

*ESTABLISHING VERBAL REPERTOIRES IN CHILDREN WITH AUTISM
USING FUNCTION-BASED VIDEO MODELING*

JOSHUA B. PLAVNICK AND SUMMER J. FERRERI

MICHIGAN STATE UNIVERSITY

Previous research suggests that language-training procedures for children with autism might be enhanced following an assessment of conditions that evoke emerging verbal behavior. The present investigation examined a methodology to teach recognizable mands based on environmental variables known to evoke participants' idiosyncratic communicative responses in the natural environment. An alternating treatments design was used during Experiment 1 to identify the variables that were functionally related to gestures emitted by 4 children with autism. Results showed that gestures functioned as requests for attention for 1 participant and as requests for assistance to obtain a preferred item or event for 3 participants. Video modeling was used during Experiment 2 to compare mand acquisition when video sequences were either related or unrelated to the results of the functional analysis. An alternating treatments within multiple probe design showed that participants repeatedly acquired mands during the function-based condition but not during the nonfunction-based condition. In addition, generalization of the response was observed during the former but not the latter condition.

Key words: autism, functional analysis, observational learning, verbal behavior, video modeling

Skinner (1957) defined the *mand* as a verbal operant that is reinforced by the delivery of a specific consequence and is therefore under the control of deprivation or aversive stimulation related to that consequence. Several researchers have found that some children with autism demonstrate idiosyncratic communication repertoires that limit their ability to contact reinforcers mediated by others (Bourret, Vollmer, & Rapp, 2004; Charlop-Christy, Carpenter, Le, LeBlanc, & Kellet, 2002; Jennett, Harris, & Delmolino, 2008). These children may develop a variety of gestures or mild problem behaviors that function as communication in some situations (Keen, 2005; Sigafos et al., 2000). In other situations,

listeners may not deliver reinforcement due to a lack of familiarity with the topography of the child's behavior; this pattern can lead to the development of severe problem behavior and social isolation (Durand & Carr, 1991; Keen, 2005; Langdon, Carr, & Owen-Deschryver, 2008). Interventions that promote spontaneous communication in a variety of situations are therefore critical for young children with autism.

Sundberg and Partington (1998) described a mand training procedure as the first step in a comprehensive language training program for children with autism. A critical component of mand training is to contrive or capture an establishing operation (EO), which temporarily increases the value of a reinforcer and therefore increases the probability of behavior that has previously been followed by that reinforcer (Laraway, Snyckerski, Michael, & Poling, 2003). Once an EO is contrived, an interventionist can prompt or model a target response and deliver the corresponding reinforcer after the child emits the mand. Prompts then are faded to transfer control of the mand to the EO. This general process has been used to teach a variety of mand topographies, including sign language

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Correspondence concerning this article should be addressed to Joshua B. Plavnick, College of Education, Michigan State University, East Lansing, Michigan 48824 (e-mail: plavnick@msu.edu).

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(G. A. Hall & Sundberg, 1987), picture exchange (Charlop-Christy et al., 2002), and vocal speech (Jennett et al., 2008).

Despite positive outcomes of mand training for some children with autism, others do not demonstrate spontaneous manding across environments (Jennett et al., 2008). Some of the barriers to effective mand training include programmed EOs that do not evoke the response, consequences that do not function as reinforcers, the inability of an individual to emit the targeted response, and restriction of stimulus control to training conditions (Bourret et al., 2004). These barriers appear to vary across children based on individual learning history and severity of impairment.

The proliferation of preintervention functional analysis over the last 30 years has substantially improved the efficiency of interventions that target a reduction in problem behavior and might offer a process for removing barriers to mand training (Hanley, Iwata, & McCord, 2003). For example, functional communication training (FCT) has been used to decrease problem behavior that functions as a mand while an acceptable alternative response is increased (Carr & Durand, 1985). The alternative response is reinforced using the functional reinforcer for problem behavior, which is most accurately determined by a functional analysis (S. S. Hall, 2005). As reinforcers and related EOs are identified a priori, an interventionist can rely on empirical information to develop procedures that are likely to teach or strengthen the alternative response.

A recent line of research has sought to extend the logic of preintervention functional analysis to inform verbal behavior teaching procedures without an emphasis on problem behavior (Ferreri & Plavnick, 2011; Kelley et al., 2007; LaFrance, Wilder, Normand, & Squires, 2009; Lerman et al., 2005; Normand, Severtson, & Beavers, 2008). Lerman et al. (2005) showed that experimental analyses could be used to identify the antecedents and consequences that evoke and

maintain vocalizations emitted by children with developmental disabilities. Ferreri and Plavnick (2011) identified a similar capacity of functional analysis for gestural behavior. These results suggest that an interventionist might be able to reduce barriers to effective mand training by identifying EOs and reinforcers for nonproblem verbal behavior prior to teaching a new response. However, interventions based on the results of a functional analysis of verbal behavior have yet to be validated empirically.

Another procedure that may diminish barriers to mand acquisition and generalization is video modeling. Video modeling typically involves showing a video-recorded display of a target response to teach a child to emit specific behaviors (Bellini & Akullian, 2007). Video modeling has been used to teach a variety of play, social, vocational, and other skills to children with autism (Rayner, Denholm, & Sigafos, 2009).

A feature of video modeling that could enhance mand training is that the participant has an opportunity to observe a sequence that includes an evocative event, the model responding to the evocative event by producing the target mand, and a listener delivering the related consequence to the model (Nikopoulos & Keenan, 2004; Wert & Neisworth, 2003). In contrast, mand training often requires the interventionist to deliver an in vivo model after the evocative event is contrived (Sundberg & Michael, 2001). The participant in the latter case observes an atypical temporal sequence, which could restrict stimulus control and thereby delay acquisition or generalization of the mand (Bourret et al., 2004; Jennett et al., 2008).

Previous studies have shown the importance of teaching generalized mand repertoires to young children with autism (Bourret et al., 2004; Jennett et al., 2008). To accomplish this goal, teaching strategies must ensure that the mand is brought under control of EOs that occur in an individual's natural environment. Pretreatment functional analysis offers one

procedure for identifying EOs that evoke mands. Additional research is needed to identify the benefit of conducting a functional analysis of emerging communicative behavior to inform interventions that target the acquisition of verbal operants. A functional analysis may be especially informative when video modeling is used to teach mands, because known EOs and consequences can be embedded into a video sequence that displays the environmental variables and the mand in their proper temporal order.

The present studies examined the potential of function-based video modeling for teaching recognizable mands to children with autism who demonstrated severe impairment in verbal behavior. The primary purpose was to extend the function-based methodology exemplified by FCT to teach mands outside the context of treating problem behavior. A secondary purpose was to examine video modeling as a procedure for establishing vocal or picture-exchange mand repertoires in young children with autism.

METHOD

Participants, Setting, and Observers

Three boys (Fuller, Victor, Matthew) and one girl (Bailey) between 4.5 and 6.5 years of age participated. Participants were included in the studies based on a diagnosis of autistic disorder by a psychologist and severe language impairment by a speech and language pathologist. None of the participants used vocal speech, sign language, pictorial communication, or a voice output device to emit verbal behavior. Fuller, Victor, and Matthew were in their second year in public early childhood special education (ECSE) classrooms and had not received any previous one-on-one services. Bailey was in her third year in a public autism spectrum disorders (ASD) classroom and previously had received some speech and language therapy in small-group and occasional one-on-one sessions.

Fuller and Bailey each demonstrated delayed echolalia (Schreibman & Lovaas, 1974) in the form of one- or two-word utterances. Fuller

attended to video screens when cartoons or movies were displayed, but he did not follow simple directions, imitate others, or attend to other people when they spoke to him. Bailey attended to both video screens and other individuals, followed some simple directions, and imitated others when prompted. Victor and Matthew had no history of emitting vocal verbal behavior at any time, attending to video screens or other people, following simple directions, or imitating others.

Assessment and training sessions were conducted in a private room located next to or across the hall from the participants' classrooms. The student and experimenter sat in child-sized chairs at tables raised approximately 75 cm from the floor. The rooms were empty except for cabinets that remained closed or bookshelves that were turned away from the participant during sessions. A video recorder was placed on a tripod to record sessions for later data collection.

Generalization sessions were conducted for three of the four participants. Sessions for Fuller and Matthew were conducted in their ECSE classrooms located in an elementary school. Each classroom included a teacher, two paraprofessionals, and 10 or 11 students with various disabilities. Sessions for Bailey were conducted in her classroom, an ASD program administered at the county level. A teacher, three paraprofessionals, and seven children with autistic disorder between 2 and 6 years of age were in the classroom.

All observers were undergraduate or graduate students in special education who were trained to collect data on dependent measures using video of children similar to the participants in the present studies. Observers were required to demonstrate 90% agreement with data collected by the primary experimenter (first author) over three consecutive 5-min scoring sessions using the video samples prior to scoring behavior for either experiment. Agreement was scored by dividing the smaller number of identified behaviors by the larger number and converting this ratio to a percentage.

EXPERIMENT 1: FUNCTIONAL ANALYSIS

Prior to the functional analysis, the experimenter conducted a paired-stimulus preference assessment (Fisher et al., 1992) to identify highly preferred toys for use during the materials and play conditions and low-preference toys for use during the attention condition. The three most frequently selected stimuli were identified as highly preferred, the next three were identified as moderately preferred, and the remaining stimuli were identified as less preferred. Materials associated with less preferred tasks (e.g., puzzles and sorting activities) were used during the escape condition.

Following the preference assessment, the experimenter asked each participant's teacher and speech and language pathologist to complete the Inventory of Potential Communication Acts (IPCA; Sigafoos et al., 2000) to identify gestural behavior and its perceived functions. The IPCA is an interview that allows caregivers to provide information about behaviors that children may use to communicate with others (Keen, Sigafoos, & Woodyatt, 2001; Keen, Woodyatt, & Sigafoos, 2002; Sigafoos et al., 2000). For example, the IPCA asks how an individual "let's you know if he or she wants an object" or "how the individual gets your attention." The instrument was used in the present study to identify target gestures that occurred in a variety of environmental conditions. Thus, the results of the IPCA provided information about potential target communication behaviors as well as antecedent and consequent stimuli that may function to evoke and maintain a participant's gestures. These relations could then be tested during the functional analysis.

Definition and Measurement of Dependent Variables

Using educator ratings from the IPCA, the experimenter used the following criteria to select target behaviors: (a) The behavior was reported to occur in the presence of other people, (b) the

classroom teacher considered the behavior to be nonproblematic, (c) the behavior was reported to correspond with multiple antecedents or consequences, and (d) the topography of the behavior was judged to approximate recognizable verbal behavior. For example, approaching, reaching toward, or making physical contact with others was selected over jumping, hand flapping, or interacting with objects.

Fuller's gestures were grasping and reaching. A gesture was scored if Fuller grasped the experimenter's hand or arm with his own hand or extended his arm away from his body and in the direction of the experimenter. Bailey's gesture was hand grabbing, defined as placing her hand on (a) the experimenter's hand or (b) an item in the experimenter's hand for a minimum of 1 s. The target gesture for Victor and Matthew was gazing toward and approaching the experimenter. A gesture was scored if the participant directed his eyes toward the experimenter and he either walked toward and stopped within 0.5 m of the experimenter or extended his arm toward the experimenter.

Observers used a handheld counter to tally the frequency of each target behavior during live or video-recorded functional analysis sessions. Rate of target behavior was obtained by dividing total occurrences of a target behavior in a session by the number of minutes in the session. Data were directly entered into an Excel spreadsheet for graphing and visual analysis on a daily basis.

A second independent observer collected data for a mean of 33% (range, 25% to 40%) of functional analysis sessions across a representative sampling of participants and conditions. Interobserver agreement was calculated by comparing the primary observer's data with the secondary observer's data using the total agreement method (Cooper, Heron, & Heward, 2007). The smaller number of recorded occurrences of the target response was divided by the larger number of recorded occurrences and multiplied by 100% to obtain a percentage of

agreement. Mean agreement for Fuller during the materials, attention, escape, and play conditions was 93%, 100%, 86%, and 100%, respectively. Mean agreement for Bailey during the materials, attention, escape, and play conditions was 93%, 100%, 100%, and 100%, respectively. Mean agreement for Victor during the materials, attention, escape, and play conditions was 93%, 100%, 100%, and 100%, respectively. Mean agreement for Matthew during the materials, attention, escape, and play conditions was 100%, 86%, 100%, and 100%, respectively.

Design and Procedure

An alternating treatments design was used to compare the occurrence of the target behavior across a control and three test conditions. Variables within each condition included potential EOs, discriminative stimuli, and reinforcing consequences that had been previously suggested to evoke and maintain mands (Carr & Durand, 1985; Hagopian, Bruzek, Bowman, & Jennett, 2007; Skinner, 1957; Taylor & Hoch, 2008).

The functional analysis procedures were similar to those used by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) and included materials, escape, attention, and control conditions. To account for differences in EOs for each condition, the attention and escape sessions lasted 10 min, whereas the materials and play (i.e., control) sessions lasted 5 min. Specifically, the EOs in the escape and attention conditions were the presentation of an aversive stimulus (e.g., puzzle, nonpreferred music toy) and deprivation of attention, respectively. Each EO was likely strengthened as a function of extended exposure to the experimental condition. The EO for requests for assistance in accessing preferred materials (materials condition) was deprivation from the item or event. A shorter session length may control for satiation that could occur if a participant quickly learned the contingency for the materials condition and had multiple opportunities to obtain the

preferred item or event during a single session (Chappell, Graff, Libby, & Ahearn, 2009). Although extending the length of the session could have increased deprivation if a participant did not emit the gesture during the 5-min session, it was assumed that the former confounding effect was more likely to occur than the latter.

A maximum of four sessions (one of each condition) were completed during a single day for each student and were separated by at least 10 min. During all functional analysis conditions, the experimenter redirected any problem behaviors (e.g., motor stereotypy, flopping) with light physical guidance whenever possible and ignored nonproblem behaviors that were not targeted or problem behaviors that could not be redirected (e.g., vocal stereotypy, crying).

Materials. The materials condition was used to determine whether the behavior functioned as a request for an adult to assist the child in obtaining or operating a preferred item. At the beginning of each session, the experimenter guided the child into the assessment room where a preferred item or activity that required adult assistance was set out for the child. For example, the child's most preferred item was placed inside a transparent container with a lid that he or she could not open. The experimenter told the child that he or she could have the preferred item and then stepped away. If the child engaged in the target behavior at any time during the materials condition, the experimenter assisted in obtaining or operating the item and then stepped away.

If the item was edible, the child was allowed to consume the item and the sequence started again from the beginning. If the item was a toy, the child was allowed to interact with it for 20 s. The experimenter then said "all done," gently removed the item, and started the sequence from the beginning. If the child did not engage in the target behavior within 20 s of stimulus removal, the experimenter briefly manipulated the item in the child's line of sight, then returned the item to the container or placed

it back on the table and stepped away. This process continued for the duration of the materials session.

Escape. The purpose of the escape condition was to determine whether the child engaged in gestural behavior to escape or avoid a non-preferred item (for Fuller), a person (for Bailey and Victor), or a demand to complete a task (for Matthew). Conditions varied across participants to account for differences in potentially nonpreferred items as identified in each participant's IPCA. Specifically, the IPCA indicated that Fuller emitted the target gesture when presented with something he did not like, that Bailey and Victor emitted target gestures before moving away from an adult, and that Matthew emitted the target gesture when required to do something he did not want to do.

The programmed antecedent for Fuller was presenting him with toys that played music. For Bailey and Victor, the antecedent was the experimenter standing or sitting near the participant and talking while the participant interacted with moderately preferred items. For Matthew, the antecedent involved a direction to complete nonpreferred tasks such as coloring a picture, sorting blocks, or completing simple puzzles. The consequence variable was always the removal of the nonpreferred stimulus for 20 s. Specifically, the experimenter removed the music toy from Fuller's line of vision, stepped away from Bailey and Victor, or removed the assigned task from Matthew after the participant engaged in the target behavior.

Participants were instructed to sit at a table or on the floor and were presented with the antecedent stimulus to start the escape condition. For Matthew, the experimenter also used a three-step prompt sequence including (a) the instruction followed by a 5-s pause, (b) the instruction with a model followed by a 5-s pause, and (c) the instruction with manual guidance. Matthew received praise for completing a task unless manual guidance was required for initiation. Prompts and praise were not delivered to other

participants during the escape condition. Anytime the child engaged in the target behavior, the experimenter delivered the programmed consequence while interacting minimally with the child. This sequence (i.e., present antecedent, observe for behavior, administer consequence) continued for the entire 10-min escape condition.

Attention. The attention condition was used to determine whether a gesture functioned to obtain various forms of attention (e.g., vocal statement, high five, pat on the back). Each participant was directed to sit down in a chair at or near the assessment table and was directed to play with low-preference items. The experimenter sat or stood at least 1 m away from the participant and pretended to complete paperwork attached to a clipboard. If the participant engaged in the target behavior, the experimenter delivered attention in the form of a vocal statement related to the activity the participant was engaged in and physical interaction such as a tickle or pat on the back. The participant then was directed to play with the toys by him- or herself. This process continued for the duration of the attention session.

Control. The control condition was used to test for the occurrence of the target behavior when the participant received noncontingent access to preferred items and frequent access to adult attention. The child was instructed to sit at a table in the assessment room and was given unlimited access to his or her most preferred toys or snacks and also received physical and verbal attention from the experimenter every 20 s as long as gestural or problem behavior had not occurred during the preceding 5 s. In addition, the experimenter assisted in the operation of any items the participant was not able to operate independently.

Procedural Integrity

A trained observer measured the accurate implementation of functional analyses using a categorical checklist during a minimum of 20% of all sessions across conditions and participants. Checklist components included the accurate delivery of instructions or stimulus materials,

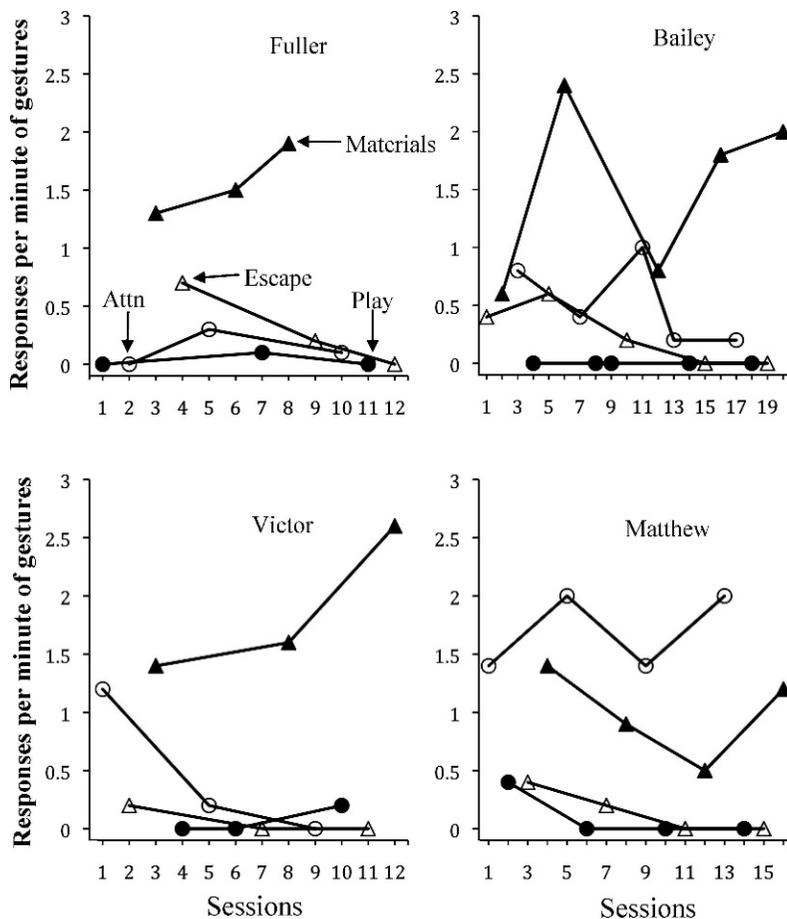


Figure 1. Gestures per minute for each participant across all functional analysis conditions.

accurate delivery of prompts, accurate responding to targeted behavior, and accurate responding to all other behavior. Mean percentage of procedural integrity during the materials, attention, escape, and play conditions was 98% (range, 94% to 100%), 100%, 95% (range, 91% to 100%), and 100%, respectively.

Results

The results of the functional analysis are presented in Figure 1. All participants demonstrated differential levels of responding during at least one test condition compared to the control condition. Fuller demonstrated a mean level of 1.6 gestures per minute (range, 1.3 to 1.9) during the materials condition and 0.03 gestures

per minute (range, 0 to 0.1) during the play condition. Bailey demonstrated a mean level of 1.5 gestures per minute (range, 0.6 to 2.4) during the materials condition and no gestures during the play condition. Victor demonstrated a mean level of 1.9 gestures per minute (range, 1.4 to 2.6) during the materials condition and 0.07 gestures per minute (range, 0 to 0.2) during the play condition. Function-based interventions for these participants therefore were based on the materials condition. In contrast, Matthew engaged in gestural behavior at the highest level during the attention condition with a mean of 1.7 gestures per minute (range, 1.4 to 2.0) and 0.1 gestures per minute (range, 0 to 0.4) during the play condition. He engaged in some gestures during

the materials condition ($M = 1.0$), although levels of behavior in this condition were lower than behavior observed during the attention condition. Therefore, the function-based intervention for Matthew was based on the attention condition.

EXPERIMENT 2: MAND TRAINING

Participants and Setting

All participants from the first experiment participated in the second experiment. Three typically developing children ranging from 3 to 9 years of age were included as video models. Jane was a 3-year-old female peer who modeled responses for Fuller, Bailey, and Victor. Mackenzie was a 9-year-old female peer who modeled responses for Fuller, Victor, and Matthew. Sebastian was a 5-year-old male peer who modeled responses for Bailey and Matthew. The experimenter and the participants' teachers participated as listeners in the video clips. Models and listeners volunteered to create video clips during 10-min recording sessions at recess, lunchtime, or after school.

Materials

Items used to evoke verbal behavior during the function-based condition had to meet two criteria. First, items had to be identified as highly preferred following a paired-stimulus preference assessment conducted after the functional analysis and prior to the second experiment. Second, the item had to be related to the target mand selected for a specific participant. For example, a wind-up toy that a child could not operate was included if "help" or "help me" was a target mand. Other items included spinning tops, balloon inflators, balls that lit up when bounced, cars that made noise when pushed, Polly Pocket dolls, Thomas the Train toys, and bubbles. Transparent containers with lids that participants could not open were used to store preferred items when the target mand was "open" or "open this." Edible items such as Skittles, fruit snacks, Starbursts, and

potato chips were used with some participants. Items used during the nonfunction-based intervention sessions included low-preference stimuli such as puzzles, sorting games, building blocks, and crayons and paper.

When picture exchange was selected as an alternative form of verbal behavior, laminated picture cards (4.5 cm by 4.5 cm) were used. Each picture card displayed a word printed on the top of the card with a picture representing the word below the text.

Video clips. A video camera was placed on a tripod and used to record video clips of peer models engaging in the target behaviors. Video clips were streamed into an MP4 format using iSkysoft software and a MacBook computer. The video clips then were loaded onto an iPhone 3G, which was used to show the video clips to participants.

During intervention, participants viewed 15- to 27-s video clips of a typically developing peer emitting the target response. Video clips started with a close-up view of a specific setting such as a peer model sitting alone or a preferred item inside a transparent container. The camera zoomed out to capture a scene including a peer model, an adult listener, and any stimulus materials involved in the original setting. The model looked at the adult and emitted the target mand; the adult then delivered the consequence specified by the model's mand. Function-based video clips depicted a peer model manding for consequences that maintained gestural behavior during Experiment 1. Conversely, nonfunction-based video clips depicted a peer model manding for a class of consequences unrelated to the functional analysis outcomes.

Definition and Measurement of Dependent Variables

Three mand pairs, each consisting of a function-based and nonfunction-based mand, were targeted and measured for each participant. A licensed speech and language pathologist was

Table 1
Function of Gestural Behavior and Target Mand with Corresponding Antecedents

Participant	Function-based targets		Nonfunction-based targets	
	Mand	Antecedents	Mand	Antecedents
Fuller	help me	HP item required assistance to operate	come play	student plays alone with LP toys
	open this	HP item in transparent container with tight lid	break	work task assigned
Bailey	I want [item name]	HP item on high shelf	look	novel toy that does something unique
	help me	see above	come play	see above
	open movie	see above provide movie without player	break look	see above see above
Victor	open	see above	wow	exciting event
	help	see above	look	see above
	again	brief access to HP event	break	see above
Matthew	tickle	brief ignore	break	see above
	chase	brief ignore	ball	hold ball out of reach
	high five	brief ignore	music toy	hold toy out of reach

Note. HP = high preference; LP = low preference.

consulted to confirm that the function-based mand in each pair required the same or more effort than the nonfunction-based mand. Table 1 identifies the target mands and antecedent conditions created to evoke mands for each participant.

For Fuller and Bailey, each phoneme in the target response needed to be emitted in the correct order and with no pause between phonemes to be scored as a correct response. That is, the word needed to be stated clearly. Correct responses initially were scored for Victor if any phoneme in the targeted response was emitted. The response requirement was increased when he either demonstrated two consecutive sessions with 100% correct responding or emitted a closer approximation to the target word. A correct response was recorded for Matthew if he picked up a picture card and placed the card in the palm of the experimenter's hand. Picture exchange was selected for Matthew by his parent, teacher, and service providers at school after vocal responding was not observed during the initial intervention condition.

Target behaviors were recorded as correct if they occurred within 20 s of the experimenter's

presentation of stimulus materials or within 20 s of the participant being exposed to an antecedent event designed to evoke the behavior (described in the procedures section). Responses were recorded as incorrect if they did not occur within that same time frame. Percentage of trials with an accurate response was calculated for all baseline, training, and generalization sessions.

A second independent observer collected data during 25% of the sessions across all conditions, participants, and experimental phases. Agreement was calculated by comparing the primary observer's data with the secondary observer's data using a point-by-point reliability calculation (Cooper et al., 2007). Each trial was scored as an agreement or disagreement; total agreements were divided by the sum of agreements and disagreements and multiplied by 100% to obtain a percentage. Mean agreement for Fuller during baseline and function-based and nonfunction-based conditions was 100%, 100%, and 98% (range, 80% to 100%), respectively. Mean agreement for Victor during baseline and function-based and nonfunction-based conditions was 100%, 93% (range, 80% to 100%), and 94% (range, 80% to 100%), respectively. Mean agreement for Bailey and Matthew was 100% in all conditions.

Design and Procedure

An alternating treatments within a multiple probe across behaviors design was used to examine the differential effects of function-based and nonfunction-based video modeling on vocal mand acquisition for Fuller, Bailey, and Victor. An alternating treatments design was used in isolation to examine the differential effects of the conditions on picture exchange mand acquisition for Matthew. The alternating treatments design allowed a comparison of the intervention conditions on all dependent measures. The multiple probe design allowed an independent analysis of the intervention conditions on target mands and several replications of the original experiment.

Baseline. Baseline for each participant consisted of a series of trials administered by the experimenter that were embedded within a one-on-one play session that lasted approximately 20 min. Trials started with antecedent events that tend to evoke the targeted mands in typically developing peers (see Table 1). For example, the experimenter gave Fuller a spinning top that he could not operate to evoke a vocal mand for help. In another example, the experimenter instructed Bailey to play by herself with a low-preference toy to evoke a vocal mand for attention.

If the child emitted the target mand within 20 s of the stimulus presentation, the experimenter provided 20-s access to the consequence that corresponded with the mand. If the child did not emit the target mand within 20 s, the experimenter removed the stimuli. The experimenter administered another trial after a 10-s intertrial interval. Five trials for each target mand were administered in random order during a baseline session. The total number of trials per session started at 30, when all target mands were probed, and decreased to 10 as mand pairs were targeted successively for intervention. All behaviors other than the target mand were ignored or lightly redirected with minimal interaction between the experimenter and participant.

Matthew required a baseline for both vocal verbal and picture exchange topographies. During the picture exchange baseline, the experimenter held a picture icon that symbolized the target response in front of Matthew's field of vision and then set the icon on the table prior to presenting the stimulus, as described above. All other aspects of the picture exchange baseline were identical to the vocal verbal baseline.

Baseline lasted until a participant demonstrated a steady state of verbal behavior during a minimum of three experimental sessions. At that time, the initial mand pair was targeted for intervention and all other mand pairs were probed under baseline conditions; baseline probes continued until the intervention was applied to each mand pair.

Video modeling: Phase 1. Following baseline, video modeling was used to teach vocal or picture exchange mands to each participant. The intervention consisted of two conditions: function-based video modeling and nonfunction-based video modeling. Function-based conditions were designed to teach a response that was functionally equivalent to the participant's gesture, whereas nonfunction-based conditions were designed to demonstrate an unrelated verbal response. Antecedent and consequence variables were identical to those programmed during baseline for each target mand (see Table 1).

The experimenter started all video modeling sessions by instructing the participant to sit down at the table. To start each trial, the experimenter showed the participant a video clip that corresponded with the target mand for a specific session. After showing the video, the experimenter delivered the programmed antecedents, paused 20 s to allow the participant to emit the target response, and provided the programmed consequence contingent on the target response. The experimenter ignored or lightly redirected all other responses and allowed the 20-s response period to elapse if the participant did not emit the target response.

Each trial was followed by a 10-s intertrial interval and another trial was initiated. This sequence was repeated until five trials were conducted for a particular condition.

All training sessions involved five trials of one video modeling condition, a 3-min break, and five trials of the second video modeling condition for a particular word pair. It was assumed that the function-based condition would be more likely than the nonfunction-based condition to produce the target mands. Thus, function-based trials were administered prior to nonfunction-based trials for the majority of sessions to rule out any possibility of the nonfunction-based condition affecting responding during the function-based condition. However, one of every four sessions was randomly selected for nonfunction-based trials to be administered prior to function-based trials to control for training fatigue as an explanation if only the function-based mands were acquired.

A slight procedural variation was included for Matthew. During picture exchange training, the experimenter held a picture card of the target mand in Matthew's field of vision and placed the card on the table within Matthew's reach immediately after the programmed antecedent. The experimenter sat within 0.5 m of Matthew during the 20-s response period to permit easier acquisition of the exchange.

No prompts, aside from the presentation of the video, were provided during training sessions. In addition, no reinforcers, aside from those specified by participants' target mands, were delivered for accurate responding. However, because Victor and Matthew did not follow simple directions or attend to videos prior to the intervention, the experimenter gave them small pieces of candy for sitting down when instructed and directing eye gaze toward the video screen during all video modeling conditions.

Once a participant demonstrated 80% accurate responding across three consecutive sessions for one of the targets in a word pair, the word

was considered to be acquired, and the video modeling procedures were applied to another word pair. Additional training for acquired words involved the presentation of stimulus materials prior to the video model and a progressive prompt delay starting at 5 s to allow the transfer of stimulus control from the video to the materials. The video was played at the end of the delay if the response did not occur. Training for target responses not yet acquired continued to include video modeling prior to presentation of stimulus materials.

Video modeling: Phase 2. An additional phase was included for Victor and Matthew to shape closer approximations of the target mands. Victor's initial target response was a vocal approximation that included any phoneme within the complete word. Once Victor demonstrated 100% accurate responding across two consecutive sessions for the initial response or began emitting additional sounds within the target response, his response requirement was increased for that word only. For example, the requirement for "open" went from "o" to "o-en." Victor had to emit a response with at least 75% of the correct phonemes in the correct order at 80% accuracy for three consecutive sessions before video modeling was applied to additional word pairs.

For Matthew, the second phase involved increasing the distance between himself and the experimenter once he met acquisition criteria for three different words within one of the video modeling conditions. During the second phase, Matthew had to travel approximately 1.5 m to complete the picture exchange, which more closely approximated typically occurring classroom conditions.

Training for generalization. Several aspects of the training procedures were explicitly designed to promote generalization to natural environments (Stokes & Baer, 1977). Target responses were selected, in part, because of the likelihood that the response would be followed by reinforcement in natural environments. Second,

multiple stimulus exemplars and video clips were used for each target response. Finally, each participant's teacher was used as an adult listener in some video clips. The teachers as listeners in the video clips may have functioned as common stimuli for the generalization setting. These procedures were incorporated into all phases of both video modeling conditions.

Generalization probes. Throughout all experimental conditions, the experimenter probed for generalization of the target response to a new setting or situation by contriving conditions in the participants' classroom that were similar to the training sessions. For example, to evoke the mand "open this," Fuller's teacher gave him a bag of potato chips that he could not open himself for a snack. Three to five generalization probes were conducted during each session in the students' classroom with a teacher or paraprofessional as the listener, using novel stimuli. Similar to baseline, listeners complied with target mands emitted by participants and ignored or redirected other behavior. No videos were presented prior to the three to five probes conducted during a generalization session, and no unrelated reinforcers were provided for correct responding. Generalization probes were not conducted for Victor due to scheduling conflicts.

Follow-up. A series of follow-up sessions that were identical to baseline conditions occurred at 1, 2, 4, and 8 weeks after video modeling for Fuller and at 1, 2, and 4 weeks after video modeling for Bailey. The purpose of these sessions was to assess maintenance of acquired skills after termination of verbal behavior training. Follow-up sessions were not conducted for Victor and Matthew because the intervention was administered through the end of the school year; the participants were not available for additional sessions beyond that point.

Procedural Integrity

A trained observer used a categorical checklist with a behavioral description of each procedural component to measure adherence to procedures

during 20% of all intervention sessions across participants, conditions, and phases. Broadly speaking, the measured components involved showing the video to the participant, presenting the programmed stimulus, delivering differential consequences, and including a 10-s intertrial interval. The mean level of procedural integrity was 96% (range, 91% to 100%).

Social Validity

Social validity (Wolf, 1978) was assessed by asking parents and teachers of participants to view and evaluate a 5-min video clip of the participant during each of the baseline, nonfunction-based, and function-based conditions. Video clips were presented in random order, and raters were unaware of the experimental condition in each video. After each video clip, caregivers ($N = 8$) were asked to indicate their agreement or disagreement with four statements pertaining to the intervention. Statement 1 was "the student is able to communicate basic needs and wants in a way that people who do not know him are likely to understand." Statement 2 was "the student appears to be having a good time." Statement 3 was "the student is learning skills in addition to communication." Statement 4 was "this is a good use of the student's time." A 10-point rating scale was used with a score of 10 indicating *total agreement* and a score of 1 indicating *total disagreement*. Table 2 displays social validity ratings for each statement provided by caregivers after viewing the video clips. Caregivers rated both intervention conditions higher than baseline on all items and rated the function-based condition higher than the nonfunction-based condition on all items.

Results

Results of video modeling on targeted mands and during generalization probes for Fuller are displayed in Figure 2. Fuller demonstrated no responding during baseline across all word pairs. When video modeling was introduced, he acquired all three target mands during the function-based condition ($M_s = 78\%, 88\%$,

Table 2
 Mean (Range) Social Validity Ratings for All Conditions

Question	Baseline	FB	NFB
Other listeners would understand this response	3.5 (2-5)	9.25 (8-10)	5.5 (1-10)
Student is having a good time	5.5 (4-7)	10	7.25 (5-10)
Student is learning skills in addition to communication	5 (2-10)	9.5 (8-10)	7.5 (6-10)
Good use of student's time	8.25 (5-10)	9.75 (9-10)	8.5 (6-10)

Note. FB = function based; NFB = not function based.

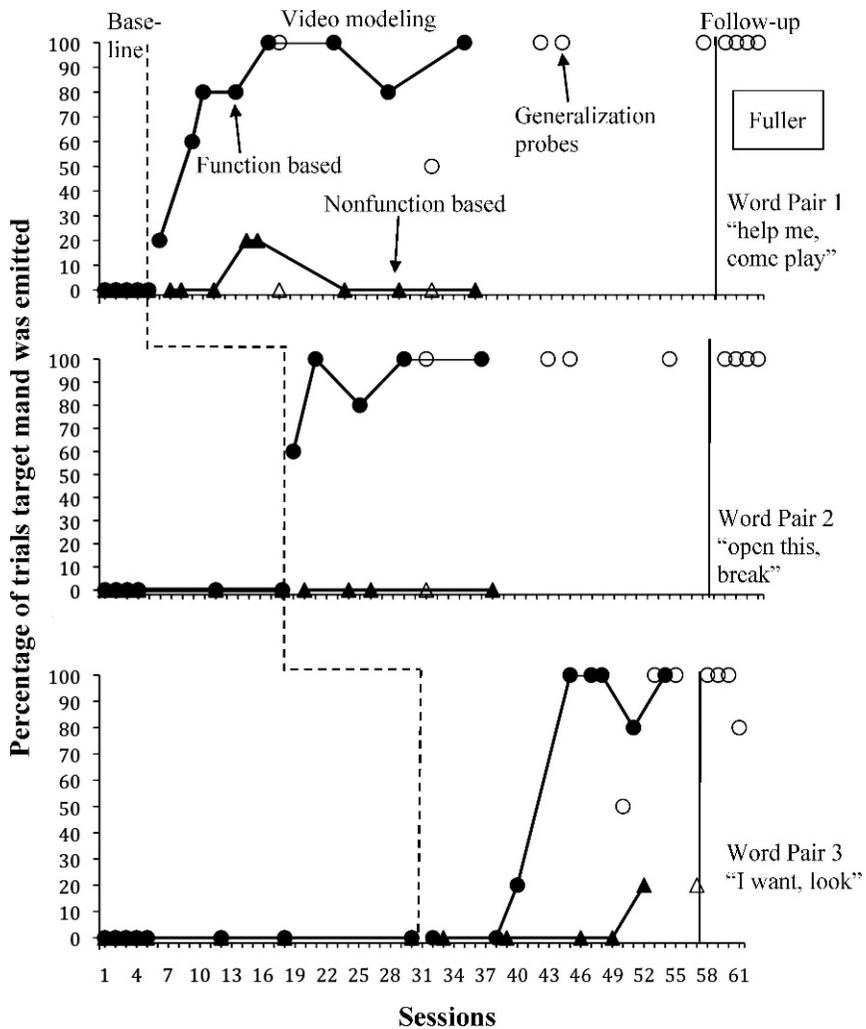


Figure 2. The percentage of trials in which Fuller emitted the target mand during all conditions and across targeted word pairs. Filled data points indicate training trials; open data points indicate generalization probes. Follow-up probes occurred at 1, 2, 4, and 8 weeks posttraining.

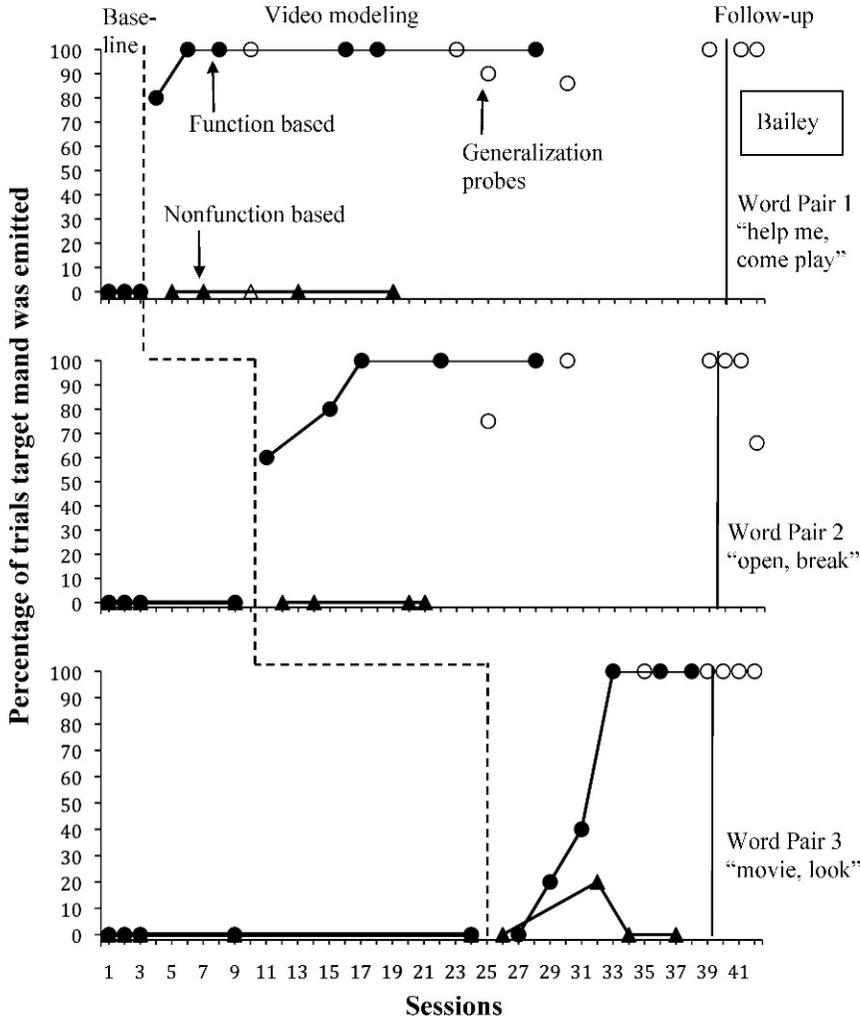


Figure 3. The percentage of trials in which Bailey emitted the target mand during all conditions and across targeted word pairs. Filled data points indicate training trials; open data points indicate generalization probes. Follow-up probes occurred at 1, 2, and 4 weeks posttraining (2 and 4 weeks for Word Pair 1).

and 63%) and did not acquire target mands during the nonfunction-based condition ($M_s = 5\%, 0\%, \text{ and } 4\%$). The emergence of the third function-based mand was delayed somewhat in comparison to the first two, although he did meet the 80% acquisition criterion over three consecutive sessions. Generalization of the response to novel situations also was observed ($M = 95\%$), and Fuller emitted mands at a high level ($M = 98\%$) during follow-up sessions.

Results of video modeling on targeted mands and during generalization probes for Bailey are

displayed in Figure 3. She did not emit vocal mands during baseline conditions. She rapidly acquired function-based mands for the first and second word pairs ($M_s = 97\% \text{ and } 88\%$). Although a slight delay in the emergence of the third function-based mand decreased her overall level of accurate responding ($M = 60\%$), Bailey emitted the target mand with 100% accuracy over the final three training sessions. She did not acquire nonfunction-based mands ($M_s = 0\%, 0\%, \text{ and } 5\%$). Generalization of function-based mands to novel situations was observed ($M =$

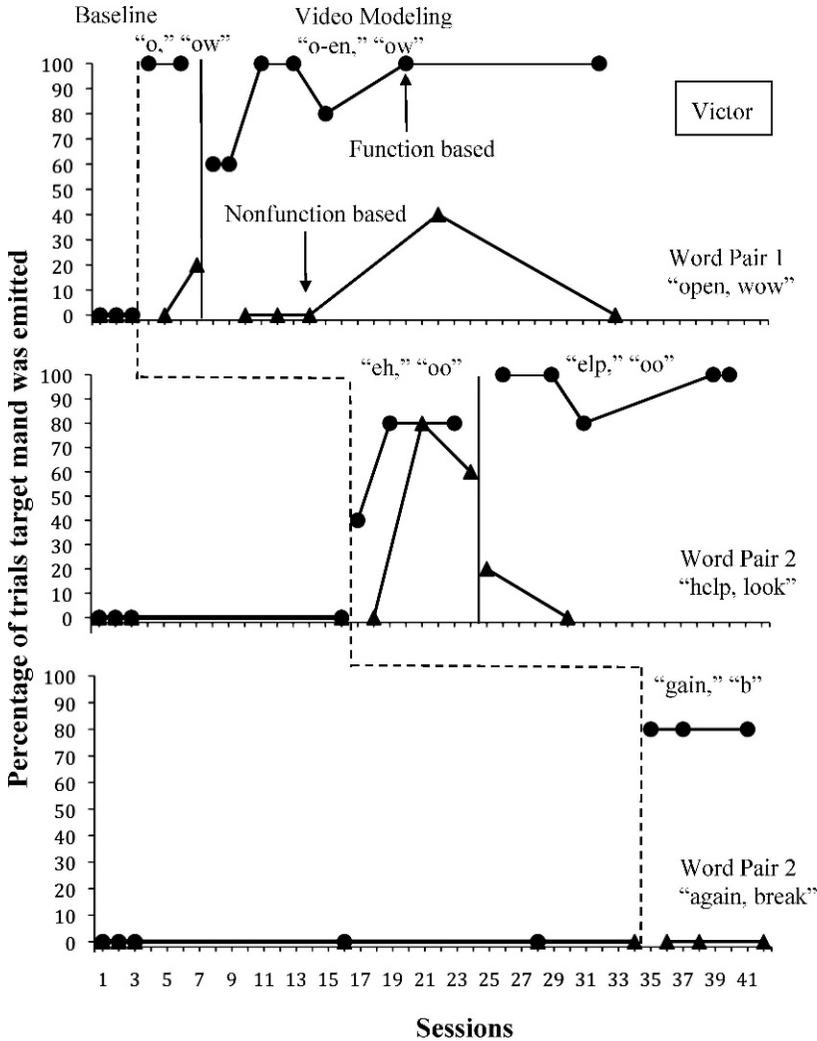


Figure 4. The percentage of trials in which Victor emitted an approximation of the target mand during all conditions and across word pairs.

95%), and Bailey also emitted mands at a high level during follow-up sessions ($M = 96\%$).

Results of the video modeling intervention on targeted mands for Victor are displayed in Figure 4. He demonstrated no target responding during baseline across all word pairs. When video modeling was implemented for each word pair, he immediately emitted an approximation of the function-based response ($M_s = 100\%$, 67%, and 80%). When the response requirement was increased for the first and second function-based responses, vocal mands were

shaped successfully into closer approximations of the target response ($M_s = 86\%$ and 96%). Victor also emitted approximations of the first and second nonfunction-based response ($M_s = 9\%$ and 32%). However, responding was variable and could not be sustained over time or shaped into a closer approximation of the target mand. Victor did not emit approximations of the third nonfunction-based response.

Results of the video modeling intervention on targeted mands for Matthew are displayed in Figure 5. Matthew's original intervention was

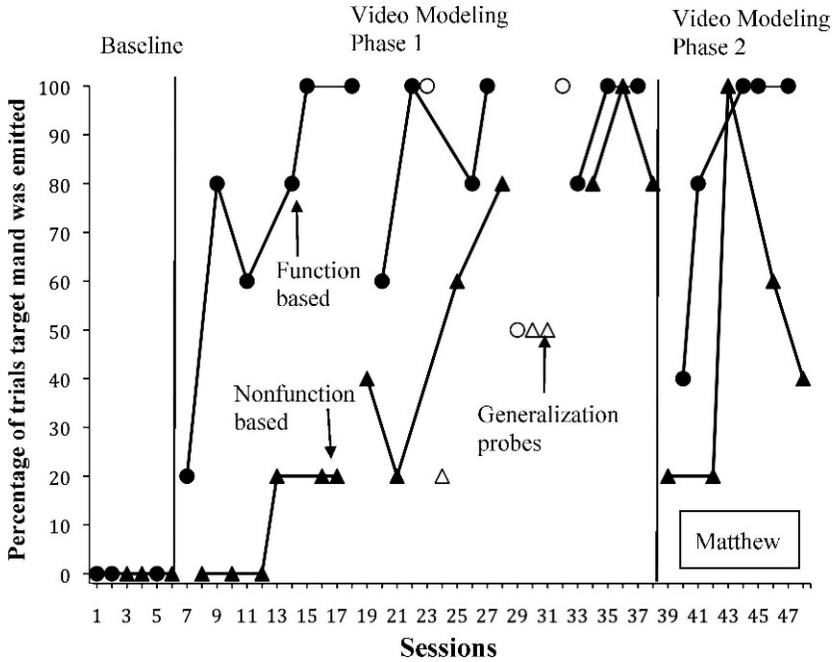


Figure 5. The percentage of trials in which Matthew emitted mands across all conditions and phases. Filled data points indicate training trials; open data points indicate generalization probes. Separated data series indicate training for a new word.

adjusted to target a picture exchange topography after he did not demonstrate any vocal verbal responding during the initial intervention sessions. He demonstrated no responding during the picture exchange baseline. When video modeling was introduced, his mean responding during function-based and nonfunction-based conditions was 80% (range, 20% to 100%) and 41% (range, 0% to 100%), respectively. He rapidly acquired function-based mands, but nonfunction-based mands were acquired more slowly. When the experimenter increased the distance Matthew had to travel to mand (i.e., Phase 2), mean percentage of picture exchange behavior was 84% (range, 40% to 100%) and 48% (range, 20% to 100%) during the function-based and nonfunction-based conditions, respectively. Generalization of the function-based mands to novel settings was observed ($M = 83\%$), and generalization of nonfunction-based mands was observed less often ($M = 23\%$).

DISCUSSION

Results of the current studies demonstrated that video modeling procedures that are based on the identified function of communicative behavior are more effective in teaching new communicative responses than are video modeling procedures that are unrelated to identified functional relations. The results provide support for the application of a functional analysis of communicative behavior (Ferreri & Plavnick, 2011; Lerman et al., 2005) and function-based verbal behavior training in some situations. Essentially, the functional analysis of gestures allowed the experimenters to make empirically informed decisions when selecting intervention components such as target mands, environmental variables, and response topographies. Although previous research clearly has shown that mands can be taught without conducting a functional analysis of gestures (e.g., Jennett et al., 2008), a function-based process may be

an important component of verbal behavior training procedures in some situations.

The function-based approach could assist consultants in settings such as public schools, where service providers may not have a background in behavior analysis. The IPCA allowed the identification of communicative behaviors and the conditions that may evoke and maintain those behaviors in the child's natural environment. The functional analysis then was used to identify the precise environmental variables that were functionally related to the target gesture. A consultant could use this information to recommend target mands and training procedures to an educator who wants to teach a child to emit requests in the classroom environment but who has limited experience capturing or contriving EOs to conduct mand training.

Support for function-based mand training in a consultation framework was demonstrated in the present study by comparing mand acquisition across the two video modeling conditions. The condition related to functional analysis outcomes led to mand acquisition and the unrelated condition did not. Acquisition and reliable use of mands could be delayed if a consultant were to suggest teaching mands for toys to a child whose gestures were controlled more reliably by attention (e.g., Matthew).

A function-based approach to mand training also may be particularly important when a child demonstrates minimal vocalizations prior to mand training (e.g., Victor and Matthew). The absence of previous speech combined with uncertainty pertaining to manipulating EOs could lead to the premature adoption of alternative communication systems or ongoing environmental manipulation when, in fact, an alternative system is necessary. In Victor's case, reinforcers identified during the functional analysis were used to contrive EOs during mand training that led to an emerging vocal repertoire. However, Matthew did not acquire vocal mands despite the fact that EOs known to evoke gestural behaviors were contrived during

the intervention. As a result, we had reason to believe that ongoing manipulation of environmental variables was not likely to produce vocal behavior in the immediate future and that an alternative communication system was appropriate. The acquisition of picture exchange mands under the same conditions ultimately confirmed this hypothesis. The process offered an empirical supplement to professional judgment, which is the current standard for deciding if and when a child requires an alternative communication system (Schlosser & Wendt, 2008; Sundberg & Michael, 2001).

The observed generalization of mands exhibited by Fuller, Bailey, and Matthew after video modeling further supports the utility of this procedure as a tool to promote generalization. These findings are consistent with those of Charlop-Christy, Le, and Freeman (2000), who demonstrated that video modeling was more effective than in vivo training for promoting generalization. The present investigations incorporated several tactics to promote generalization, such as selecting responses that contact reinforcement in the natural environment, using multiple exemplars, and including common stimuli (Stokes & Baer, 1977). Furthermore, video modeling may be especially effective for promoting the generalization of verbal behavior. Instead of prompting or modeling the target response after the EO is contrived (Jennett et al., 2008), video modeling allows the participant to see an entire antecedent-behavior-consequence unit as a model before the EO is contrived. This sequence may facilitate the transfer of stimulus control to the EO, which makes the response more likely to occur whenever the EO is present.

An important contribution of the present study related to video modeling is that participants acquired mands and then demonstrated generalization of target responses during the function-based condition only, even though the models and teaching procedures were held constant across conditions. Conceptually speaking, this finding is best attributed to stimulus control established by the observed

consequences (Masia & Chase, 1997). That is, replication of the modeled response was reinforced only when the model obtained a consequence that was preferred by the observer. Although the observed consequence has received minimal attention in previous video modeling research, it appears to have important implications for selecting target responses and constructing modeled sequences.

A second contribution to knowledge about video modeling for children with autism is that participants rapidly acquired recognizable mand repertoires despite the absence of an established imitative repertoire prior to training. Previous findings suggest that some level of imitation is a prerequisite to learning through video modeling; however, clear criteria for pretreatment levels of imitation have not been identified (Rayner et al., 2009). The findings of the present study suggest that individuals with autism may learn to imitate a video model prior to demonstrating motor or vocal imitation under instructional control (e.g., imitation when told to “do this” and presented with a model).

A noteworthy benefit of video modeling is that it was used to teach picture exchange communication with a one-to-one instructor-to-student ratio. Although picture exchange typically is taught using two adults, one as a prompter and one as a listener (Frost & Bondy, 2002), Matthew rapidly acquired picture exchange mands and demonstrated generalization of the response with a single interventionist. This procedural modification is especially important in public school settings where financial resources do not typically support two interventionists for a single child (Stahmer, 2007).

Although participants acquired mands and generalized target responses following the intervention, some limitations of the procedures should be addressed in future research. In terms of the functional analysis, it is important to note that the test conditions may need to be modified to produce consistently accurate results. For example, the materials condition of

the functional analysis combined assistance and the delivery of tangible items as consequences. Future research could address this limitation by examining assistance and tangible items under different experimental conditions. In addition, some of the tested reinforcers may not have been effective and some relevant EOs may not have been contrived in the functional analyses. For example, attention may have functioned as a reinforcer only when it was delivered in a certain way or by a specific person. Similarly, it is possible that the stimuli used during the escape condition were not aversive or were initially aversive but became less so due to extended exposure to the stimuli.

A second limitation of the functional analysis was that total agreement was used to calculate interobserver agreement, as opposed to more accurate and commonly used estimates such as an interval-by-interval assessment. Thus, the high levels of agreement during the functional analysis must be interpreted with caution, because it is possible that the observers recorded different instances of the target behaviors during an observation period.

Other limitations were relevant to the intervention procedures. Mands may have been maintained during the nonfunction-based condition if unrelated or additional rewards were paired initially with the specific consequences delivered for manding. This process often is used when the natural consequence, such as attention, is not a highly preferred item or event (Taylor & Hoch, 2008). Future research could compare mand acquisition and generalization when the corresponding consequence for the mand initially is paired with unrelated rewards. This type of analysis could provide additional information regarding the necessity of a functional analysis of gestural behavior.

An additional limitation of the intervention was that function-based mand training and video modeling could not be analyzed in isolation. For reasons discussed above, it seems likely that the combination of procedures led to the outcomes demonstrated by the participants.

However, it will be important to know if these outcomes could be attained when video modeling is used to teach mands without a preintervention assessment or when in vivo modeling is used in conjunction with the function-based approach.

The present study extends the use of function-based interventions to promote the acquisition of a mand repertoire for children with autism without an emphasis on problem behavior. In addition, the results show that video modeling can be an effective and efficient way to teach verbal behavior. In the current experiment, children who had no way to mand for preferred events and items prior to the intervention demonstrated generalization of target mands in a relatively short period of time. Instead of waiting until problem behavior becomes frequent or severe, intervention agents can apply functional assessment tactics to behaviors that children often use as verbal operants and teach new response topographies based on the results of this assessment.

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