator, teacher, and parent reports indicate that the participants continue to emit mands and other forms of vocal verbal behavior. Because we have replicated this procedure with several children with autism and other pervasive developmental disorders, we are eager to see the procedures tested because for some students it has made critical differences in their acquisition of communicative behavior.

Acknowledgments

This study was conducted as part of the first author’s doctoral dissertation at Teachers College, Columbia University.

References

- Baer, D. M., Peterson, R. F., & Sherman, J. A. (1967). The development of imitation by reinforcing behavioral similarity to a model. *Journal of the Experimental Analysis of Behavior*, *10*, 405–416.
- Baer, D. M., Wolf, M. M., & Risley, T. (1968). Current dimensions of applied behavior analysis. *Journal of Applied Behavior Analysis*, *1*, 91–97.
- Bayley, N. (1969). *Bayley scales of infant development*. New York: Psychological Corp.
- Bowman, L. G., Fisher, W. W., Thompson, R. H., & Piazza, C. C. (1997). On the relation of mands and the function of destructive behavior. *Journal of Applied Behavior Analysis*, *30*, 251–265.
- Brown, K. A., Wacker, D. P., Derby, K. M., Peck, S. M., Richman, D. M., Sasso, G. M., Knutson, C. L., & Harding, J. W. (2000). Evaluating the effects of functional communication training in the presence and absence of establishing operations. *Journal of Applied Behavior Analysis*, *33*, 53–71.
- Charlop, M. H., Schreibman, L., & Thibodeau, M. G. (1985). Increasing spontaneous verbal responding in autistic children using a time delay procedure. *Journal of Applied Behavior Analysis*, *18*, 155–166.
- Cooper, J. O., Heron, T. E., & Heward, W. L. (1987). *Applied behavior analysis*. Columbus, OH: Merrill.
- Drasgow, E., Halle, J. W., & Ostrosky, M. M. (1998). Effects of differential reinforcement on the generalization of a replacement mand in three children with severe language delays. *Journal of Applied Behavior Analysis*, *31*, 357–374.
- Drash, P. W., High, R. L., & Tudor, R. M. (1999). Using mand training to establish an echoic repertoire in young children with autism. *The Analysis of Verbal Behavior*, *16*, 29–44.
- Fisher, W. W., Thompson, R. H., & Kuhn, D. E. (1998). Establishing discriminative control of responding using functional and alternative reinforcers during functional communication training. *Journal of Applied Behavior Analysis*, *31*, 543–560.

- Garcia, E., Baer, D. M., & Firestone, I. (1971). The development of generalized imitation within topographically determined boundaries. *Journal of Applied Behavior Analysis*, 4, 101–112.
- Greer, R. D., McCorkle, N., & Twyman, J. (1996). *Preschool inventory of repertoires for kindergarten*. Yonkers, NY: Fred S. Keller School.
- Halle, J. W., Marshall, A. M., & Spradlin, J. E. (1979). Time delay: A technique to increase language use and facilitate generalization in retarded children. *Journal of Applied Behavior Analysis*, 12, 431–439.
- Harris, S. L. (1975). Teaching language to nonverbal children—with emphasis on problems on generalization. *Psychological Bulletin*, 82, 565–580.
- Heward, W. L. (1978, May). *The delayed multiple baseline design*. Paper presented at the Fourth Annual Convention of the Association for Behavior Analysis, Chicago.
- Ingenmey, R., & Van Houten, R. (1991). Using time delay to promote spontaneous speech in an autistic child. *Journal of Applied Behavior Analysis*, 24, 591–596.
- Leiter, R. J. (1979). *Leiter international performance scale*. Chicago: Stoelting Co.
- Lovaas, O. I., Koegel, R. L., Simmons, J. Q., & Long, J. S. (1973). Some generalization and follow-up measures on autistic children in behavior therapy. *Journal of Applied Behavior Analysis*, 6, 131–165.
- Matson, J. L., Sevin, J. A., Box, M. L., Francis, K. L., & Sevin, B. M. (1994). An evaluation of two methods for increasing self-initiated verbalizations in autistic children. *Journal of Applied Behavior Analysis*, 23, 227–233.
- Michael, J. (1982). Distinguishing between discriminative and motivational functions of stimuli. *Journal of the Experimental Analysis of Behavior*, 37, 149–155.
- Mullen, E. M. (1984). *Mullen scales of early learning manual*. Providence, RI: TOTAL Child, Inc.
- Nevin, J. A. (1996). The momentum of compliance. *Journal of Applied Behavior Analysis*, 29, 535–547.
- Rutter, M. (1978). Diagnosis and definition of childhood autism. In M. Rutter & E. Schopler (Eds.), *Autism: A reappraisal of concepts and treatments* (pp. 1–25). New York: Plenum Press.
- Rutter, M. (1985). The treatment of autistic children. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 26, 193–214.
- Schopler, E., Reichler, R. J., & Renner, B. R. (1988). *Childhood autism rating scale*. Los Angeles: Western Psychological Services.
- Skinner, B. F. (1957). *Verbal behavior*. Englewood Cliffs, NJ: Prentice-Hall.
- Sloane, H. N., Johnston, M. K., & Harris, F. R. (1968). Remedial procedures for teaching verbal behavior to speech deficient or defective young children. In H. N. Sloane & B. D. MacAulay (Eds.), *Operant procedures in remedial speech and language training* (pp. 77–101). Boston: Houghton Mifflin.
- Sparrow, S. S., Balla, D. A., & Cicchetti, D. V. (1984). *Vineland adaptive behavior scales: Expanded form manual interview edition*. Circle Press, MN: American Guidance Service.
- Stutsman, R. (1948). *Merrill-Palmer scale of mental tests*. Chicago: Stoelting Co.
- Williams, G., & Greer, R. D. (1993). A comparison of verbal-behavior and linguistic communication curricula for training developmentally delayed adolescents to acquire and maintain vocal speech. *Behaviorology*, 1, 31–46.
- Young, J. M., Krantz, P. J., McClannahan, L. E., & Poulson, C. L. (1994). Generalized imitation and response-class formation in children with autism. *Journal of Applied Behavior Analysis*, 27, 685–697.