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INFANT SIGN TRAINING AND FUNCTIONAL ANALYSIS

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We taught manual signs to typically developing infants using a reversal design and caregiver-nominated stimuli. We delivered the stimuli on a time-based schedule during baseline. During the intervention, we used progressive prompting and reinforcement, described by Thompson et al. (2004, 2007), to establish mands. Following sign training, we conducted functional analyses and verified that the signs functioned as mands. These results provide preliminary validation for the verbal behavior functional analysis methodology and further evidence of the functional independence of verbal operants.

Key words: sign language, functional analysis, verbal behavior

A number of studies published in recent years report the success and potential benefits of teaching sign language to infants (e.g., Goodwyn & Acredolo, 1993; Goodwyn, Acredolo, & Brown, 2000). However, in many cases this research has been limited by the absence of systematic teaching procedures and the lack of any direct observation of sign training. Recently, Thompson and colleagues described effective prompting and reinforcement procedures for teaching sign language to infants (Thompson, Cotnoir-Bichelman, McKerchar, Tate, & Dancho, 2007; Thompson, McKerchar, & Dancho, 2004). The acquisition of sign language was accompanied by reductions in problem behavior (e.g., crying and whining) when sign training was combined with extinction for problem behavior (Thompson et al., 2007). These reports are important contributions to the infant sign-language literature because of their technological precision and sound experimental methodology.

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However, the degree to which sign language taught under well-controlled conditions generalizes to other settings has received relatively little attention. Thompson et al. (2007) reported that signing generalized across experimenters and settings, but they assessed only two participants, and the generalization sessions incorporated the same teaching procedures used in the initial training. In addition, the experimenters did not identify the conditions under which the sign would be expected to occur.

According to Skinner's (1957) taxonomy of language, the basic unit of a verbal behavior analysis is the verbal operant, described in terms of the primary controlling variables over the verbal response form, be it manual or vocal. In recent years, the clinical functional analysis methodology first described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) has been modified for the purposes of evaluating the function of emerging language in young children with autism and other developmental disabilities according to Skinner's functional taxonomy (Kelley et al., 2007; LaFrance, Wilder, Normand, & Squires, 2009; Lerman et al., 2005; Normand, Severtson, & Beavers, 2008). This methodology shows promise for assessing the established function of signs taught to young children using general acquisition strategies such as those described by Thompson et al. (2004, 2007). A more complete under-

standing of the variables that evoke and maintain signs would enable a better understanding of the conditions under which one would expect the sign to occur, and would suggest the operant functions to be targeted in future teaching sessions if certain functional analysis conditions did not evoke functional communication.

In their seminal report, Lerman et al. (2005) described a functional analysis in which a number of test and control conditions corresponding to Skinner's taxonomy were used to evaluate the function of emerging speech in four children with developmental disabilities. The analysis was designed to test three of the elementary verbal operants described by Skinner: the mand, tact, and intraverbal. In addition, an echoic condition was introduced for one participant after undifferentiated responding across the three primary test conditions. Each condition involved the manipulation of relevant antecedents and consequences, and the dependent measure was the number of target responses observed per minute. The results suggested that the verbal operants were functionally independent and that the functional analysis distinguished among the various functions. Moreover, the analysis most often identified a mand function for the target vocal responses.

Kelley et al. (2007) assessed the functions of vocal speech with four young children with developmental disabilities using a trial-based procedure in which the dependent measure during each condition was the percentage of trials during which the target response was observed. Despite the procedural modification, the results indicated at least one clear function for each response assessed, similar to the results reported by Lerman et al. (2005). However, the mand was not the most commonly identified verbal operant (cf. LaFrance et al., 2009). More recently, Normand et al. (2008) assessed the function of a manual sign with a young boy with autism using the procedure described by Lerman et al., but they omitted the intraverbal condition and modified the echoic condition so as to be appropriate for a manual sign rather than a vocal response.

The present study extends the existing research on sign-language training in infants and young children by replicating the procedure described by Thompson et al. (2007) and incorporating the trial-based verbal behavior functional analysis methodology described by Kelley et al. (2007). Our goals were to test for generalization in controlled situations and to assess the specific variables that controlled signing after structured sign training. To our knowledge, this is the first report of the verbal behavior functional analysis methodology following specific functional communication training with typically developing children, and only the second to target manual rather than vocal language.

METHOD

Participants and Setting

Three children participated. At the time of their initial participation, Julie and Ed were 8 months old and Yvonne was 15 months old. None of the participants exhibited any vocal language, but Ed's mother reported that he would occasionally use informal sign language (i.e., communicative hand gestures not used in American sign language [ASL]). Caregiver nominations of preferred food and tangible items were used for the target response and reinforcer selection. All three participants attended a local day-care center. Sessions for Julie were scheduled during the center's normal hours of operation. For Yvonne and Ed, sessions were scheduled in their homes at a time mutually convenient for caregivers and experimenters. To avoid contrived periods of food restriction or access, which might cause distress on the part of the infant, all sessions were scheduled at times that naturally followed periods of food deprivation (e.g., first thing in the morning, after nap time) or satiation (e.g.,

after a scheduled mealtime). All sessions were 5 min in duration and were conducted in an unoccupied area of the home or day-care center. Sessions were conducted one to three times per day, several days per week, and were videotaped for purposes of interobserver agreement and intervention integrity analyses. The local institutional review board approved all procedures.

Response Measurement and Interobserver Agreement

During all sessions, observers recorded the number of independent and prompted signs exhibited by the participant. For all participants, independent signing was defined as demonstrating the correct hand orientation and hand movement in the absence of any prompts. A sign was scored as prompted if the response occurred following any visual (i.e., experimenter modeling of the sign, experimenter showing the target item) or physical assistance (i.e., hand-over-hand guidance) from the experimenter.

The target response for Julie was an informal sign for ''applesauce,'' defined as bringing the open palm of one hand to the crown of the head. The target response for Ed was an informal sign for ''rattle,'' defined as the palm of one hand hitting the thigh with a double movement. The target response for Yvonne was a modified ASL sign (i.e., a communicative hand gesture approximating but not matching a formal ASL sign) for ''pears,'' defined as bringing the palm of one hand to the nose.

Interobserver agreement was calculated by having a second independent observer collect data on independent and prompted signing either during the session or from a videotape after the session. For sign training, each 5-min session was divided into 1-min intervals, and the total number of intervals on which the two observers agreed was divided by the total number of intervals scored and the dividend multiplied by 100%. An agreement was scored if both observers recorded independent or prompted signing as having occurred or not occurred during each interval. Interobserver agreement scores were scored for 89%, 73%, and 59% of sessions for Julie, Yvonne, and Ed, respectively. Mean agreement levels were 93% (range, 80% to 100%) for Julie, 89% (range, 67% to 100%) for Yvonne, and 89% (range, 60% to 100%) for Ed. For the functional analysis sessions, the total number of trials on which the two observers agreed on the occurrence or nonoccurrence of an independent sign was divided by the total number of trials scored and the quotient multiplied by 100%. Interobserver agreement scores were scored for 100%, 90%, and 100% of functional analyses for Julie, Yvonne, and Ed, respectively. Mean agreement levels were 100% for Julie, 96% (range, 90% to 100%) for Yvonne, and 99% (range, 96% to 100%) for Ed.

Design and Procedure

A reversal design was used to evaluate the effects of sign training with all participants. The functional analysis conditions were arranged according to a multielement design.

Initial baseline. The designated reinforcer was delivered on a fixed-time 10-s schedule (Thompson et al., 2004). Julie and Yvonne received a bite of applesauce or pears (respectively) 10 s after consuming the previous bite. Ed received 10 s of access to the rattle. Reinforcer delivery was independent of the participant's behavior during these sessions.

Sign training. After the initial baseline phase, sign training was implemented for each participant. For Julie and Yvonne, a model prompt was delivered immediately at the beginning of each session and also according to a progressive delay schedule after consumption of the previously delivered reinforcer. If no signing occurred within 5 s of the model prompt, the researcher physically prompted the target response. The delay to model prompts was systematically increased across sessions on a progressive schedule (e.g., 0 s, 5 s, 10 s, and 20 s) until three consecutive sessions occurred with 10% or more of signs occurring indepen-

dently at the longest delay. The delay to physical prompts remained constant at 5 s following model prompts, and no prompts were delivered once the participant had met the response criterion at the longest delay.

For Ed, a verbal prompt (''What do you want?'') was delivered immediately at the beginning of each session and also according to the progressive delay schedule after removal of the previously delivered reinforcer. If no signing occurred within 5 s of the verbal prompt, the experimenter repeated the verbal prompt while simultaneously holding the target item within Ed's sight line. If no signing occurred within 5 s of the verbal–visual prompt, the experimenter modeled the target response. If no signing occurred within 5 s of the model prompt, the experimenter physically prompted Ed to perform the target response. The delay to verbal prompts was systematically increased across sessions (e.g., 0 s, 5 s, 10 s, and 20 s) until three consecutive sessions occurred with 10% or more of signs occurring independently at the longest delay. The delay to verbal–visual, model, and physical prompts remained constant, and no prompts were delivered once the participant had met the response criterion at the longest delay.

The target reinforcer for each participant was delivered immediately after all prompted and independent signing. If the participant exhibited an approximation of the target sign, the experimenter physically prompted him or her to complete the target sign correctly and then delivered the reinforcer.

Return to baseline. Procedures were identical to the initial baseline condition; however, the reinforcer schedule was yoked to half the interresponse time from the preceding sign-training phase.

Return to sign training (booster sessions). Procedures were similar to the initial sign-training phase, except that the delay to each subsequent model or verbal prompt was held constant at 5 s after consumption or removal of the previously delivered reinforcer. Sessions continued until an increase in independent signs was observed. Booster sign-training sessions were conducted on days between functional analysis sessions.

Functional analysis. Three test and corresponding control conditions were arranged according to Skinner's (1957) functional taxonomy of verbal operants. Skinner described the response form of a particular verbal operant as occasioned by specific variables, either verbal or nonverbal, and maintained by specific or generalized forms of reinforcement. The mand response form, for example, occurs when an organism is in a state of deprivation for a specific reinforcer, and receipt of that reinforcer contingent on the mand will strengthen similar response forms in the future, under similar conditions. The controlling variables for the mand, tact, and echoic or mimetic (manual equivalent to the echoic condition; Michael, 2004; Vargas, 1986) are outlined in Table 1, along with the specific test and control variables used in the functional analyses. Two test sessions were conducted for every one control, and the procedure was replicated twice for each of the three verbal operants tested. The specific arrangement of the conditions was similar to that described by Lerman et al. (2005), but a trial-based procedure was used (Kelley et al., 2007). However, unlike the Lerman et al. and Kelley et al. arrangements, the mimetic condition was conducted for all participants. In addition, the intraverbal condition was omitted, because the means by which one would select the appropriate antecedent verbal response forms is unclear, making difficult any clear interpretation if responding is not observed in this condition.

All functional analysis conditions were arranged to evaluate the function of the sign as a mand, tact, or mimetic. For the mand test conditions, access to the target food item or rattle was restricted for 60 min prior to the session, and access to the food item or rattle was

Table 1
Summary of Controlling Variables for the Targeted Verbal Operants

	Skinner's taxonomy		Functional analysis methodology		
Operant	Antecedent	Consequence	Condition	Antecedents	Consequence
Mand	Listener plus deprivation for a specific reinforcer	Access to the specific reinforcer	Test	1 hr deprivation; listener in close proximity; verbal or visual prompt	Access to the specified reinforcer
			Control	Free access to specified reinforcer; listener seated across room	No programmed consequences
Tact	Listener plus nonverbal stimulus	Generalized reinforcement (e.g., praise)	Test	Sight of item; listener in close proximity; verbal prompt	Brief praise
			Control	Item removed; listener seated across room	No programmed consequences
Echoic (mimetic)	Listener plus nonverbal stimulus	Generalized reinforcement (e.g., praise)	Test	Item removed; listener in close proximity; model prompt	Brief praise
			Control	Item removed; listener seated across room	No programmed consequences

provided following each instance of the target sign. For example, Julie's access to applesauce was restricted for 60 min prior to conducting a mand test session, and access to applesauce during the session was contingent on the occurrence of the target sign. For the mand control conditions, participants had free access to the target food item or rattle for 30 min prior to the session (i.e., they were placed in close proximity to the target item and were allowed to consume or manipulate the item for 30 min), and there were no programmed consequences for independent signing.

For the tact test conditions, participants were given free access to the target food items or rattle for 30 min prior to and throughout the test condition. Brief verbal praise was delivered following each instance of the target response. For the tact control, mimetic test, and mimetic control conditions, participants had free access to the target food items or rattle for 30 min prior to the session. The target food items or rattle was not present during these sessions. The experimenter provided no programmed consequences for independent signing during the tact and mimetic control conditions; independent signing in the mimetic test conditions resulted in brief verbal praise.

Test conditions consisted of 10 trials, with results expressed as the percentage of trials with independent signing (Kelley et al., 2007). The length of control sessions was yoked to the length of the corresponding test condition. The mand test conditions were 5 min in length (10 trials), so the mand control conditions were 5 min in length (10 30-s intervals).

RESULTS

Figure 1 shows the results of sign training, booster sessions, and functional analysis for Julie. Julie did not sign during the initial baseline phase. Her frequency of independent signing reached the criterion to move to the delayed model prompt in four sessions (20 min of training). Independent signing increased steadily across 32 sign-training sessions (a total of 2.7 hr of sign training) and decreased to zero within five sessions after reinstatement of baseline. When sign training was resumed, independent signing increased to levels slightly higher than those observed during the initial sign-training phase within five sessions, and signing was maintained during three booster sessions conducted between functional analysis sessions. In total, the experimenter conducted 48 sessions (4 hr of training) with Julie.

Julie signed most often during the mand test sessions of the functional analysis, with a few

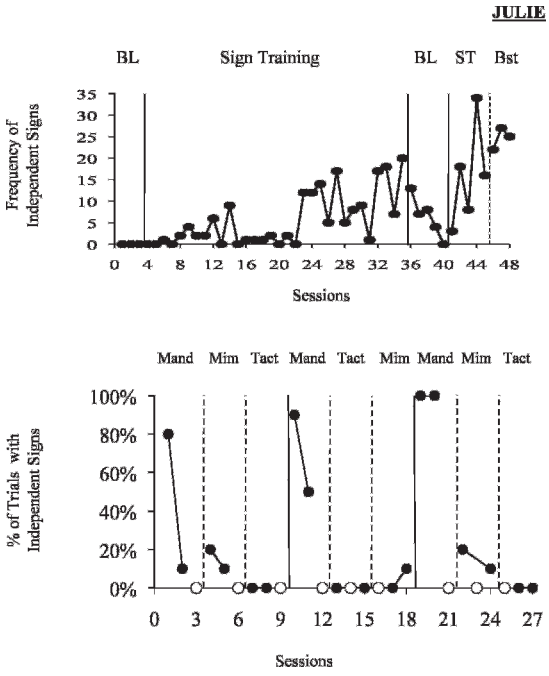

Figure 1. Julie's total number of independent signs for "applesauce" in each session during baseline (BL), sign training (ST), and booster training (Bst) (top). The percentage of trials during which Julie signed "applesauce" during test and control sessions for each verbal operant (bottom).

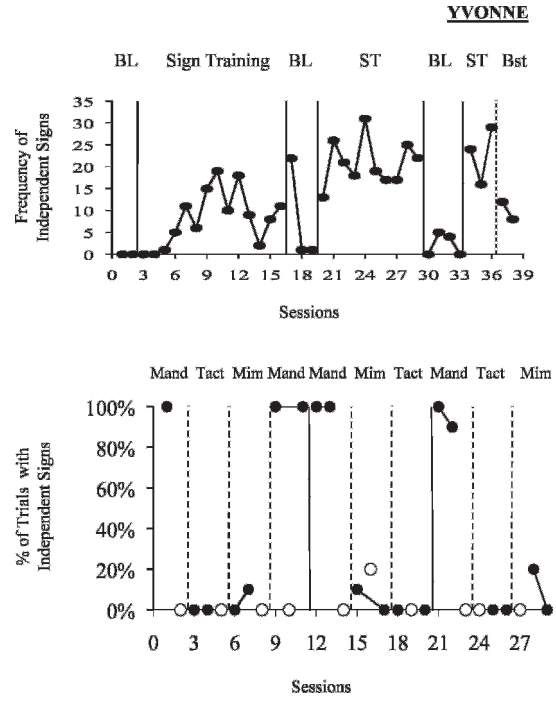

Figure 2. Yvonne's total number of independent signs for "pears" in each session during baseline (BL), sign training (ST), and booster training (Bst) (top). The percentage of trials during which Yvonne signed "pears" during test and control sessions for each verbal operant (bottom).

signs observed during the mimetic test sessions. No signing was observed during the mand control, mimetic control, tact test, or tact control sessions (Figure 1, bottom). These results indicate that the sign for "applesauce" functioned as a mand and as a mimetic.

Figure 2 shows the results of sign training, booster sessions, and functional analysis for Yvonne. Yvonne did not sign during the initial baseline condition. Her frequency of independent signing reached the criterion to move to the delayed model prompt in five sessions (25 min of training). Independent signing increased steadily during 13 sign-training sessions (a total of 1.1 hr of sign training) and increased during the initial return to baseline; this was followed by an immediate decrease to near-zero levels. Reinstatement of sign training for 10 sessions (50 min of training) resulted in higher levels of independent signing than those observed in the initial sign-training sessions. Four subsequent baseline sessions produced little to no signing. Sign training was again reinstated, and rates of independent signing comparable to the previous sign-training condition were observed within three sessions. Two booster sessions conducted on days between functional analysis sessions resulted in slightly decreased rates of independent signing; however, these levels still exceeded baseline levels. In total, the experimenter conducted 38 sessions (3.2 hr of training) with Yvonne.

Yvonne signed often during all mand test sessions, with a few signs observed during the mimetic test condition (Figure 2, bottom). No responding was observed in the mand control, tact test, or tact control conditions. These

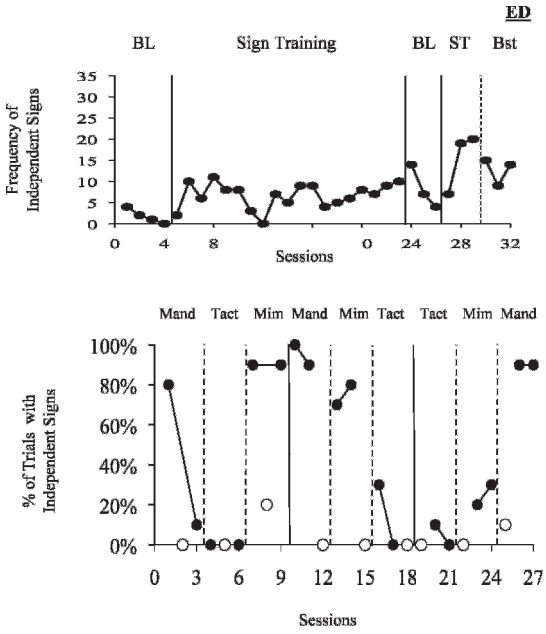

Figure 3. Ed's total number of independent signs for "rattle" in each session during baseline (BL), sign training (ST), and booster training (Bst) (top). The percentage of trials during which Ed signed "rattle" during test and control sessions for each verbal operant (bottom).

results indicate that the sign for "pears" functioned as a mand and as a mimetic.

Figure 3 shows the results of sign training, booster sessions, and functional analysis for Ed. Ed signed independently during the initial baseline, but independent signing decreased to zero within four sessions. His frequency of independent signing reached the criterion to move to the delayed model prompt in four sessions (20 min of training). Independent signing steadily increased during 19 sign-training sessions (a total of 95 min of training) and then decreased to near zero within three sessions during the return to baseline. After reinstatement of sign training, independent signing increased to levels higher than those observed during the initial sign-training phase. In total, the experimenter conducted 32 sessions (2.7 hr of training) with Ed.

The results from Ed's functional analyses are less clear than those of Julie and Yvonne. Ed signed during the mand test and mimetic test conditions and occasionally signed during the tact test condition (Figure 3, bottom). Although more variable than the other participants, these results suggest that the sign for "rattle" functioned as a mand and as a mimetic.

DISCUSSION

All participants learned to sign under the training conditions, with the frequency of signing much higher in the sign-training conditions than in baseline. Independent signing was observed within a few brief training sessions for all participants. In addition, results provided support for some functional independence of the targeted verbal operants. That is, the functional analysis identified a specific condition or conditions that evoked signing. The greatest amount of signing was observed in the mand test condition, with signing also observed in the mimetic test condition. Signing was almost never observed in the tact test condition or in any of the control conditions.

These results are consistent with previous reports, in that young children (i.e., 8 to 15 months old) quickly acquired signing skills in a few training sessions (Thompson et al., 2004, 2007) using a teaching procedure that consisted of delayed model and physical prompts combined with reinforcement (Thompson et al., 2007). The functional analysis results support previous research, in that the signs occurred only under specific test conditions (Kelley et al., 2007; LaFrance et al., 2009; Lerman et al., 2005; Normand et al., 2008), and responding occurred most often in the mand condition (Lerman et al., 2005). However, unlike in these previous studies, the experimenters in the current study both taught the manual signs and conducted the functional analysis, with similar settings used for training and testing. Thus, one might be more likely to see clearly differentiated responding during the functional analysis, as opposed to situations in which the target verbal response was established under somewhat different conditions

and with different individuals than those involved in the functional analysis. That responding also was observed in the mimetic test condition, albeit less frequently than in the mand test condition, might be explained by the prompting procedures used during sign training. As a result of systematic model prompting, the infants had the opportunity to sign under conditions relevant both to mand and mimetic functions. These training procedures might establish multiple verbal operants simultaneously, an outcome that could be beneficial in sign-training programs. Future research is necessary to evaluate this possibility.

These results extend previous research in several ways. First, the present study served as a preliminary validation of the verbal behavior functional analysis methodology in that the signs were taught under specific stimulus conditions (i.e., as mands) and the functional analysis subsequently identified a mand function for the signs. This is the first reported study in which verbal operants were established by the experimenters and then assessed using the verbal behavior functional analysis methodology first described by Lerman et al. (2005). As Normand et al. (2008) noted, the functional analysis methodology developed by Iwata et al. (1982/1994) has been validated by a sizable research literature that has reported successful clinical interventions based on the results of functional analyses. This kind of empirical validation is not generally applicable to verbal behavior analyses. A viable alternative to treatment evaluations might be to establish novel verbal operants under specific sources of stimulus control and then assess function using the functional analysis methodology. The results reported herein constitute such a validation.

Second, this is the first report of the verbal behavior functional analysis methodology used with typically developing individuals in general and infants in particular. Although a number of studies have demonstrated that this methodology produces differential responding across experimental and test conditions arranged according to Skinner's (1957) taxonomy, all such results have been reported with young children with autism or other developmental disabilities (Kelley et al., 2007; LaFrance et al., 2009; Lerman et al., 2005; Normand et al., 2008).

Given the potential generality of the methodology, it might be a useful tool for the longitudinal study of both typical and atypical language development. For example, ongoing descriptive analyses of child and caregiver interactions could be conducted (e.g., Moerk, 1990; Vollmer, Borrero, Wright, Van Camp, & Lalli, 2001) in combination with repeated functional analyses conducted at regular intervals. The results of these descriptive analyses of verbal behavior could be used to inform the arrangement of functional analysis conditions. Likewise, the results of the functional analysis could inform the interpretation of possible behavioral contingencies suggested by the results of the descriptive analysis. These types of arrangements could inform both basic and applied research on language development. These areas are promising avenues for future research. Similar methods that involve descriptive and functional analyses of verbal behavior also could be used to inform clinical practice if results are used to track progress through language acquisition programs and to identify deficits in functional communication. Perhaps more important, a more complete understanding of the types of stimulus control produced by language acquisition procedures could lead to more effective and efficient teaching technologies. Further research on verbal behavior functional analyses seems to be a promising tool for such an endeavor.

Third, the current study is one of only a few empirical demonstrations of functional independence among verbal operants exhibited by typically developing individuals (cf. Lamarre & Holland, 1985). The demonstration of functionally independent verbal operants is difficult

in typically developing populations, because language acquisition occurs quickly and multiple sources of stimulus control are readily established. Early sign training offers a unique opportunity to capture early language development in typically developing infants and toddlers and might also be applied to very early vocal development in this same population. A number of inferences concerning language development can be made based on Skinner's (1957) verbal behavior analysis. One example is the claim that mands, because they are the only verbal operant that directly benefits the speaker, develop prior to any other of the verbal operants in early language learners (Bijou & Baer, 1965; Lerman et al., 2005; Novak, 1996; Skinner, 1957; Sundberg, 2007; Sundberg & Michael, 2001). Although this is a plausible hypothesis, no strong empirical support for it exists in the literature. Functional analyses could be used to evaluate such claims empirically by assessing the variables that control the vocal or nonvocal language observed in very young children as they begin to develop functional communication skills.

In addition to the strengths noted above, several limitations of the current study warrant attention. With respect to the sign-training procedures, the signs were taught only under mand conditions. Future research should evaluate the degree to which other verbal operants (e.g., tacts or intraverbals) could be established with infants and young toddlers. Also, the most relevant controlling variable (food deprivation) was only loosely controlled during training. Although this seems not to have affected acquisition adversely, more careful control over the relevant variables for each operant being taught might improve acquisition rates or generalization.

With respect to the verbal behavior functional analysis, perhaps the most pressing question is the degree to which the control conditions were adequately arranged. Two likely ways in which the control conditions used in the present study (and in each of the verbal behavior functional analysis studies published to date) might be limited are that (a) a nonverbal stimulus was absent in the tact control condition, and (b) verbal discriminative stimuli similar to those arranged in the test conditions were absent in the tact and mimetic (echoic) control conditions. Future studies could address these concerns by incorporating nonverbal stimuli that are irrelevant to the target response into the tact control condition and delivering irrelevant verbal prompts during the tact and mimetic control conditions on schedules yoked to those in the test conditions (similar to the arrangement of the intraverbal control condition reported by Lerman et al., 2005).

Future research could focus on several other areas. First, the sign-language acquisition procedures reported thus far used delayed physical or model prompts to establish signing (Thompson et al., 2004, 2007). A procedure potentially as or more effective might be to identify a salient motor response already exhibited by the infant and then to shape a clear manual sign. Second, more attention should be given to the degree of generalization that results from the reported sign-teaching procedures, especially as assessed in natural settings with caregivers, and the variables that influence such generalization should be systematically investigated. Third, to establish further the validity of the verbal behavior functional analysis methodology, an experimenter who is blind to the specific conditions under which the sign was taught should conduct the functional analysis as a means of increasing its internal validity.

In summary, the results reported herein demonstrate that typically developing infants and young toddlers can be taught to sign under conditions that correspond to those described by Skinner (1957) as controlling the mand and mimetic (echoic). In addition, the verbal behavior functional analysis methodology produced differential signing across the test and

control conditions, evoking the most signing in mand test conditions and somewhat less signing in mimetic test conditions, thus providing one of the few demonstrations of functional independence among verbal operants in typically developing children. The results of the functional analysis also suggest that the methodology might be a useful tool for investigating language development and for guiding language-acquisition programs.

REFERENCES

Bijou, S. W., & Baer, D. M. (1965). *Child development: II. Universal stage of infancy*. New York: Appleton-Century-Crofts.

Goodwyn, S. W., & Acredolo, L. P. (1993). Symbolic gesture versus word: Is there a modality advantage for onset of symbol use? *Child Development*, *64*, 688–701.

Goodwyn, S. W., Acredolo, L. P., & Brown, C. (2000). Impact of symbolic gesturing on early language development. *Journal of Nonverbal Behavior*, *24*, 81–103.

Iwata, B. A., Dorsey, M. F., Slifer, K. J., Bauman, K. E., & Richman, G. S. (1994). Toward a functional analysis of self-injury. *Journal of Applied Behavior Analysis*, *27*, 197–209. (Reprinted from *Analysis and Intervention in Developmental Disabilities*, *2*, 3–20, 1982)

Kelley, M. E., Shillingsburg, M. A., Castro, M. J., Addison, L. R., LaRue, R. H., & Martins, M. P. (2007). Assessment of the functions of vocal behavior in children with developmental disabilities: A replication. *Journal of Applied Behavior Analysis*, *40*, 571–576.

LaFrance, D., Wilder, D. A., Normand, M. P., & Squires, J. L. (2009). Extending the assessment of functions of vocalizations in children with limited verbal repertoires. *The Analysis of Verbal Behavior*, *25*, 19–32.

Lamarre, J., & Holland, J. G. (1985). The functional independence of mands and tacts. *Journal of the Experimental Analysis of Behavior*, *43*, 5–19.

Lerman, D. C., Parten, M., Addison, L. R., Vorndran, C. M., Volkert, V. M., & Kodak, T. (2005). A methodology for assessing the functions of emerging speech in children with developmental disabilities. *Journal of Applied Behavior Analysis*, *38*, 303–316.

Michael, J. L. (2004). *Concepts and principles of behavior analysis* (rev. ed.). Kalamazoo, MI: Society for the Advancement of Behavior Analysis.

Moerk, E. L. (1990). Three-term contingency patterns in mother-child interactions during first language acquisition. *Journal of the Experimental Analysis of Behavior*, *54*, 293–305.

Normand, M. P., Severtson, E. S., & Beaver, G. A. (2008). A functional analysis of nonvocal verbal behavior of a young child with autism. *The Analysis of Verbal Behavior*, *24*, 63–67.

Novak, G. (1996). *Developmental psychology*. Reno, NV: Context Press.

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

Sundberg, M. L. (2007). Verbal behavior. In J. O. Cooper, T. E. Heron, & W. L. Heward (Eds.), *Applied behavior analysis* (2nd ed., pp. 526–547). Upper Saddle River, NJ: Merrill/Prentice Hall.

Sundberg, M. L., & Michael, J. (2001). The benefits of Skinner's analysis of verbal behavior for children with autism. *Behavior Modification*, *25*, 698–724.

Thompson, R. H., Cotnoir-Bichelman, N. M., McKerchar, P. M., Tate, T. L., & Dancho, K. A. (2007). Enhancing early communication through infant sign training. *Journal of Applied Behavior Analysis*, *40*, 15–23.

Thompson, R. H., McKerchar, P. M., & Dancho, K. A. (2004). The effects of delayed physical prompts and reinforcement on infant sign language acquisition. *Journal of Applied Behavior Analysis*, *37*, 379–383.

Vargas, E. A. (1986). Intraverbal behavior. In P. N. Chase & L. J. Parrott (Eds.), *Psychological aspects of language* (pp. 128–151). Springfield, IL: Charles C Thomas.

Vollmer, T. R., Borrero, J. C., Wright, C. S., Van Camp, C., & Lalli, J. S. (2001). Identifying possible contingencies during descriptive analyses of severe behavior disorders. *Journal of Applied Behavior Analysis*, *34*, 269–287.

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Action Editor, Rachel Thompson