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THE EFFECTS OF PROMPTING, FADING, AND DIFFERENTIAL REINFORCEMENT ON VOCAL MANDS IN NON-VERBAL PRESCHOOL CHILDREN WITH AUTISM SPECTRUM DISORDERS

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There are few procedures to teach non-vocal children vocal mands. This study evaluated the effects of prompting, fading, and differential reinforcement on eye contact, pointing, vocal approximations, independent requests and immature mands in three children with Autism Spectrum Disorders who in baseline emitted almost no independent vocal mands. This procedure resulted in a large and socially valid increase in independent vocal mands, other appropriate responses and near elimination of immature mands. Copyright © 2010 John Wiley & Sons, Ltd.

INTRODUCTION

Non-vocal children often exhibit non-vocal mands, such as pointing, grabbing, leading, and problem behavior before they learn to emit conventional vocal mands (Drasgow, Halle, & Ostrosky, 1998). Thus, early intervention to promote conventional vocal mands both increases conventional vocal mands and decreases concurrent immature, non-vocal, verbal behavior (Drasgow et al., 1998; Drasgow, Sigafoos, Halle, & Martin, 2008; Sigafoos, O'Reilly, Schlosser, & Lancioni, 2007).

Children aged 6–13 months can learn conventional mands, such as manual signs, to access preferred activities or items with delayed physical and imitative prompts (Thompson, Cotnoir-Bichelman, McKerchar, Tate, & Dancho, 2007; Thompson, McKerchar, & Dancho, 2004). Vocal mand training for children with language delays often starts with the echoic prompts and vocal imitation (Bourret, Vollmer, & Rapp, 2004) which requires that the learner is first deprived of the relevant reinforcer, and

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then emits a one word vocal response which approximates the teacher's echoic prompt (Bourret et al., 2004). This procedure may be highly successful for children with existing vocal repertoires who can accurately echo vocal models; however, some young children and some children with developmental delays enter educational programs without these skills. Another important consideration in teaching new vocal mand forms is that before the experimenter begins vocal mand training they should conduct an inventory of the child's current vocal repertoire to ascertain current vocal approximations to possible vocal mands and which vocalizations are high frequency and apparently easy for the child to emit. Thus, research should develop and evaluate an appropriate vocal mand training curriculum and procedures to teach vocal mands to non-vocal children. Therefore, this study investigated the effectiveness of prompting, fading, and differential reinforcement to teach independent vocal mands to non-verbal children with autism spectrum disorders by sequentially teaching pointing, eye contact, oral motor approximations, imitated vocalizations, and finally, independent vocalizations for preferred items. In addition to observing the effect of this intervention on vocal mands we also observed the effects on immature non-vocal mands.

METHOD

Participants and Setting

Three children aged 3 years who attended a full day applied behavior analysis oriented special education preschool program and had been diagnosed with either autism spectrum disorders or Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS) by an independent licensed practitioner participated. All had severe language delays, had no full words and limited vocal repertoires that only included a restricted range of monosyllables. None communicated using vocalizations or gestures at the beginning of the study.

Isaac was 3.2 years when the study began. He had been diagnosed with PDD-NOS. His vocalizations consisted of sounds 'b' and 'm'. He did not make eye contact with others. To gain access to preferred items, Isaac would reach or lunge toward and grab an object. He did not exhibit any conventional vocal or non-verbal requests. Preference assessments (Roane, Vollmer, Ringdahl, & Marcus, 1998) showed that Isaac's preferred items included balls, babies, M &M candies, lollipops, and pens for coloring. Lindsey was 3.6 years and had been diagnosed with Autism. Lindsey's vocal repertoire consisted of the sounds 'k', 'm', 'd', 'b', 'p', and 'n'. Lindsey did not have any conventional gestural or vocal mands. Lindsay yelled for, reached and grabbed preferred items. Preference assessments showed that Lindsey's preferred items included a toy camera, toy keys, cookies, M &M candies, lollipops, popcorn, and

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pinwheels. Shawn was 3.6 years and had been diagnosed with PDD-NOS. Shawn made very limited eye contact with others and did not vocally mand for preferred items. Shawn's vocalizations consisted of monosyllabic utterances including 'b', 'm', 'p', 'k', 'd', 'g', 'Guh', and 'Wuh.' Occasionally Shawn would lead an adult's hand or reach and grab an item while whining or yelling 'Bee-baw'. Preference assessments showed that Shawn's preferred items included bubbles, balls, cars, M &M candies, lollipops, and a small lighted fan toy.

Baseline and training took place in a 1.8 m × 1.8 m alcove in the corner of the children's morning classroom. Ongoing classroom activities, distractions and other students were in full view of the participant. The room contained one chair for the participant and one chair for the researcher.

Target Behaviors

There were three target behaviors: Independent vocal mands; immature mands, and appropriate responses.

Independent Vocal Mands

An independent vocal mand was a target vocalization emitted without any model or prompt that was appropriate for the context and corresponded to the item's label. For example, if a child said 'pen' without a prompt when there was a pen in front of the child, and the experimenter gave the child the pen, this was an independent vocal mand.

Immature Mands

Immature mands were reaching, grabbing, yelling, or leading. The researchers defined reaching and grabbing as a full extension of the student's arm, leaning out of the chair or standing from chair and taking the item out of the researcher's hand from a stationary presentation position. Yelling was a loud, undifferentiated vocalization of more than 1 s in the presence of an adult and an item of which the child could not directly obtain. Leading was taking an adult by the hand or wrist, guiding the adult's hand or wrist to an object, and placing the adult's hand on the object (Drasgow et al., 1998)

Appropriate Responses

Appropriate responses included independent vocal mands and all other responses that the children learned during intervention including pointing, looking, oral motor

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approximations, and echoic vocalization. Researchers defined a *pointing* as a fully extended and straight index finger with the remaining middle, ring, and pinky fingers curled at least 50% toward the closed or fist position. *Looking* was the participant looking at the face, eyes, or mouth of the researcher for at least 1 s. *Oral motor approximations* included displays of any approximation of the target sound, defined as similar lip movement to the target with or without sound (i.e., pressing lips together if target is a 'Bah' or 'Pah,' or vocalizing 'Ahh' for 'Pah').

Procedure

Pre-baseline Assessments

Prior to baseline, the researchers interviewed the parents to identify potential preferred and non-preferred items and conducted at least two free-operant preference assessments (Roane et al., 1998) with each child. The experimenter presented 10 items in the preference assessments including snacks, such as raisins or cookies, and toys and activities, such as puzzles. The experimenter occasionally added new items during training based on teacher reports of preferred items following the initial preference assessments. The experimenter contrived motivation by restricting access to the preferred items and activities students selected during preference assessments. Students only gained access to the items/activities during training sessions following the target response corresponding to each phase. Experimenters also documented child vocalizations by conducting observations during the preference assessments and interviews with parents and speech pathologist to identify frequently occurring sounds. The experimenter then selected preferred items that matched the first phoneme of the target word of preferred items with an existing high frequency syllable. For example, preference assessments indicated that balls were highly preferred for one participant and 'bah' occurred frequently, then the experimenter selected saying 'ball' for this child as a target response. In order to present a model that is visible during oral motor imitation, where possible the experimenter selected phonemes beginning with a bilabial phoneme such as 'bah' (Lovaas, 2003).

General Procedure

All trials began with the participant seated directly and squarely across from the researcher. The researcher presented a single preferred item for the participant and modeled the target sound once. The experimenter terminated the trial during the training phases for *pointing* and *looking* when the participant held the item. For *oral motor* approximation and *actual target sound* training steps, the trial ended when either the child held the item, or the child failed to emit a response following a second vocal prompt. Researchers scored trials as non-occurrence if the participant did not

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emit a response prior to the second vocal prompt. Item presentations when the child did not request the item were not trials and the experimenter removed the item.

During all trials the experimenter delivered vocal models of the target item's sound in a neutral tone with elevated voice volume. The experimenter presented three to five preferred items in each training session which included at least three contrasting sounds. The experimenter presented the items in an unsystematic order. The researcher presented the item at arms length, directly off the right or left shoulder (depending on the subject's predominant reaching hand), and at the participant's eye level, but within a minimum of approximately 0.25 m of the participant's reach in order so that the experimenter could observe looking. If at anytime a child failed to emit a previously established response, the experimenter used least to most intrusive prompting (Sisson, Kilwein, & Van Hasselt, 1988). During one trial per session the experimenter also asked '(*name*), what do you want?' while presenting a preferred item. A session was five consecutive trials.

Baseline

During baseline, the experimenter modeled the target sound as the participant reached for and/or grabbed the item or while giving the student the item. If the child emitted an immature mand, then the experimenter gave the item to the child.

Intervention

There were four steps in the intervention: Non-verbal replacement mand training; eye contact training; oral motor training and vocalizing.

During non-verbal replacement mand training the experimenter taught the subject to point to a preferred item. The experimenter did not give the item to the child if the child emitted immature mands and the experimenter only gave the item to the child after the child emitted an independent or prompted point. First, the experimenter used hand over hand prompts to form the participant's hand into a pointing gesture. The experimenter then faded these prompts by reducing prompts from the hand, to lightly touching the wrist, touching the forearm, touching elbow, and to a gestural prompt of the researcher raising his arm toward the participant's hand. The experimenter used a 4–5 s prompt delay to provide the opportunity for an unprompted pointing response to occur. The experimenter also modeled the target sound for the item as the subject emitted with an independent or prompted pointing response

In Step 2, eye contact training, if the subject pointed to the preferred item, the researcher moved the item to approximately 0.3 m towards his own face until the participant's eyes met the researcher's face, eyes, or mouth. The experimenter then modeled the target sound. If the participant pointed to the item and looked at the

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experimenter's face, eyes, or mouth after the item was presented for at least 1 s, the experimenter gave the item to the participant. The experimenter used a 4–5 s prompt delay before moving the item toward the researcher's face in order to provide the opportunity for an unprompted looking response. The experimenter faded item position prompts from directly in front of the researcher's face to approximately half the distance between the presentation position and the researcher's face, to one quarter the distance, to a slight movement of the object toward the researcher's face. The prompts were faded until the participant was looking at the researcher independently for each opportunity.

In Step 3, oral motor training, if the participant pointed to the item, looked at the face, eyes, or mouth of the researcher for at least 1 s and displayed any slight approximation of the target sound or similar oral-motor/lip movement to the target with or without sound, the experimenter gave the item to the child. The experimenter also modeled the target sound as the subject looked at the researcher's eyes, face, or mouth prompted or independent by leaning forward approximately 45° toward the child, elevated his voice volume as in the previous phases, clearly annunciated the target sound, and exaggerated the oral motor movements. The researcher reinforced successive oral motor and sound approximations toward the vocal model prompt of the target sound until either the target sound was emitted, or the participant met criterion for phase change. The experimenter reinforced these responses by giving the child the object. If no oral movement or sound was emitted the researcher repeated the vocal prompt a second time after 10 s. The trial was scored as non-occurrence if the participant did not emit a response following the first vocal prompt. If no oral movement or sound was emitted 10 s after the second prompt, the trial was terminated and another reinforcer was presented in a new trial.

In Step 4, vocalizing, if (a) the participant pointed to the item, looked at the face, eyes, or mouth of the researcher for at least 1 s and accurately echoed the vocal target sound model, or (b) if the child emitted an independent vocalization, then the experimenter gave the item to the child. If the child did not emit an independent vocalization the experimenter then used the same prompting and time delay procedure as in Step 4.

The criterion for phase change was two consecutive sessions of 100%, or 3 consecutive sessions of $\geq$80% target behavior occurrence. Meeting the criterion for Phase 4 signaled successful completion of the training procedure. The experimenter then collected generalization and follow-up data.

Generalization and Follow-up Sessions

Generalization probes took place in novel settings and with novel preferred items at 2 weeks and 4 months after completion of the four step-teaching program. Shawn was

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not available for generalization probes due to his scheduled summer break. For Isaac, the 2 months generalization probe sessions took place in a hospital waiting room with the experimenter and three new untrained sounds: 'Duh' for a Dorah Plush Doll ©, 'k' for a cookie, and 's' for slinky. The full generalization sessions took place in Isaac's classroom with his classroom teacher and the sounds 'Duh' for a Dorah Plush Doll ©, the full word 'Cookie' for a cookie, and the approximation of 'Sinky' for slinky. For Lindsey, the 2-week generalization probe took place during snack time with her classroom teacher where she requested a cookie by emitting 'k'. The 4 month generalization and follow-up took place with the experimenter in a hospital waiting room and four untrained sounds: 'F' for a rubber frog toy, 'Yo' for a yogurt covered raisin, 'h' for a toy horse, and 'Tuh' for a toy truck.

Data Collection and Experimental Design

There were three dependent variables. The first was the percentage of trials with independent vocal mands. The experimenter calculated this by dividing the number of trials in which the child emitted an independent mand by the total number of trials (5) in each session and multiplying by 100%. The second dependent variable was the percentage of trials with immature mands. The experimenter calculated this by dividing the number of trials in which the child emitted an immature mand, dividing it by the number of trials and multiplying it by 100%. The experimenter calculated the percentage of opportunities per session with appropriate responding by dividing the number of appropriate responses by 20 and multiplying by 100%.

The experiments used a multiple baseline design across subjects to show experimental control.

Interobserver Agreement

The experimenter collected interobserver agreement (IOA) data during all phases for all three participants. The independent observer scored taped video recordings of the baseline and intervention sessions for each child. The experimenter collected follow-up data *in vivo* because the experimenter did not have permission to videotape all children in the facility in public settings. The experimenter also collected data Linday's a data *in vivo* for sessions 13 and 14. The experimenter scores all data on immature mands retrospectively from videotapes; hence there are no data on immature mands at follow-up and for sessions 13 and 14 for Lindsay.

Agreement was defined as observer score exactly matching on the occurrence or non-occurrence of a target behavior on a trial. The experimenter calculated IOA by dividing total number of agreements by the total number of agreements plus disagreements, multiplied by 100%.

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The independent observer scored taped video recordings of the baseline, intervention, and follow-up sessions for each child by marking a plus or minus on a prepared data sheet indicating the presence or absence of pointing, eye contact, looking, and a vocal mand during each trial.

The experimenter collected IOA data throughout 100% of sessions across baseline, intervention, and follow-up phases for Isaac. IOA was 100% for independent vocalizations, 100% for immature mands, and 93.7% (range 90.0–96.25%) for appropriate responses, respectively. The experimenter collected IOA data for Lindsey throughout 85.3% of sessions randomly distributed across baseline, intervention, and follow-up phases. IOA was 96.0% (range 93.0–100%) for independent vocalizations, 92.5% (range 85.0–100%) for immature mands, and 92.1% (range 90.0–95.0%) for appropriate responses, respectively. The experimenter collected IOA data for Shawn throughout 80% of sessions randomly distributed across baseline and intervention phases. IOA was 95.0% (range 90.0–100%) for independent vocalizations, 100% for immature mands, and 94.0% (range 90.0–98.0%) for appropriate responses, respectively.

Social Validity

The three teachers and three parents each completed an eight-item questionnaire regarding the acceptability of the procedures and the impact on the children's behavior. Each item used a five-point Likert scale. A copy of the questionnaire is available from the first author.

RESULTS

Figure 1 presents data for baseline, post-training, generalization and follow-up data for all three participants and Table 1 summarizes the number of training sessions each participant took part in for each training phase. During baseline phases all participants emitted few or zero independent mands or appropriate responses, but did emit immature mands during many trials. Following treatment phases all three participants emitted the four target behaviors between 80–100% of trials. During generalization and follow-up, Isaac continued to emit many independent mands and appropriate responses and Lindsey continued to emit many appropriate responses and independent vocal mands during approximately 40% of trials.

During four baseline sessions and three post-training sessions Isaac emitted no independent vocalizations. Isaac emitted independent vocalizations during 60–100% of trials during follow-up. During baseline Isaac emitted immature mands during 60–80% of trials and following intervention he emitted immature mands during 0–20% of

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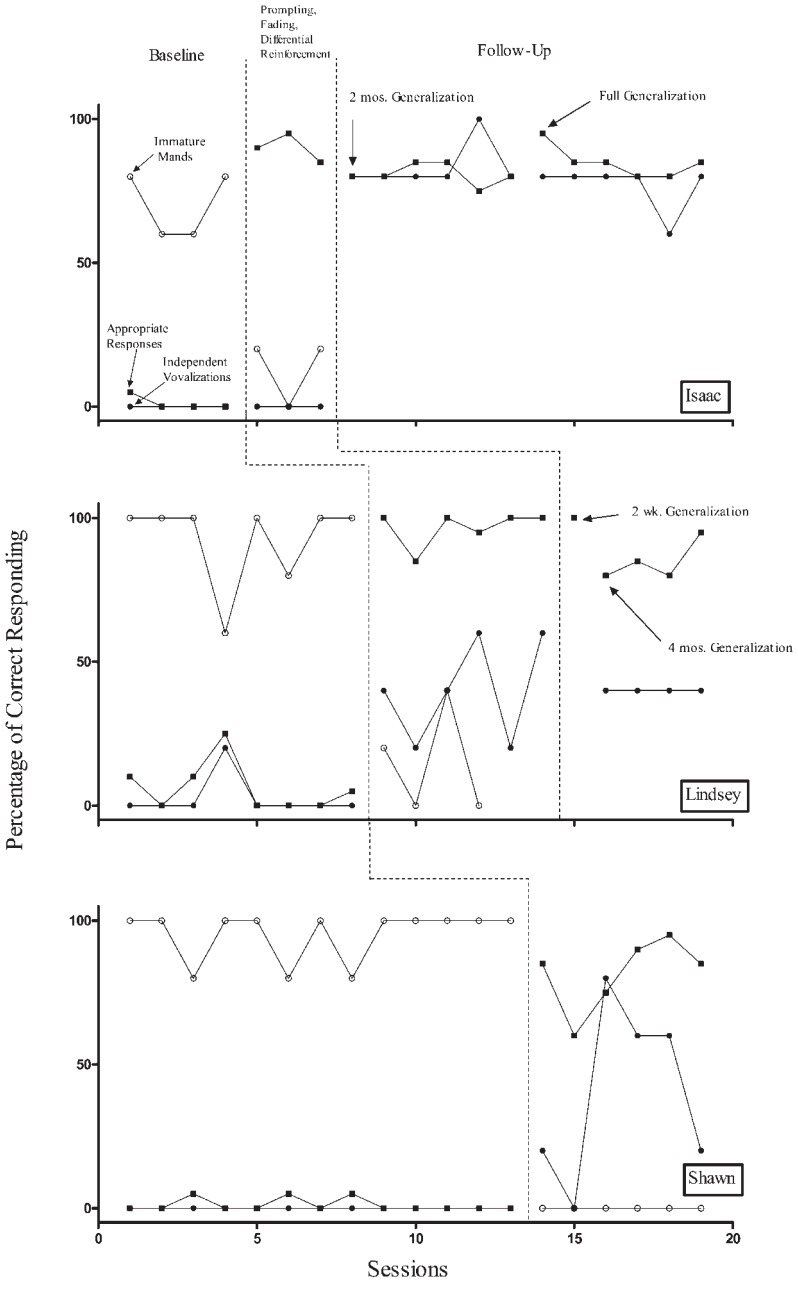

Figure 1. The percentage of independent vocalizations, appropriate responses, and immature mands for Isaac, Lindsay, and Shawn during baseline, following prompting, fading, differential reinforcement, and during follow-up.

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Table 1. The number of sessions for each participant to reach criterion in each of the four phases of the experiment

	Number of training sessions to reach criterion			
	Phase 1	Phase 2	Phase 3	Phase 4
Isaac	4	7	4	6
Lindsey	17	15	8	2
Shawn	7	14	14	2

trials on sessions 5–7. During baseline he emitted appropriate responses during only 0–5% of opportunities. Isaac emitted appropriate responses during 85–95% and 75–85% of opportunities during post-training and follow-up.

During baseline Lindsey emitted independent vocalizations during 0–20% of trials. Following intervention, Lindsey emitted independent vocalizations during 20–60% of trials. During generalization and follow-up probes this increased to 100% in session 15 and then fell to 40% in sessions 15 through 19. During baseline Lindsay emitted immature mands during 60–100% of trials. During sessions 9–13 of post-training Lindsay only emitted immature mands during 0–40% of trials. Finally, during baseline the percentage of opportunities with appropriate responses was only 0–25% and during post-training this increased to 85–100% of opportunities. During follow-up and maintenance this remained at 85–100% of opportunities.

During baseline Shawn emitted no independent vocalizations. After the training sessions he emitted independent vocalizations during 0–80% of trials. During baseline Shawn emitted immature mands during 80–100% of trials. After training Shawn did not emit immature mands during trials. During post training Shawn emitted appropriate responses during only 0–5% of opportunities. After training he did so during 60–90% of opportunities.

Social Validity

Four questions asked about the value, acceptability of the teaching method, the teaching time, overall speech acquisition, and whether or not the rater would recommend the program to other parents and children. All ratings were highly positive. Of 24 ratings 23 were 5 on a 5-point scale with a mean rating of 4.9. Shawn's parent reported that his response to treatment was 'somewhat acceptable' in terms of speed of response to the program. Four questions inquired concerning the impact of the intervention on the children's use of mands. The first questions asked about the child's use of mands before the study. All raters agreed that all three children only requested preferred items either 'not at all' ($N = 4$) or 'sometimes' ($N = 2$). Three

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questions asked about the impact on the children's use of mands after intervention in terms of making vocal approximations, or words, overall speech acquisition and use of request for preferred items outside the home. All teachers and parents reported observing improvements in all children's requesting after the study. The mean ratings ($N = 6$ ratings for each child) on the three questions related to acceptability were 4.0, 4.3, and 2.6 for Isaac, Lindsay, and Shawn, respectively. There was agreement that the impact was very marked for Isaac and Lindsay and more modest for Shawn.

DISCUSSION

During baselines all three participants emitted independent vocalizations on zero or near-zero percentage of trials. Following training all three children emitted independent vocal requests on many trials. Thus, since child behavior changed only upon the introduction of the treatment, we conclude that there was a functional relationship between the treatment and child behavior. Similar functional relations were observed for both immature mands and appropriate responses. Thus, the introduction of the treatment package resulted in a large change in these children's mand repertoire, including both increases in mands and reduction in immature mands. These changes are notable since in baseline the children had virtually no conventional vocal mands and at follow-up and generalization two of the three children for whom generalization and follow-up data were available had acquired several new vocal mands. Further, social validation data indicated that the methods used were highly acceptable. The outcomes for two children were very acceptable and for Shawn both raters agreed that change had occurred, but was less socially valid than for the first two children. Perhaps if Shawn had remained in the study for longer greater changes would have occurred. This study extends Drasgow et al. (1998) and Thompson et al. (2004, 2007) by teaching vocal mands to non-vocal children and by evaluating a curriculum that includes a sequence of responses that lead to vocal mands

This study has a number of limitations. First, it is unknown if the order in which the experimenter taught the responses, the time window in which the experimenter allowed a response to occur, and the criterion requirements for phase change were optimal. There are many possible procedural variations which might be more efficient or result in faster acquisition or greater generalization. Future research should investigate these procedural variations. Second, it is unclear as to why Isaac's independent vocal mands increased during follow up despite near zero levels during post-training. During post-training Isaac echoed vocal models for greater than 80% of opportunities. During follow-up, Isaac echoed the model on the first opportunity for novel items, and emitted independent vocalizations during the majority of subsequent presentations of the item. Although we have no data on this point, it is possible that

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vocal imitation generalized to his everyday environment. Due to a restricted range of preferences, Isaac likely encountered repeated presentations of similar items over the 2 months following training which facilitated the acquisition of independent vocal mands. Future research should also extend the results of this study by replicating them with other children; rigorously addressing generalization across items, people, and settings; and by teaching routine staff and parents to teach their children to vocally mand.

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