Extending the Assessment of Functions of Vocalizations in Children with Limited Verbal Repertoires

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The current study examined the effectiveness of an experimental functional analysis for assessing the functions of emergent vocal-verbal behavior in children with developmental disabilities. Experiment 1 consisted of a systematic replication of Lerman et al. (2005). Participants were 3 children with developmental disabilities, between the ages of 2 and 5 years, with limited vocal-verbal repertoires, who could emit at least two clear vocalizations. Results indicated that for all participants, targeted vocalizations functioned as mands, tacts, or both. The purpose of Experiment 2 was to address some of the limitations of Experiment 1 while using a different experimental design. Results of Experiment 2 suggested that participants' targeted vocalizations served as tacts, echoics, or both. Results are discussed in terms of the utility of this methodology for the selection and development of effective language interventions as well as implications for our current knowledge of verbal behavior.

Key words: language assessment, developmental disabilities, functional analysis, verbal behavior

Some of the most common impairments of individuals diagnosed with developmental disabilities are language deficits. Without an appropriate means of communication, these individuals may exhibit more problem behaviors than their typically developing peers, and as a result, may become socially isolated. Although early and intensive behavioral intervention has been demonstrated to remediate a variety of skill deficits in this population (Bibby, Eikeseth, Martin, Mudford, & Reeves, 2001; Howard, Sparkman, Cohen, Green, & Stanislaw, 2005), some children still fail to develop functional vocal-verbal repertoires (Lord & Paul, 1997). As reported in several studies, the age at which a child receives services, as well

as the efficiency of treatment, are critical variables in determining optimal outcomes (Bibby et al.; Howard et al.; Lovaas, 1987). For children diagnosed at an older age, the speed with which they receive services also becomes critical. One way to facilitate language intervention might be to conduct an analysis of verbal behavior in a manner similar to that used in functional analyses of problem behavior (e.g., Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994). This analysis could result in the identification of specific verbal deficits and thus hasten acquisition of language skills, especially within an early intervention framework.

In recent years, the formal clinical assessment of verbal behavior has come to the forefront of behavioral research (e.g., Bourret, Vollmer, & Rapp, 2004; Kelley, Shillingsburg, Castro, Addison, & LaRue, 2007; Lerman et al., 2005). Bourret et al. conducted an investigation in which the authors assessed participants' mands using a combination of prompt-delay and prompt-fading procedures to determine how intrusive prompts needed to be to occasion a mand response. Each trial in the assessment was 1 min in duration. Ten seconds after the beginning of a trial, a nonspecific prompt was delivered; 20 s after the beginning of a trial, a model prompt was delivered; and 30 s after the beginning of a trial, a phoneme prompt was delivered. Information obtained in assessment was then used to develop treatment

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procedures in a second study. Results suggested that the assessment made mand training more efficient. Although the study assessed mands prior to intervention, the methodology used was not that of a formal functional analysis, and the authors indicated the need to incorporate other procedures (i.e., interviews, preference assessments, and experimental functional analyses).

To date, only a few studies reporting a formal experimental functional analysis of verbal behavior have been published. Lerman et al. (2005) published an article highlighting the importance of assessment in the selection and development of language intervention strategies. In this study, a functional analysis of participants' vocalizations was conducted based on the methodology proposed by Iwata et al. (1982/1994). Four children with developmental disabilities, between the ages of 7 and 12 years, participated. Prior to the start of the study, indirect assessment methods (e.g., interviews) were used to identify frequently emitted vocalizations. Assessment conditions were modified to facilitate the analysis of verbal behavior according to Skinner's (1957) taxonomy. Each test condition was associated with a corresponding control condition that excluded those variables specific to the test condition. Test and control conditions were presented in a sequential format, alternating between test and control sessions for each condition type, according to a pairwise multielement design. In this manner, operants delineated in Skinner's taxonomy were tested individually. Results suggested that this functional analysis methodology successfully identified the functions of participants' vocalizations.

In a follow-up study conducted by Kelley et al. (2007), participants were 4 children with varying diagnoses (e.g., autism, spina bifida, and apraxia). The study incorporated methodological modifications that primarily involved the number of trials presented in session, length of control sessions, and duration of deprivation or satiation periods prior to session. Results largely replicated those of Lerman et al. (2005) insofar as clear functions were suggested for all participants' vocalizations, although fewer mand functions were identified than in the analyses conducted by Lerman et al.

Normand, Severtson, and Beavers (2008) expanded these findings to the signing

behavior of a 7-year-old boy with autism. Procedural modifications included the use of a multielement design and a single control condition. Results obtained suggest that the analyzed topography served either mand or mimetic functions, which, in part, corroborates the findings of Lerman et al. (2005) and Kelley et al. (2007).

Results of these studies suggest that attempts to assess language using experimental functional analyses were successful. However, several potential limitations can be found in these studies. For example, prompts delivered in experimental conditions may have obscured the critical controlling variables because of the frequency with which they were delivered. Consequently, they may have functioned as discriminative stimuli that evoked target responses. It is also possible that experimental conditions did not resemble conditions encountered in participants' natural environments. If so, then test conditions may have excluded variables necessary for the occurrence of target responses. Finally, an echoic test condition was included only for those participants whose functional analyses remained inconclusive, because it was assumed that an echoic repertoire was a prerequisite to all other operants. However, based on the literature on functional independence, it may be inferred otherwise (Lamarre & Holland, 1985; Skinner, 1957).

The purpose of the present study was to replicate and extend Lerman et al. (2005) by testing the use of an experimental functional analysis methodology to assess the functions of children's vocal-verbal utterances. Experiment 1 consisted of a systematic replication with younger participants, those for whom this assessment may be most useful. Experiment 2 examined results through a different experimental design, and further tested the current methodology as it applies to verbal behavior via procedural modification of experimental conditions.

EXPERIMENT 1

METHOD

Participants and Setting

Three children with developmental disabilities, between the ages of 2 and 5 years,

participated in the study. Participants were chosen based on the selection criteria delineated by Lerman et al. (2005): (a) Reports obtained from the children's parents indicated that they engaged in little or no functional speech; and (b) participants could produce at least one distinguishable vocal response. The first 3 children to meet these criteria were included in the current study.

Annie. Annie was 4 years 2 months old at the beginning of the study. She had previously received a diagnosis of pervasive developmental disorder (not otherwise specified), microcephaly, and epilepsy. She engaged in several one- and two-word utterances, and she could produce a few three-word utterances, mostly consisting of a combination of the same one or two statements (i.e., "I want —" or "It's a —"). Although Annie emitted many single-word utterances, she often used a very limited set of words to communicate with her family members. Much of her speech was incomprehensible and seemed to occur out of context (i.e., sources of control were not always evident). All sessions for Annie were conducted in one of the bedrooms at her home. The room contained a small table and chairs, two beds, a dresser, a variety of toys and all materials necessary to conduct experimental test and control conditions.

Michael. Michael was 3 years 11 months old at time of inclusion. He had been diagnosed with global developmental delay and severe low facial muscle tone. He engaged in several one-word utterances and a few two-word utterances (e.g., "all done"). His vocal behavior was entirely prompt dependent and often unintelligible. He began to produce vocal utterances approximately 1 month prior to inclusion in the study. All sessions were conducted in vacant rooms at his school, each containing a small table and chairs, a variety of toys, and materials necessary for conducting experimental sessions.

Daniel. Daniel was 3 years 10 months old at the start of the study. He had a diagnosis of autism with congenital myopathy that caused significantly low muscle tone throughout his body. Daniel emitted several two- and three-word utterances (e.g., "want — please"; "momma go, please"; "water on, please"; "white shoes"; "green shirt"; etc.). Many of these utterances consisted of approximations

and were difficult to comprehend. Much of his vocal behavior seemed to be contextually appropriate, in that the relevant controlling stimuli (e.g., food item, toy, color, person, etc.) needed to be present for him to vocalize. All sessions were conducted in the playroom at his home. The room contained a small table and chair, a variety of toys, and all materials necessary for conducting the experimental test and control conditions.

Dependent Measures

Parent interview. Prior to the beginning of the study, participants' parents were interviewed and asked to identify at least two frequently emitted vocalizations, and to provide information with respect to the perceived functions of selected vocalizations.

Target vocalizations. For Annie, parent-identified target vocalizations were "eat" and "TV." When asked to speculate on the function of these vocalizations, Annie's parents indicated that "eat" occurred when she was hungry or bored, and that "TV" seemed to occur in the context of task demands, during periods of down time, or when she was tired. For Michael, parent-identified target vocalizations were "daddy," "star," "blue," "ball," and "wee." His mother believed that the function of these utterances was mainly imitative and emphasized that all of Michael's language was prompt dependent. Parent-identified target vocalizations for Daniel consisted of approximations of the words "water" and "cracker." His mother also noted that he would often attempt to label clothing and colors. She perceived these utterances as mands for specific items (i.e., in the case of "water" and "cracker") and mands for attention (i.e., in the case of tacting colors and clothing).

Data Collection

Data were collected using frequency per interval. Sessions were divided into 20 s time blocks, during which each occurrence of the target vocalization was recorded. All sessions were videotaped; the tapes were used to collect measures of interobserver agreement and integrity of the independent variable.

Interobserver agreement. Interobserver agreement was assessed by two independent

observers on at least 35% of sessions across all conditions. Agreement was defined as both observers recording the same number of responses per block. Agreement was calculated by adding the total number of agreements and dividing by the number of agreements plus disagreements and multiplying by 100%. Agreement averaged 99% for Annie (range, 90% to 100%), 99% for Michael (range, 90% to 100%), and 99.7% for Daniel (range, 97% to 100%).

Integrity of the independent variable. Data were collected on the therapist's behavior to ensure that the investigator adhered to the research protocol designed for each type of condition. Data were collected on the following: delivery of proper instruction, if applicable; delivery of prompts according to type and time schedule delineated; and delivery of appropriate consequences. Data were collected on a minimum of 35% of sessions across conditions, by two independent observers. Integrity of the independent variable was calculated in the same manner as interobserver agreement, and averaged 99% for Annie (range, 90% to 100%), 99% for Michael (range, 97% to 100%), and 99.7% for Daniel (range, 97% to 100%).

Experimental Design and Procedure

In an attempt to replicate the general procedures of Lerman et al. (2005) and Kelley et al. (2007), discriminative and motivational variables were systematically manipulated across eight experimental conditions: (a) mand test, (b) mand control, (c) tact test, (d) tact control, (e) intraverbal test, (f) intraverbal control, (g) echoic test, and (h) echoic control. Conditions were presented sequentially, alternating between test and control sessions, according to a pairwise multielement design. A minimum of three data points were collected for each condition and operant type. Control conditions excluded those variables manipulated in corresponding test conditions.

Across all conditions, a vibrating pager was used to regulate the delivery of prompts as specified in the experimental protocol. Prompts were delivered immediately following the vibration of the pager, and signaled a transition to the next interval. Specific prompt schedules are described below.

A function was identified if the targeted vocal response occurred at a consistently higher frequency during the test condition than in its corresponding control condition. All sessions were 10 min in duration, conducted approximately four times per day, 4 days per week on average. For all conditions, the same methodology was employed as described by Lerman et al. (2005).

Reinforcer assessment. A reinforcer assessment was conducted with each participant following baseline to ensure that praise would function as a reinforcer during tact, intraverbal, and echoic conditions. This brief assessment consisted of the identification and measurement of an arbitrary response (i.e., eye contact) for 10 min prior to the delivery of contingent reinforcement (i.e., praise), then measurement of the response for 10 min following the contingent presentation of reinforcement. The reinforcer assessment was conducted in the context of the child's normal activities. During the first 10-min interval, the experimenter did not interact with the participant, and all behaviors directed toward the experimenter were ignored. During the second 10-min interval, all instances of eye contact immediately resulted in brief praise (e.g., "nice looking!"). Data were collected continuously on a frequency counter. Praise was found to function as a reinforcer for all participants.

Baseline. Baseline data were collected on the frequency of parent-selected target responses in baseline sessions. Three 10-min baseline sessions were conducted for each participant. All sessions were conducted in a naturalistic manner at the child's home or school. During baseline sessions, a video camera and tripod were present and were used to record sessions.

Mand test. Prior to the mand test, access to the item corresponding to the target vocalization was restricted for 60 min in an attempt to establish its value as a reinforcer. If, for example, one of the child's frequently emitted vocalizations was identified as "crackers," all crackers were withheld for 60 min before the session. At the beginning of the session, the participant was shown the relevant item. The item was then hidden in an opaque bag. The purpose of this manipulation was to test whether participants were able to request the item in its absence

following a period of restricted access to the item. If the target vocalization did not occur within 20 s of the presentation of the item, the therapist asked the child, "What do you want?" This prompt was issued every 20 s, up to a maximum of two times (or 40 s). If no target vocalization occurred by the third 20-s interval (or 60 s from the initial presentation of the item), the item was again shown to the child and then placed back in the bag. No vocal prompt was provided. Throughout the session, the experimenter remained in close proximity to the participant, and target vocalizations produced brief access (e.g., 20 s) to the corresponding item. All other vocalizations were ignored.

For both Michael and Daniel, additional modifications were made to the mand test. These became necessary to demonstrate experimental control, because responding in the replicated mand test condition remained at or near zero, suggesting that perhaps there was a lack of stimulus control between test and control sessions. This manipulation (item in sight) was made to demonstrate experimental control and determine which variables controlled responding. In this modified version of the mand test, the original stimulus (e.g., a chocolate chip cookie for Michael and a cracker for Daniel), although inaccessible, was left in sight of the participant. All other aspects of the condition remained unchanged.

Mand control. Prior to and during mand control sessions, participants had free access to the item. For example, if the target vocalization was "crackers," crackers were freely available for 60 min prior to the session and remained available throughout the session. In all mand control sessions, the item was contained in an open plastic container placed near the participant. The therapist sat across the room from the child, and all vocalizations were ignored.

Tact test. For 60 min prior to and during tact tests, participants had continued access to the relevant item. During this condition, the item was contained in an open plastic container placed near the participant. The therapist asked, "What is it?" or "What's this?" every 20 s throughout the entire session. The experimenter remained in close proximity to the child, and target vocalizations produced brief praise (e.g., "good

job!"). No other consequences were provided for the target vocalization, and all other vocalizations were ignored.

Tact control. Tact control sessions were identical to mand control sessions.

Intraverbal test. For a period of 60 min prior to intraverbal tests, the participant had free access to the relevant item. However, the item was not present during the experimental session. A verbal prompt was provided every 20 s following the beginning of the test, and consisted of one of several statements likely to be heard in the natural environment. Each statement was related to the target vocal response. For example, statements related to crackers were "Mmm, yummy —," "I like to eat —," "Give me some —," or "This is my favorite —." The experimenter remained in close proximity to the child and delivered brief praise contingent on production of the target vocalization. All other vocalizations were ignored.

Intraverbal control. Intraverbal control sessions were similar to intraverbal test sessions, except that the experimenter made statements that were not related to the target vocal response (e.g., "I sleep in a —," "I like to watch —"), and all vocalizations were ignored. Table 1 lists therapist statements issued in the context of the intraverbal test and control conditions for each child.

Echoic test. For 60 min prior to echoic tests, the participant had free access to the relevant item. During sessions, the item was not present. The experimenter remained in close proximity to the child and delivered an echoic prompt (e.g., "say 'crackers'") every 20 s. Target vocalizations were followed by brief praise, and all other vocalizations were ignored.

Echoic control. Echoic control sessions were identical to the echoic test sessions except that no echoic prompts were delivered and all vocalizations were ignored.

RESULTS

Annie

Figure 1 (top) depicts results of Annie's assessment. The targeted vocalization ("apple juice") did not occur in either intraverbal test or control conditions. In comparison to tact control sessions, this vocalization

Table 1
Therapist Statements Issued in the Intraverbal Test Condition for Each Participant

Participant	Target vocalization	Intraverbal test	Intraverbal control
Annie	Apple juice	I'm thirsty, can I have some — I like to drink — My favorite drink is — Mmmm, yummy —	I sleep in a — I play with — I like to watch — I listen to the — My name is — I live in — My address is — My phone number is — A cat says — A dog says —
Michael	Cookie	I'm hungry, can I have a —? I like to eat — My favorite snack is —	See above

emerged at a high and stable frequency during tact tests (range, 26 to 28), suggesting that “apple juice” may have functioned as a tact. Similarly, in comparison to mand control sessions, exposure to mand test sessions produced a high, steady frequency of responding (range, 21 to 29), suggesting that this behavior also functioned as a mand.

Michael

Figure 1 (middle) depicts Michael’s results. Levels of responding in tact tests, although generally higher, remained largely undifferentiated from responding in tact control sessions. Exposure to the intraverbal test and control conditions yielded zero occurrences of the target vocalization.

As mentioned above, when the mand test was first conducted, responding remained at or near zero (range, 0 to 1). A change was made to the original mand condition (item in sight). This second manipulation of the mand condition yielded higher levels of responding, with clearer differentiation between test and control conditions, suggesting that the target vocalization (“cookie”) functioned as a mand only in the presence of the cookie.

Daniel

As shown in Figure 1 (bottom), frequency of responding for Daniel’s target vocalization (“cracker”) remained at or near zero during intraverbal conditions as well as in the

original mand test replication. As with Michael, the item was left in sight during the modified mand test condition. This change yielded drastically different results, with high levels of responding and clear differentiation between mand tests (range, 18 to 25) and control conditions (zero occurrences). Similarly, exposure to tact tests produced high and stable levels of responding, with the target vocalization occurring only in test sessions (range, 20 to 23). Data collected across conditions seem to indicate that Daniel’s vocal utterance (“cracker”) functioned as both a mand and a tact.

DISCUSSION

In summary, data showed that the current assessment seemed to have identified the functions of participants’ vocalizations. This corroborates the findings of previous studies (Kelley et al., 2007; Lerman et al., 2005; Normand et al., 2008). However, additional procedural manipulations were necessary to produce differentiated responding in the mand conditions for 2 of the 3 participants. Although the results seem to indicate that vocalizations functioned as mands, tacts, or both, the data were variable within and across participants. This may have occurred for several reasons. First, although conditions were counterbalanced, there may have been carryover effects due to the sequential presentation of conditions, which obscured the true functions of vocalizations. Another

Figure 1. Total frequency of targeted vocalizations during sequential presentation for Annie, Michael, and Daniel.

related explanation is that stimulus situations present during mand and tact tests might have not been discriminable. For instance, both conditions included the presence of a listener and the relevant item. This may have been sufficient to occasion the target response and make discrimination between mand and tact tests difficult, resulting in generalized responding.

For both Michael and Daniel, additional manipulations, in which stimulus items were left in view, were necessary. This change probably represented a more naturalistic set of stimulus conditions than the unmodified test condition, and may account for increases in responding, because in the children's home and school environments items requested were typically in sight at the time of the request.

Finally, the degree to which certain stimuli possessed reinforcing properties may have been a potential confounding effect (Roscoe, Iwata, & Khang, 1999). With Michael, for example, it was observed that he did not consistently consume the cookies when they were presented contingent on the occurrence of the target vocalization. This may suggest that the motivating operation (MO) may have not been powerful enough to evoke responding. When the stimulus item was changed (i.e., the chocolate chip cookie was replaced with a Christmas cookie), a significant increase in the frequency of the target vocalization, as well as clear differentiation between mand test and control conditions, was observed.

EXPERIMENT 2

Given the limitations discussed above, further experimentation was warranted to elucidate the utility of this methodology. Hence, the purpose of Experiment 2 was twofold. First, a multielement design was used to address some of the possible confounding variables identified in the sequential design. Second, procedural modifications were made to the existing experimental conditions in an attempt to better isolate the independent variables.

METHOD

Participants and Setting

The three participants from Experiment 1 participated in Experiment 2. The experiment was conducted in the same settings.

Dependent Measures

The method of response selection remained the same as in Experiment 1. However, different response topographies were targeted in Experiment 2. This was done to control for the possibility that functional relations had been established during Experiment 1.

Parent interview and target vocalizations. Information obtained in the original parent interview and baseline observations was used to select additional response topographies for Experiment 2. For Annie, the target vocalization was “cracker.” When asked to

speculate on the function of this vocalization, Annie’s parents indicated that “cracker” occurred either when she was hungry or in the presence of the item. The target vocalization for Michael was “fish.” His mother reiterated that the function of his utterances was mainly imitative. For Daniel, the target vocalization selected was “raisin.” His mother perceived this utterance as a mand.

Data Collection

Data were collected in the same manner as Experiment 1, and all sessions were videotaped for later data collection of interobserver agreement and integrity of the independent variable.

Interobserver Agreement and Independent Variable Integrity

These measures were assessed as in Experiment 1. Interobserver agreement averaged 98% for Annie (range, 93% to 100%), 99% for Michael (range, 90% to 100%), and 99.6% for Daniel (range, 95% to 100%). Integrity of the independent variable averaged 100% for Annie, 99% for Michael (range, 93% to 100%), and 100% for Daniel.

Experimental Design and Procedure

As in Experiment 1, discriminative and motivational variables were systematically manipulated across experimental conditions. In Experiment 2, these conditions consisted of (a) mand test, (b) mand control, (c) tact test, (d) tact control, (e) automatic test, (f) echoic test, and (g) echoic control. Intraverbal test and control conditions were not conducted (see below). Further, the frequency with which verbal prompts were delivered in the mand and tact tests was modified (see below). Conditions were presented according to a multielement design, with a minimum of three data points for each condition and operant type. Control conditions excluded those variables manipulated in corresponding test conditions. Finally, each condition was also associated with a salient discriminative stimulus (i.e., color card and verbal instruction) to enhance discrimination between changes in contingencies.

Setting and materials all remained the same as in Experiment 1. Across all experimental conditions, a vibrating pager was used to signal the intervals at which prompts were to be delivered. All sessions were reduced to 5 min in duration and were conducted approximately six times per day, 4 days per week.

As in Experiment 1, a function was identified if the targeted vocal response occurred at a consistently higher frequency during the test condition than in its corresponding control condition.

Mand and tact test. The high frequency with which verbal prompts were delivered in Experiment 1 (every 20 s) might have obscured the critical controlling variables within each condition. To control for this in Experiment 2, prompts delivered in tact tests consisted of a nonvocal prompt (e.g., pointing to the item, holding the item up) issued every 20 s and a vocal prompt (e.g., "What's this?") issued every 60 s following emission of the last target vocalization. Further, vocal prompts were eliminated from the mand test sessions altogether. Instead, the relevant item was presented to participants on a fixed-time schedule. Prompts were delivered after 60 s had elapsed from the start of the session and every 60 s thereafter.

Intraverbal test. It is important to consider the controlling variables contained in each test and control condition. It is possible that even though conditions contained in this type of analysis did not identify certain types of verbal operants, these did in fact exist in participants' repertoires in relation to other response topographies. With respect to an intraverbal test condition, all possible sources of stimulus control for the intraverbal response would first need to be identified for use in this assessment. Because this was beyond the scope of the current study, the intraverbal test and control conditions were eliminated.

Automatic test. Repetitive stereotypical behavior, including vocal behavior from which no obvious source of reinforcement is derived, is characteristic of children with autism and other developmental disabilities (Ahearn, Clark, MacDonald, & Chung, 2007). Absent any obvious source of reinforcement, such behavior might be maintained by response-produced stimulation (automatic

reinforcement). Therefore, automatic test sessions (e.g., an alone condition) were conducted, as in traditional experimental functional analyses (Iwata et al., 1982/1994). For 60 min prior to these sessions, the participant had free access to the relevant item. During the session, all materials were removed from the therapy room. The participant remained alone in the room, and sessions were videotaped and scored at a later time.

Echoic test. For 60 min prior to echoic tests, the participant had free access to the relevant item. During sessions, the item was not present. The experimenter remained in close proximity to the child and delivered an echoic prompt (e.g., "say 'cracker'") every 20 s. Target vocalizations were followed by brief praise, and all other vocalizations were ignored.

Echoic control. Echoic control sessions were identical to the echoic test sessions except that no echoic prompts were delivered and all vocalizations were ignored.

Experimental design. Each participant was exposed to experimental conditions in a multielement format, resulting in a more time-efficient analysis that was similar to a traditional functional analysis. Session order was randomly determined in advance of the functional analysis, thereby minimizing the potential for carryover effects. If the experimental conditions contained all the relevant variables, those verbal operants being tested for should be evoked. Thus, there should be clear differentiation between test and control conditions as well as across test conditions.

RESULTS

Annie

As shown in Figure 2 (top), Annie's responding occurred at the highest frequencies in tact (range, 14 to 15) and echoic (range, 11 to 15) tests. These data seem to indicate that the vocalization ("cracker") functioned as both a tact and an echoic. In contrast, exposure to mand test conditions produced low and stable levels of responding. Annie did not vocalize during the automatic test sessions, indicating that the targeted vocalization was not maintained by automatic reinforcement.

Figure 2. Total frequency of targeted vocalizations during multielement presentation for Annie, Michael, and Daniel.

Michael

As shown in Figure 2 (middle), Michael’s target vocalization (“fish”) occurred at the highest frequency in echoic (range, 12 to 28) tests. Data collected during this condition show a steep increasing trend, which may suggest acquisition. In comparison to tact control sessions, high and variable levels of

responding were observed in tact tests (range, 6 to 17). Exposure to mand tests produced low and stable levels, and no responding was observed in the automatic test sessions.

Daniel

Figure 2 (bottom) depicts Daniel’s results. The highest frequency of responding occurred

in the echoic test. Similarly, the target vocalization also was observed during tact and mand tests, suggesting multiple functions. However, supplemental stimuli (i.e., leaving the item in sight or leaving the item in sight and providing a verbal prompt ["What do you want?"]) were needed to occasion responding during the mand test, indicating that the targeted vocalization might have functioned as a tact rather than as a mand.

DISCUSSION

Results of the modified functional analysis identified at least one function for each vocalization. For all participants, it appears that the targeted vocalizations served as echoics, tacts, or both. This partially corroborates results obtained in Experiment 1.

Although the tact and echoic test conditions consistently produced the highest frequencies of responding, some responding was also observed in the mand and tact tests. This finding suggests one of two things: (a) Either levels of responding were due to unintended characteristics of the mand condition, or (b) responding was multiply controlled and required supplementary stimuli to reliably occasion responding (see Michael's and Daniel's data). Higher response rates may have occurred in tact and echoic tests for several reasons. For example, with Annie, it is possible that social positive reinforcement (i.e., praise) may have been a more powerful reinforcer than was access to the item (e.g., crackers). Also, an extensive history of reinforcement for vocal and motor imitation obtained through behavioral therapy and language skills training may have primed both Annie and Daniel to respond in echoic tests of the current assessment.

Interestingly, although it seems that participants' vocalizations may have functioned as mands, closer analysis of the mand tests reveals consistent responding only contingent on presentation of the relevant item, rendering antecedent conditions of the tact and mand tests identical. It is likely that the similarity of prompts may have promoted stimulus generalization between mand and tact tests. In the absence of the item, the target vocalization often did not occur, suggesting that responses functioned as tacts

rather than mands. If this were the case, findings could suggest that a previous learning history (e.g., reinforcement of response topographies under faulty stimulus control) may serve to block responding in contrived experimental test conditions (Catania, 1998).

GENERAL DISCUSSION

To understand the implications of these results, it is critical to make a distinction between terms. The use of the term *functional analysis*, in the sense defined by Iwata et al. (1982/1994), refers to a systematic manipulation or structured analysis of potential variables that affect a behavior of interest. The term itself defines a methodology and is typically restricted to the analysis of problem behavior. In contrast, a functional analysis in the Skinnerian sense presents a theoretical distinction that does not necessarily include systematic experimental manipulation. Rather, Skinner (1957) defined a functional analysis as an analysis of existing variables (e.g., antecedents, consequences, learning history) as they are related to a specific instance of verbal behavior. Skinner's use of the term *functional analysis* is synonymous with a causal analysis.

In the current study, several modifications became necessary to occasion responding with participants exposed to the functional analysis methodology. Although the primary purpose of this assessment was to identify conditions under which verbal behavior reliably occurs, traditional functional analysis methodology may not provide sufficiently distinct motivating and discriminative stimulus conditions. In their current form, the mand and tact tests may be too similar. This suggests that this type of experimental functional analysis may not be the best methodology for the identification of variables responsible for the emission of verbal responses. Although this analysis has been invaluable to our understanding and treatment of problem behavior, it may be that the functional analysis methodology does not fit the primary purpose of a language assessment.

One of the most important contributions of the current paper may be that it points to the need for modification of the existing assessment methodology or a restructuring of experimental conditions. Note that an exper-

imental functional analysis does not account for the independent verification of a putative MO. Rather, the way experimental conditions are structured assumes that an MO exists. For additional research on this topic to progress, the methodology needs to be modified to account for this variable.

Another important characteristic of verbal behavior to consider in the interpretation of the current results is the combinatorial effect of stimuli on the evocation of behavior (Skinner, 1953, 1957). The likelihood that a single verbal response is a function of more than one variable is extremely likely, because any single verbal response usually belongs to more than one functional class (Normand *et al.*, 2008; Skinner, 1957). This is particularly true of early speakers. Applied to results of the current study, this could signify that any function found to exist for a particular vocalization is not the sole function of that vocalization. Although attempts were made to bring some of these variables under experimental control, factors such as previous conditioning and motivation remained largely beyond the control of the experimenter. Demonstrations of the potential impact of antecedent variables in functional analyses highlight the importance of experimental control over such variables. Studies that focus on the role of antecedent conditions reveal such a large variety of these types of stimuli that it is possible to overlook their importance during assessment. However, due to the large array and the idiosyncratic nature of stimulus variables that have the potential to influence the behavior of interest, such an oversight can be detrimental to the point of altering potential outcomes (Carr, Yarbrough, & Langdon, 1997). An analysis of verbal behavior is particularly susceptible to the effects of antecedent stimulus conditions. As mentioned above, a variable critical to a causal analysis of verbal behavior necessarily involves the manipulation of MOs. Further investigations along this line must ensure that an MO that will evoke responding exists.

Although results indicate that functions were successfully identified for all participants' vocalizations, many additional variables must be considered that limit the conclusions that can be drawn. For 2 of 3 participants, the original mand test protocol

did not reliably occasion responding, and modifications were needed to establish experimental control. It could be argued that the assessment tool, according to its original conception, was not sensitive enough to assess function accurately. However, without clear verification of a relevant MO in the mand condition, this cannot be ascertained, and the distinction between the mand and tact conditions remains unclear. Consequently, responding may have been a function of the way in which stimuli and conditions were presented and manipulated rather than a function of the variables that actually control each operant type. At best, the present demonstration illustrates how the vocal behavior of individuals is subject to, and a function of, specific environmental arrangements and motivational variables.

Future Research

Participants in the present study were all early speakers, and, for each child, single vocal responses were chosen as targets. It is likely that with typically developing children at the same level, similar verbal responses are multiply controlled. Future researchers might consider replication with a different age group.

As stated above, a possible limitation of this study is that it was not clear whether there was an MO in place during the mand condition. There are several ways to determine the control of an MO over a response. These may include measuring the intensity and frequency of the target response in the presence of the putative MO, acceptance and consumption of or interaction with the item, and a decrease in the mand response following access to the item (*i.e.*, abolishing effect). Another possible indication that an MO is in effect may be aggression in response to denied access to the preferred item.

Further studies should also seek to evaluate how to best establish an MO, because this is essential for determining the relevant sources of control for manding. In the current study, as well as those preceding it (Kelley *et al.*, 2007; Lerman *et al.*, 2005), deprivation and free access to stimulus items were taken as evidence of the presence of an MO. Although it is possible that deprivation might increase the value of the item and that free

access to the item could abolish its effectiveness, this may not always be the case. Theoretically, an MO may continue to exert evocative control following limited access to a preferred item. In the absence of such an evaluation, however, it remains questionable whether an MO served as an antecedent variable during the mand condition.

Implications

Results of the current study, as well as those of its predecessors, are compelling and represent an important step towards a Skinnerian causal analysis and, ultimately, a better understanding of verbal behavior. Further investigations along this line can have important implications for both theory and practice.

The current assessment contributes much to our conceptual understanding of verbal behavior insofar as it allows researchers to better understand both functional independence (e.g., pure mands as distinguished from pure tacts) and the interaction between verbal operants. If this is to be accomplished, however, future investigations should consider the use of MOs which are more easily manipulated. Further, different types of mands may also be required. An example of MOs that have a more controllable onset and offset is illustrated by an interrupted chain procedure (Hall & Sundberg, 1987). This procedure eliminates the presence of the item as necessary to evoke the mand and is more readily measured. Recall that presentation of the item in the current study may have confounded the results.

A functional analysis of defective verbal behavior is essential for developing effective language-intervention programs. If the experimental functional analysis methodology is to contribute to our practice, a more careful analysis of multiple sources of control is necessary (e.g., Bourret et al., 2004). Perhaps the strength of this type of analysis lies in its ability to identify the specific stimulus conditions that are responsible for the emission of verbal behavior.

Prior to the application and dissemination of the experimental functional analysis of verbal behavior, further refinement is essential with respect to its validity. This is an important line of research that combines two

central areas in applied behavior analysis: functional assessment and development of verbal behavior. Although much research has been done in the area of functional analysis, empirical evidence for the applications of Skinner's (1957) analysis of verbal behavior as it relates to clinically relevant populations is still needed.

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