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MANIPULATING ESTABLISHING OPERATIONS TO VERIFY AND ESTABLISH STIMULUS CONTROL DURING MAND TRAINING

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Acquisition of verbal behavior is a major goal of interventions for children with developmental disabilities. We evaluated the effectiveness of manipulation of an establishing operation for functional discriminated mands. Four individuals with developmental disabilities participated in a training procedure designed to teach two separate mands for two separate preferred items. Participants were taught to mand using picture cards. Following training, the manipulation of the establishing operation was used to assess and establish discriminated manding. This manipulation involved providing free access to one of the preferred items, such that there should be no motivation to ask for it, while motivation to ask for the other item remained in place. Three of the 4 participants acquired discriminated manding using topographically similar responses (picture cards). One participant did not acquire a discriminated mand until topographically distinct mands were taught (vocal and picture card). Results suggest that discrimination training is not necessarily sufficient to teach discriminated manding when more than one picture card showing preferred items is used. In addition, manipulation of the establishing operation served as an appropriate assessment tool for the verification of discriminated manding as well as a possible training tool to establish discriminated manding.

DESCRIPTORS: autism, picture cards, discrimination training

The acquisition of language for children with developmental disabilities is a major goal of training programs. A large number of young children with autism or related disabilities enter school programs without speech or other communicative behavior (Bondy & Frost,

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1994a). In the population at large, language delays are common for children under the age of 3 years (10% to 15%), and by school age it is estimated that 3% to 7% experience a language disorder (American Psychiatric Association, 2000). For children with developmental disabilities to learn to gain access to desired items appropriately, communicate their needs and desires, request information, obtain others' attention, and generally control their environments, it is important that they acquire a functional form of communication (McCoy & Buckhalt, 1990). In addition, development of functional communication skills has also been shown to reduce problem behavior by individuals with developmental disabilities (Carr & Durand, 1985; Richman, Wacker, & Winborn, 2001; Winborn, Wacker, Richman, Asmus, & Geier, 2002).

The use of a picture-card exchange system (Bondy & Frost, 1993, 1994b; Liddle, 2001) is a widely used intervention for children with communication deficits (Charlop-Christy, Carpenter, Le, LeBlanc, & Kellet, 2002), and there have been systematic programs designed with these techniques (e.g., Bondy & Frost, 1993, 1994b). Several published empirical studies have focused on procedures designed to teach communication using picture cards (Bondy & Frost, 1993; Liddle, 2001; Schwartz, Garfinkle, & Bauer, 1998). Although establishing discriminated manding was not the sole purpose of these studies, each incorporated procedures to teach mands similar to those described by Bondy and Frost (1994b).

Bondy and Frost (1993) reported on the successful implementation of picture-card mand training for 74 students with communication delays. Of those students, 18 learned to make discriminations from a group of pictures. Bondy and Frost (1994a) reported that of the 85 children who had been taught to use picture cards at the Delaware Autism Project, over 95% learned to use two or more pictures to request items following the discrimination training phase.

Schwartz et al. (1998) taught 31 children with disabilities to request items using picture cards. Results showed that children completed the discrimination phase after 7 months of training. In a similar study, Liddle (2001) taught 21 children with language delays to use picture cards to request items in their classroom. Results showed that 16 of the 21 children completed the discrimination training phase, in which they were taught to request preferred items.

Although the literature supports the use of picture cards to teach mands (Bondy & Frost, 1993, 1994b; Liddle, 2001; Schwartz et al., 1998), an empirical question remains regarding the effectiveness of training procedures to produce appropriate or discriminated manding for preferred items. At times, the success of mand training is evaluated based on the participant's ability to make the desired communicative response (e.g., hand a picture card). In other words, if a child hands a "cookie" card to the therapist and then gains access to the cookie, it is presumed that the child appropriately manded for a cookie. However, on closer examination, the appropriateness of the individual's mand cannot be entirely presumed based on his or her response. Rather, it remains unclear if the child is actually requesting a cookie or another item but accepts and consumes a cookie because it is a suitable reinforcer. It is also difficult to determine the appropriateness of the mand response because the response of handing a card, in general, has been sufficiently reinforced with access to preferred items such that an individual may have learned to hand any card to gain access to reinforcement.

Because picture-card training involves teaching individuals to hand picture cards, the topography of the response is the same from one occurrence of the behavior to another. In other words, regardless of which item the individual requested, the form of the response is the same (i.e., handing a picture card). This is

contrasted with other forms of communication training that involve teaching topographically different responses that correspond to each item (e.g., sign language, vocal responding). This distinction between response forms is referred to as topography-based and selection-based verbal behavior (Michael, 1985). Michael argued that responding using picture cards is a form of selection-based verbal behavior, and as such, the individual must learn to make a conditional discrimination to mand for an item. The individual must make a discrimination from among the visual stimuli that is not required when using topography-based verbal behavior. Michael suggested that this additional discrimination requirement may influence factors such as ease of acquisition and susceptibility to interference during training. Studies evaluating the two types of verbal behavior have shown that topography-based verbal behavior can be acquired in fewer training trials and results in more accurate performance than selection-based verbal behavior (Sundberg & Sundberg, 1990; Wraikat, Sundberg, & Michael, 1991), suggesting that discriminating between picture cards may be difficult skill for some individuals to acquire.

Bondy and Frost outlined methods for teaching mands using picture cards that include a correspondence check during the discrimination phase designed to detect and correct discrimination problems (Bondy & Frost, 1994b, 2001, 2002; Frost & Bondy, 1994). Correspondence checks involve placing two items as well as the two corresponding picture cards in front of the individual. When the individual hands the therapist a card, the therapist allows the individual to pick up the item he or she has requested. If the individual selects the appropriate item (i.e., the item that corresponds to the selected picture card), the therapist allows the individual to consume or engage with the item. If the individual attempts to select an item that does not correspond to the selected picture card, the therapist corrects the individual and prompts him or her to select the picture card corresponding to the selected item.

The correspondence check (Bondy & Frost, 1994b) is advantageous because it is practical and allows systematic correction if errors are made. It may be limited, however, because its utility does not include direct assessment of the establishing operation (EO) that evokes the mand. According to Skinner (1957) a mand is under the control of relevant conditions of deprivation. Thus, to completely assess the occurrence of a mand, it may be necessary to include an assessment of the EO that evokes the verbal response.

Interpreting the correspondence check requires the inference that the EO that evoked the selection of a particular reinforcer was the same EO that evoked the verbal response. However, the correspondence check does not involve a direct manipulation of the EO prior to the response. It may be important to test more directly whether the response emitted is functionally a mand. It may also be necessary to evaluate the extent to which the selection of a specific picture card is a discriminated response to assess the effectiveness of mand training using picture cards. If individuals do not engage in a discriminated response with picture cards, then training has not resulted in a functional, discriminated mand response.

The purpose of the current study was to evaluate the extent to which mand training using picture cards will result in discriminated mands in the context of two picture cards and to determine the extent to which manipulating EOs will function to verify the existence of and establish discriminated manding. Manipulation of the EO may have an advantage over the correspondence check, at least in some cases, because it directly manipulates the controlling variables for mands. This procedure more directly tests whether the response emitted is functionally a mand by manipulating prior controlling variables. Although the relative merits of picture-card systems can be debated,

additional research is warranted due to widespread use of these systems.

METHOD

Participants

Four individuals who did not ordinarily request items either vocally or nonvocally participated in the study. Mario was a 13-year-old boy who had been diagnosed with mental retardation (although not formally diagnosed as autistic, his behavior was characteristic of autism), Millie was a 4-year-old girl, Will was a 5-year-old boy, and Malcolm was a 6-year-old boy. All had been diagnosed with autism. Participants had minimal exposure to picture cards prior to the study. Picture cards had been placed in some classrooms at their schools (e.g., picture card for bathroom outside the bathroom), but they were not used explicitly to teach mands. Formal training of a picture-card communication system had not taken place for any participant prior to the study. Teachers or staff referred all participants following an announcement at the school that the study was underway to teach and evaluate communication using picture cards. These were the first 4 individuals referred whose parents agreed to give informed consent.

Setting

All sessions were conducted at the participant's school. Blocks of sessions lasted for approximately 30 min and were conducted 3 to 5 days per week. During sessions, each participant was seated at a table across from the therapist and data collectors. Sessions were conducted in a small room reserved for the study.

Except for the preference assessment, sessions consisted of 10 trials for Mario, Will, and Malcolm and 10 to 15 trials for Millie. During each trial the participant was presented with the opportunity to emit a mand and receive access to preferred items. After the participant was allowed access to items for approximately 30 s or to consume the food items, the card position was counterbalanced quasirandomly in an array of two and the cards were presented to the participant to start the next trial (specific procedures varied by condition; see below).

Data Collection and Response Definition

Trained graduate and undergraduate observers recorded correct and incorrect responses. During training, correct responses were defined as handing the therapist the picture card. Incorrect responses were defined as handing the therapist the distracter card. During manipulation of the EO (Michael, 1982) (explained below), observers recorded the card that was handed to the therapist. During the EO manipulation with topographically different responses (explained below), observers recorded the response emitted by the participant, which could be handing a picture card or emitting a vocal response.

Interobserver Agreement

During all phases, two trained observers collected data simultaneously and independently during 34% of the sessions. Interobserver agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements in each session and multiplying by 100%. An agreement was defined as a trial in which both observers recorded the same occurrence of behavior. Mean agreement for all sessions was 99% (range, 80% to 100%).

Materials

Two picture cards and two distracter cards were used during training. The picture cards corresponded to preferred items that were identified for each participant during a preference assessment. Distracter cards displayed an X or an O.

Procedure

Participation in each phase of the study was determined by participant performance in the

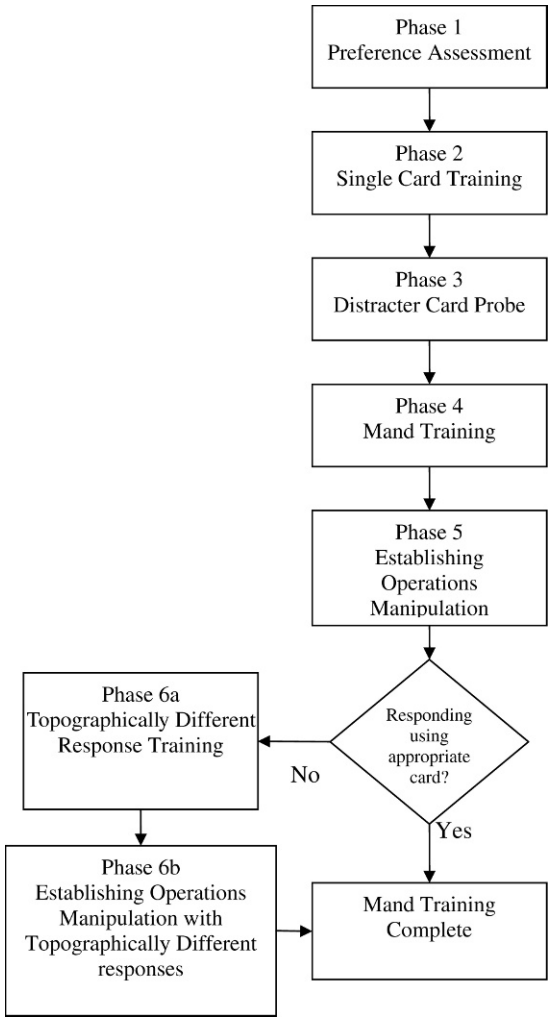

Figure 1. Flow chart depicting the order of phases during the study.

prior phase. As participants completed each phase, they either moved on to the next phase of mand training or moved to a supplemental training phase. Figure 1 shows the order of phases.

Phase 1: Preference assessment. The purpose of this phase was to identify items to be used as reinforcers. A free-operant preference assessment (Roane, Vollmer, Ringdahl, & Marcus, 1998) was conducted to identify highly preferred items for each participant. Each participant was presented with an array of food and leisure items during one or two 5-min sessions. Separate assessments were conducted for Will and Millie to identify preferred items or activities as well as consumable items. The two separate preference assessments were conducted to avoid a possible displacement of nonconsumable items by consumable items (DeLeon, Iwata, & Roscoe, 1997). Data collectors recorded the amount of time the participant spent interacting with each item. Items with which the participant spent the most time were chosen as preferred items to be used during mand training.

Phase 2: Single card. The purpose of this phase was to establish a card-handing repertoire. The participant was seated with a single picture card in front of him or her. Handing the therapist the picture card resulted in access to the item for approximately 30 s or (when food or drink was the preferred item) a small amount of the consumable item. Participants were taught to use picture cards to mand for preferred items using a four-step sequence (5-s pause, verbal instruction, physical model, physical guidance).

Phase 3: Distracter-card probe. We conducted a probe for all participants in which a picture card and a distracter card were presented. The purpose of this phase was to evaluate whether participants were more likely to select a picture card, as a point of comparison to a subsequent differential reinforcement phase. The participant was seated with the two cards in front of him or her. Responding using either card resulted in access to the preferred item. After the participant responded, the item was delivered and both cards were removed. Access to the preferred item lasted for approximately 30 s (in the case of consumable items, a small amount was delivered). After each trial, the position of the cards was reassigned quasirandomly, the cards were again presented to the participant, and the next trial began.

Phase 4: Differential reinforcement (mand training). The purpose of this phase was to differentially reinforce responses using picture

cards, to establish a simple discrimination between the target card and distracter cards or at least to provide a history of reinforcement for the picture-card response. There was no intention to show acquisition, because in some cases there was a bias towards selecting the card with the picture (see the results). During differential reinforcement, only responses using the picture card resulted in reinforcement, and responses using the distracter card resulted in extinction. The experimental design was a concurrent-schedules design, in which experimental control is demonstrated by differential responding across choice alternatives (Sidman, 1960). During these sessions, the participant was seated with the two cards placed in front of him or her. The item itself was present but out of reach. Requests using the picture card resulted in access to the item for approximately 30 s (or a small amount of the edible item), and both cards were removed. Requests using the distracter card resulted in extinction (and a brief time-out), during which the therapist removed the cards and turned away from the participant for approximately 5 s. After each trial, the position of the cards was reassigned quasirandomly and the trial was restarted. Participants were taught to use picture cards to mand for two different preferred items. Participants who passed this phase (at least two sessions with 80% correct) were deemed to have completed the initial discrimination screening and had demonstrated performance of the discrimination skills necessary to move to Phase 5.

Phase 5: Manipulation of the EO. The purpose of this phase was to evaluate the effectiveness of the initial mand training to establish complex manding in the presence of two picture cards, each corresponding to preferred items, as well as to serve as an additional training phase to establish discriminated mands. All 4 participants participated in this phase. The EO manipulation phase differed from the differential reinforcement phase in two respects. First, the two previously trained picture cards were placed in front of the participant, and there were no distracter cards present. This was the first time the participants were given both picture cards for which handing had been differentially reinforced. Second, the participant had free access to one of the items he or she had been previously taught to mand for during differential reinforcement. The EO phase was conducted using a combination of a concurrent-schedules and multielement design (Sidman, 1960) in which we compared the effects of the EO (EO present vs. EO absent) on manding. During EO manipulation sessions, the participant was allowed free access to one of the previously taught items, and access to a second item was restricted. For example, if a participant had been was previously taught to mand for the radio and a drink, during this phase the participant was allowed free access to the radio (radio EO absent) and access to the drink was restricted (drink EO present) or vice versa. Sessions in which one EO was present or absent were alternated. Also, requests using the picture card corresponding to the restricted item resulted in access to that item for approximately 30 s (or a small amount of the consumable item), and both cards were removed. Requests using the picture card corresponding to the item to which the participant already had access resulted in the therapist removing the cards for approximately 30 s (but the participant maintained access to the item). After each trial the position of the cards was reassigned quasirandomly, and a new trial was started.

Phase 6a: Topographically different response training (vocal and card). The purpose of this phase was to develop two distinct mand forms (vocal and card). Only Millie participated in this phase because she was the only participant who showed no sensitivity to the EO manipulation in Phase 5. It is possible that the topographical similarity between handing responses may have impeded discrimination during the EO manipulation (Michael, 1985). One picture card and two distracter cards were

used during the training phase. The picture card corresponded to a preferred item, and distracter cards displayed an X or an O. The participant was also presented with vocal mand training designed to produce differential responding during the EO phase. The participant was taught to request an item using a picture card and was taught to request a second item by saying the word corresponding to the item (e.g., saying "chips"). Millie was taught to respond vocally by first presenting a vocal prompt (e.g., "say 'chips'") and delivering the reinforcer (chips) following the imitative response ("chips"), and prompts were gradually faded (Bourret, Vollmer, & Rapp, 2004). During the vocal manding sessions, Millie was seated at a table and no cards were present. Requests using the vocal mand resulted in access to a small amount of the item. Vocalization of any other word resulted in extinction during which the therapist turned away from her for approximately 5 s. She was taught to use the picture card to mand for the item corresponding to the picture (music) and a vocal mand to mand for the item corresponding to the vocal mand (chips). She was taught to use the picture card to mand for the preferred item using a three-prompt sequence (verbal instruction, physical model, physical guidance) followed by access to the item. She was taught to mand vocally using prompts and modeling followed by access to the item.

Phase 6b: EO manipulation with topographically different responses (vocal and card). The purpose of this phase was to test for complex discriminations using two distinct response forms (vocal and card) as well as to serve as an additional training phase to establish discriminated mands using two distinct response forms. Two topographically different responses were used to overcome the possible discrimination problem caused when topographically similar responses were used. For Millie, the EO manipulation was similar to that used in Phase 5; however, only one picture card was placed in front of her. There were no distracter cards present, and she had free access to one of the items she had been previously taught to mand for (vocally or handing a picture) during Phase 6a, and access to a second item was restricted. The mand for the second item had also been taught previously. Requests using the mand corresponding to the restricted item resulted in access to music for approximately 30 s or a small amount of the chip (i.e., one chip), and the card was removed. Requests using the mand corresponding to the item to which the participant already had access resulted in the therapist removing the card for approximately 30 s (while the participant maintained access to the item).

RESULTS

Phase 1: Preference Assessment

For Mario, the free-operant preference assessment identified a radio as the most preferred item, and multiple observations not related to this study also identified soda as a preferred item. For Will, the assessment identified cookies and a radio as the most preferred items. For Millie, the items identified as most preferred were music and chips. For Malcolm, the most preferred items were television and chips.

Phase 2: Single Card

All participants acquired the single-card response within one very brief session (data not shown). In all cases, the last several responses occurred with no prompting.

Phases 3 and 4: Distracter-Card Probe and Mand Training

Figure 2 shows the percentage of trials with cards selected for Mario and Will during the distracter-card probe and differential reinforcement (mand training) phases. Recall that during the distracter-card probe, responding using either the picture card or the distracter card resulted in reinforcement. During the differential reinforcement phase, only responses using

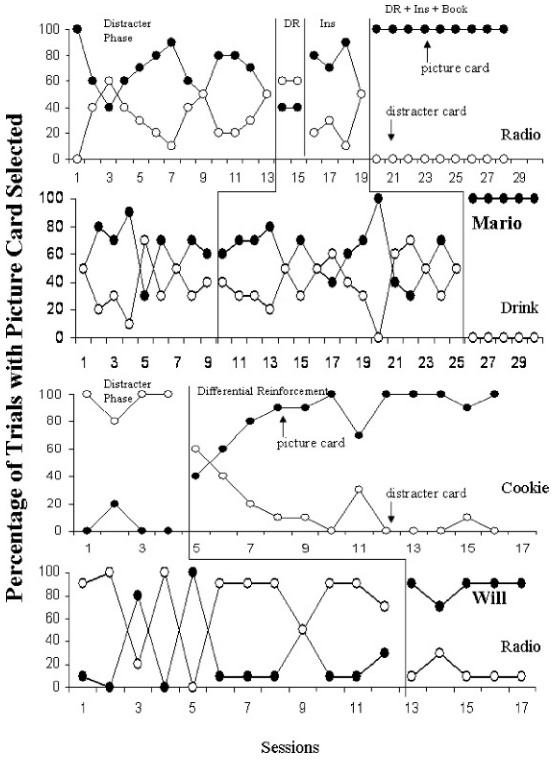

Figure 2. Percentage of trials with picture card and distracter card selected during the distracter-card probe and differential reinforcement phases for Mario and Will.

the picture card resulted in reinforcement, and responses using the distracter card resulted in extinction. During the distracter-card probe, Mario selected both the picture card and the distracter card during both radio and drink sessions but showed a slight bias for the picture card during the drink (M = 63%) and radio (M = 68%) sessions. During differential reinforcement, Mario selected the distracter card more often than the picture card when differential reinforcement was implemented during the radio sessions and drink sessions (M = 60%). During this phase, Mario did not look at the cards; instead, he handed the therapist a card without looking down. We then gave Mario instructions during the radio sessions to hand the picture card to gain access to the radio. However, this manipulation was not effective at producing 100% correct responding (M = 73%), and Mario was still not looking at the cards consistently. To ensure that Mario looked at the cards before handing them to the therapist, we placed the cards in a small photo album to create a communication book. This required that Mario open the book and find the correct card. This intervention was immediately effective at producing 100% correct responding during the radio and drink sessions.

During the distracter-card probe, Will responded using the distracter card almost exclusively during the cookie (M = 95%) sessions and showed a bias for the distracter card during the radio (M = 73%) sessions. When differential reinforcement was implemented, Will responded more often using the picture card rather than the distracter card during both cookie (M = 85%) and radio (M = 86%) sessions.

Figure 3 shows the percentage of trials with cards selected by Malcolm and Millie during distracter-card probe and differential reinforcement phases. During the distracter-card probe, Malcolm showed a bias for the picture card. He responded using the television card more often (M = 72%) than the distracter card during the television sessions and selected the chips card almost exclusively (M = 92%) during the chips sessions. When differential reinforcement was implemented, Malcolm responded using the picture card for the majority of the trials during both the television (M = 92%) and chips (M = 93%) sessions.

During the distracter-card probe, Millie responded using the chips card almost exclusively during the chips sessions (M = 95%) and the music card exclusively during the music sessions (M = 100%). When differential reinforcement was implemented, Millie responded using the picture card rather than the distracter card during both the chips (M = 95%) and music (M = 97%) sessions.

In summary, when differential reinforcement was implemented for responding using picture cards, all 4 participants responded using the

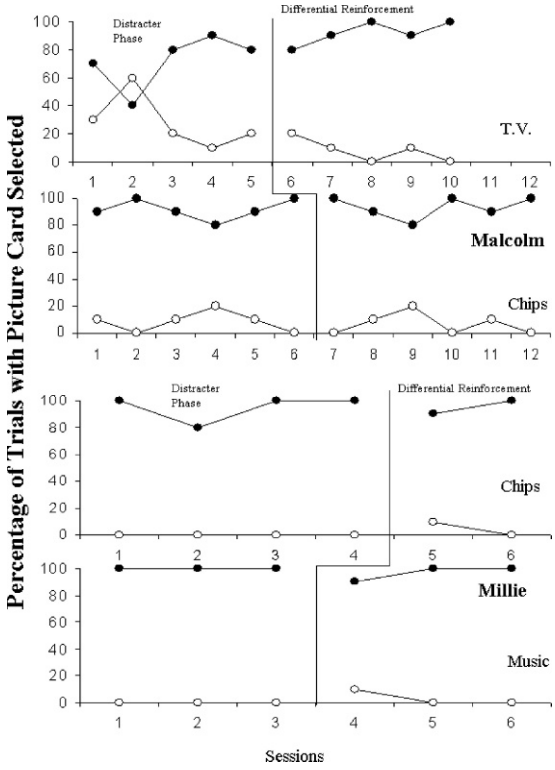

Figure 3. Percentage of trials with picture card and distracter card selected during the distracter-card probe and differential reinforcement phases for Malcolm and Millie.

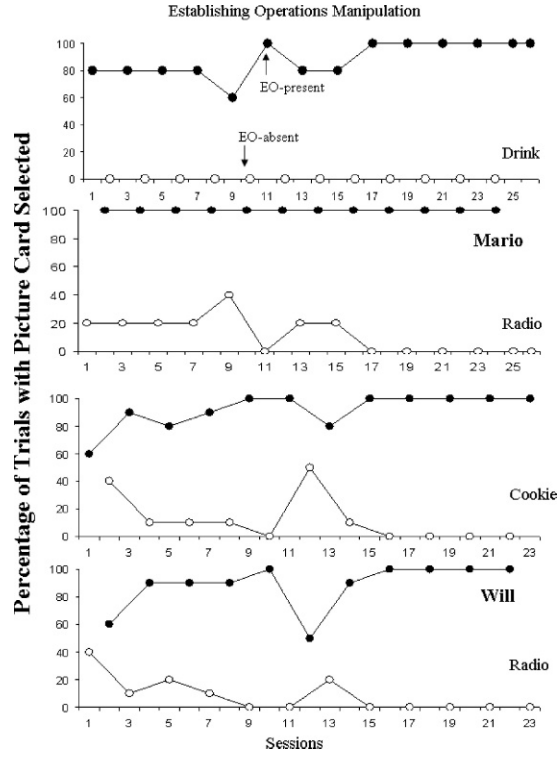

Figure 4. Percentage of trials with picture card selected during manipulation of the EO for Mario and Will.

picture card to gain access to preferred items. This was not intended to be a demonstration of acquisition (recall that 2 individuals selected picture cards prior to differential reinforcement). Rather, differential responding was a prerequisite to the EO phase. All 4 individuals responded differentially and demonstrated the prerequisite skills necessary for inclusion in Phase 5.

Phase 5: Manipulation of the EO

Figure 4 shows the percentage of trials with the picture card selected for Mario and Will during the EO phase. Responses using the picture card when the EO was present resulted in reinforcement and removal of the cards, and responses using the picture card when the EO was absent resulted in the therapist removing the cards for approximately 30 s (but the participant maintained access to the item). During the radio EO-present sessions, Mario responded using the radio card 100% of the time. Mario responded using the drink card during the drink EO-present sessions approximately 80% of the time during the first eight sessions and 100% of the time the remainder of the sessions (overall $M = 89\%$), and 0% of the time in sessions when the EO was absent (overall $M = 0\%$).

Initially, during the cookie EO-present session, Will responded using the cookie card slightly more often when the EO was present than when the EO was absent. However, during the last five sessions, he responded using the picture card only when the EO was present (overall $M = 92\%$). During the radio EO-present sessions, Will responded using the radio card most of time ($M = 88\%$) and rarely during the radio EO absent.

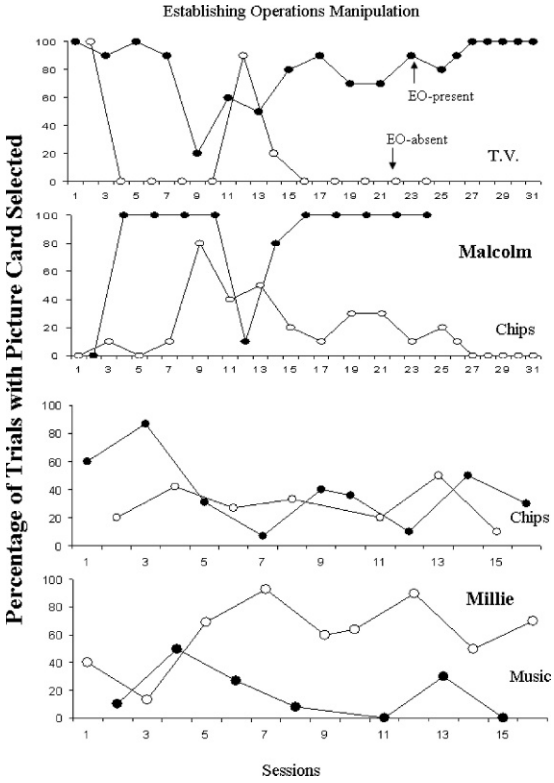

Figure 5. Percentage of trials with picture card selected during manipulation of the EO for Malcolm and Millie.

Figure 5 shows the percentage of trials with the picture card selected for Malcolm and Millie during the EO phase. During the television EO-present sessions, Malcolm responded using the television card more often ($M = 83\%$) than when the EO was absent. Malcolm responded using the chips card during the chips EO-present sessions more often ($M = 83\%$) than when the EO was absent. During the chips EO present, Millie responded using the chips card slightly more often ($M = 55\%$) than during chips EO absent ($M = 44\%$) and the music card more often ($M = 82\%$) when the EO was absent. Millie failed to emit a response during each trial during some sessions; therefore, the percentages do not always add up to 100%.

In summary, results of this phase showed that 3 of the 4 participants accurately manded for two different items using picture cards in the context of two picture cards. Three participants

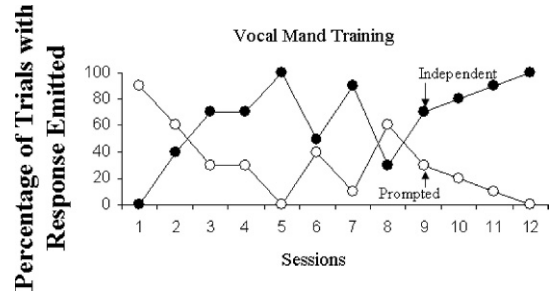

Figure 6. Percentage of trials with responses emitted during vocal mand training for Millie.

(Mario, Malcolm, and Will) were able to respond using a picture card representing an item when the EO for that item was present and did not typically respond using the picture card for an item when the EO was absent. Millie did not learn to mand for two items using picture cards in the context of two picture cards. She responded using a picture card representing an item when the EO was present and absent. This pattern of responding suggested that Millie had not acquired the complex discrimination between the two picture cards that was necessary for discriminated manding in the context of two picture cards. It was necessary to teach her a discriminated manding response for her to effectively mand for two different items. Therefore, she participated in Phase 6, in which she was taught to mand using two topographically different responses to teach a discriminated mand response in the context of two different items.

Phase 6a: Topographically Different Response Training (Vocal and Mand)

We taught Millie a topographically different response to establish the discrimination between mands for preferred items. Figure 6 shows the vocal mand training data for Millie. Millie responded independently using the vocal mand "chips" as training progressed ($M = 66\%$), and by the last four sessions she was responding independently an average of 85% of the time (100% in the final session).

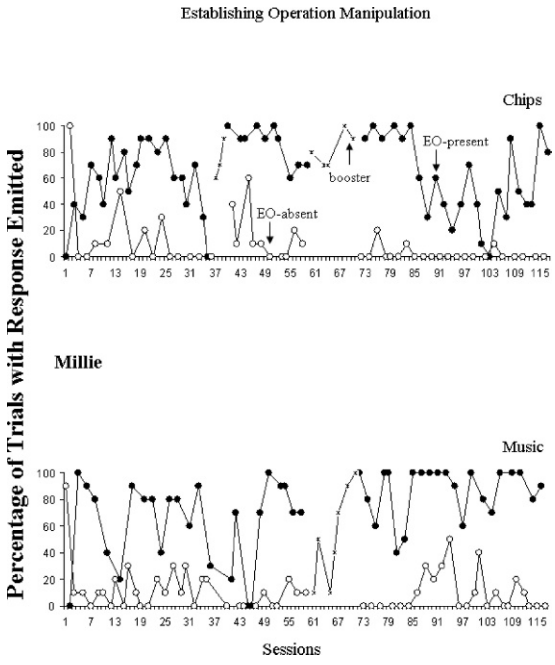

Figure 7. Percentage of trials with responses emitted during manipulation of the EO with different topographies (vocal and mand) for Millie.

Phase 6b: Manipulationof the EO with Topographically Different Responses (Vocal and Card)

Figure 7 shows the data for Millie during the EO with two topographically different responses. The Xs represent responses during booster sessions. Booster sessions consisted of supplemental mand training (of the sort done in Phase 4 for cards and Phase 6a for vocals) and were conducted when Millie returned to sessions after having missed school for a substantial amount of time. In the first sessions, Millie responded by saying ''chips'' and using the music card more often when the EO was absent, but as sessions continued she responded more often when the EO was present for both the chips (M = 77%) and the music (M = 84%).

In summary, results of this phase showed that Millie accurately manded for two different items using a picture card and a vocal response in the context of two preferred items. Millie was able to respond using a picture card representing an item or a vocal response for an item when the EO for that item was present and rarely responded using the picture card or the vocal response for an item when the EO for that item was absent.

DISCUSSION

The results of this study showed that for 3 participants (Mario, Malcolm, and Will), mand training using picture cards resulted in complex discriminated mands using picture cards. In addition, the implementation of an EO manipulation yielded additional validity to the appropriateness of discrimination training in teaching individuals to mand for preferred items. Conversely, 1 individual (Millie) did not acquire complex discrimination using picture cards. For Millie, discrimination between the picture cards and distracter cards was established in training, but did not result in discriminated responding when presented with the EO manipulation. This warrants further interpretation.

A possible explanation for Millie's undifferentiated responding during the EO phase is that she may not have been emitting the verbal operant programmed by the experimenter. This type of responding during the EO manipulation was initially interpreted as inability to mand using the picture card. It is possible, however, that Millie may have been tacting (labeling) items she had by using the picture card. This would explain why during the EO manipulation she most frequently handed the picture card corresponding to the item she already had access to (EO absent) rather than manding for the item she did not have access to (EO present). A third, but similar, possibility is that Millie was emitting a mand response but may have been manding for more of the item she had access to (as when a restaurant customer asks for a refill before his drinking glass is empty).

The results of this study have several implications for the practical use of mand

training using picture cards. At present, picture-card training has been used successfully to treat language delays and increase communicative behavior (Bondy & Frost, 1993; Liddle, 2001; Schwartz et al., 1998). Despite the literature on the application of picture-card training, far less research has been focused on factors related to the effectiveness and efficiency with which picture-card training produces discriminated mands. In one case (Millie), modifications to the initial training procedure were made that included the addition of topographically dissimilar responses (picture cards and vocal). From a practical standpoint, clinicians who use picture cards in isolation may fail to produce discriminated manding with some individuals. Rather than focusing on extensive, repeated exposure to picture cards, manding may be more quickly and accurately established with sign language or vocalizations, because verbal units of sign language or vocal speech are inherently topographically distinct.

The use of a posttraining assessment, such as the EO manipulation, may be of practical use in determining whether the desired response has been established. For Millie, the use of a book full of picture cards may have misled others into believing that she was successfully making complex discriminations given that she likely would have pulled out cards and handed them to an adult. The EO manipulation showed that more training was needed. Because the EO manipulation examines responding as a function of that manipulation, the procedure may help clinicians identify true, functional mands. In addition, the EO manipulation may also be of practical use as an additional training phase. Correct responding increased during the EO manipulation for Mario, Will, and Malcolm, suggesting that further learning may have taken place as a result of the reinforcement contingencies in place for responding using the appropriate picture card.

The results of this study systematically replicate the findings of Brown et al. (2000), who evaluated functional communication training (FCT; Carr & Durand, 1985) when the EOs were present and absent. Participants were taught to mand for reinforcers that were either relevant or irrelevant based on the function of problem behavior identified through brief functional analyses (Northup et al., 1991). Results showed that during the EO-present condition (relevant to function of problem behavior), relevant mands occurred often and irrelevant mands rarely occurred. Results also showed that relevant and irrelevant mands rarely occurred in the EO-absent condition. Data from the Brown et al. study, along with those from the current study, provide support for the use of the EO as an effective assessment and training component of mand training and FCT treatment packages. In addition, these data collectively indicate that additional research is needed to identify methods with which to assess the effectiveness of communication training programs.

The results of this study contribute to the literature on communication training for individuals with language delays. However, there are potential limitations of the study that should be taken into account when interpreting the results. One potential limitation is that the EO manipulation involved differential consequences for selecting the card for the stimulus to which the participant did not have access. If the participant selected the card for the item to which he or she had access, extinction was in effect. If the participant selected the card for the item to which he or she did not have access, that response was reinforced with access to the item. Although the EO manipulation was designed to test for the presence of discriminated manding, the data suggest that responding may have been shaped by the differential consequences in effect during this phase. In addition, the isolated occurrence of a participant (Millie) who demonstrated incorrect responding during the EO manipulation should be considered as a potential limitation. The fact that only 1 of

4 participants displayed opposite effects in this phase makes it difficult to determine the extent to which such responding may occur in others. Millie's response patterns in the EO phase were interpreted as a potential need to conduct a large number of assessments (similar to the EO phase) to determine if the participant acquired discriminated manding using the discrimination training.

Finally, future research may address the limitation noted above regarding differential consequences in effect during the EO phase by conducting an EO test phase in extinction. A test phase conducted in extinction may allow researchers to attribute more conclusively the responding using the restricted picture card to the EO manipulation and rule out any learning that may have taken place during the EO test phase. Also, future research may extend the results of the present study by evaluating whether discriminated mand responses acquired through discrimination training persist under less controlled settings. An extension of the present study may include generalization probes in more natural settings (e.g., classroom, home). The EO manipulation could be easily replicated in natural settings by providing access to one of the items while withholding access to the other. Then, in the presence of two or more picture cards, if the individual hands over the picture card of the unavailable item, generalization outside the experimental setting would be demonstrated.

REFERENCES

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

Bondy, A. S., & Frost, L. A. (1993). Mands across water: A report on the application of the picture-exchange communication system in Peru. *The Behavior Analyst*, *16*, 123–128.

Bondy, A. S., & Frost, L. A. (1994a). The Delaware autistic program. In S. Harris & J. Handleman (Eds.), *Preschool education programs for children with autism* (pp. 37–54). Austin, TX: Pro-Ed.

Bondy, A. S., & Frost, L. A. (1994b). The picture exchange communication system. *Focus on Autistic Behavior*, *9*, 1–19.

Bondy, A., & Frost, L. (2001). The picture exchange communication system. *Behavior Modification*, *25*, 725–745.

Bondy, A., & Frost, L. (2002). *The picture exchange communication system training manual*. Newark, NJ: Pyramid Educational Products.

Bourret, J., Vollmer, T. R., & Rapp, J. T. (2004). Evaluation of a vocal mand assessment and vocal mand training procedures. *Journal of Applied Behavior Analysis*, *37*, 129–244.

Brown, K. A., Wacker, D. P., Derby, K. M., Peck, S. M., Richman, D. M., Sasso, G. M., et al. (2000). Evaluating the effects of functional communication training in the presence and absence of establishing operations. *Journal of Applied Behavior Analysis*, *33*, 53–71.

Carr, E. G., & Durand, V. M. (1985). Reducing behavior problems through functional communication training. *Journal of Applied Behavior Analysis*, *18*, 111–126.

Charlop-Christy, M. H., Carpenter, M., Le, L., LeBlanc, L. A., & Kellet, K. (2002). Using the picture exchange communication system (PECS) with children with autism: Assessment of PECS acquisition, speech, social-communicative behavior, and problem behavior. *Journal of Applied Behavior Analysis*, *35*, 213–231.

DeLeon, I. G., Iwata, B. A., & Roscoe, E. M. (1997). Displacement of leisure reinforcers by food preference assessments. *Journal of Applied Behavior Analysis*, *30*, 475–484.

Frost, L. A., & Bondy, A. S. (1994). *The picture exchange communication system training manual*. Cherry Hill, NJ: PECs.

Liddle, K. (2001). Implementing the picture exchange communication system (PECS). *International Journal of Language and Communication Disorders*, *36*, 391–395.

McCoy, J. F., & Buckhalt, J. A. (1990). Language acquisition. In J. L. Matson (Ed.), *Handbook of behavior modification with the mentally retarded* (pp. 445–466). New York: Plenum.

Michael, J. (1982). Distinguishing between discriminative and motivational functions of stimuli. *Journal of the Experimental Analysis of Behavior*, *37*, 149–155.

Michael, J. (1985). Two kinds of verbal behavior plus a possible third. *The Analysis of Verbal Behavior*, *3*, 1–4.

Northup, J., Wacker, D. P., Sasso, G. M., Steege, M., Cigrand, K., Cook, J., et al. (1991). A brief functional analysis of aggressive and alternative behavior in an outclinic setting. *Journal of Applied Behavior Analysis*, *24*, 509–522.

Richman, D. M., Wacker, D. P., & Winborn, L. (2001). Response efficiency during functional communication training: Effects of effort on response allocation. *Journal of Applied Behavior Analysis*, *34*, 73–76.

Roane, H. S., Vollmer, T. R., Ringdahl, J. E., & Marcus, B. A. (1998). Evaluation of a brief stimulus preference assessment. *Journal of Applied Behavior Analysis*, *31*, 605–620.

Schwartz, I. S., Garfinkle, A. N., & Bauer, J. (1998). The picture exchange communication system: Communicative outcomes for young children with disabilities. *Topics in Early Childhood Special Education*, *18*, 144–159.

Sidman, M. (1960). *Tactics of scientific research: Evaluating experimental data in psychology*. Boston: Authors Cooperative.

Skinner, B. F. (1957). *Verbal behavior*. New York: Appleton-Century-Crofts.

Sundberg, C. T., & Sundberg, M. L. (1990). Comparing topography-based verbal behavior with stimulus selection-based verbal behavior. *The Analysis of Verbal Behavior*, *8*, 31–41.

Winborn, L., Wacker, D. P., Richman, D. M., Asmus, J., & Geier, D. (2002). Assessment of mand selection for functional communication training packages. *Journal of Applied Behavior Analysis*, *35*, 295–298.

Wraikat, R., Sundberg, C. T., & Michael, J. (1991). Topography-based and selection-based verbal behavior: A further comparison. *The Analysis of Verbal Behavior*, *9*, 1–17.

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