THE EFFECTS OF SIGN LANGUAGE TRAINING WITH YOUNG CHILDREN:

THE TACT

By

Kelly A. Dancho

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_____
Rachel H. Thompson, Chairperson

_____
Greg P. Hanley, Committee Member

_____
Edward K. Morris, Committee Member

_____
Joseph Spradlin, Committee Member

_____
Michael Vitevitch, Committee Member

Date defended: _____

The Dissertation Committee for Kelly A. Dancho certifies
that this is the approved version of the following dissertation:

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Committee:

_____
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_____
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_____
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_____
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Abstract

THE EFFECTS OF SIGN LANGUAGE TRAINING WITH YOUNG CHILDREN: THE TACT

DANCHO, KELLY A. Ph.D., Department of Applied Behavioral Science, University of Kansas, 2007. Dissertation directed by Professor Rachel H. Thompson

Thompson, McKerchar, and Dancho (2004) trained 3 typically developing children to sign using delayed physical prompting and reinforcement. Children in the Thompson et al. study exhibited a limited communicative repertoire consisting of a single mand displayed only under controlled experimental conditions. This investigation sought to expand the signing repertoires of 6 typically developing children and 3 children of atypical development by (a) teaching tacts, (b) teaching multiple signs with the same child, (c) evaluating whether the signs would occur under novel stimulus conditions, and (d) evaluating whether signs occurred under stimulus control of relevant events. Each child in Experiment 1 acquired signs using delayed model and physical prompting and reinforcement. Following training under experimental conditions, signing was measured and observed under novel stimulus conditions with 2 children, and signing was under stimulus control of relevant stimuli when assessed with 1 child. Experimental procedures were modified in Experiment 2 in an aim to decrease assessment length and increased the saliency of stimuli. Again, each of the 5 children acquired signs, 2 of 5 children signed under novel stimulus conditions and discriminated responding was observed with all 5 children.

The Effects of Sign Language Training with Young Children: The Tact

Skinner (1957) proposed functional distinctions between several verbal operants, among which are mands and tacts. Mands are verbal operants evoked by motivating operations and followed by consequences specific to those operations. For example, a young boy who is thirsty says “juice” and receives juice. Tacts, in contrast, are verbal operants evoked by nonverbal discriminative stimuli (S^D) and followed with generalized reinforcement or reinforcement nonspecific to the $S^{D,}$ as when a young girl sees a bird and says, “birdie,” and receives praise.

Mands and tacts may assume many forms. When emitting the verbal response “eat,” an individual may vocalize “eat,” place a hand up to his mouth to sign eat, make gestures for eating such as chewing, or point in the general direction of places where food is stored. Likewise, when tacting “milk” in the presence of spilled milk, one may say, sign, point to, or make some gesture for “milk.” However, verbal behavior with similar forms or topographies may not have the same function. For example, a child who signs “milk” when she sees it spilt on the floor may not be tacting milk’s presence. Perhaps she sees the milk on the floor, is thirsty, and signs “milk” due to a previous history of gaining access to milk when emitting that sign.

An emphasis on the functional relation between a verbal response, its antecedents (i.e., motivating operations, S^D), and consequences (i.e., response specific reinforcement, generalized reinforcement) is a distinguishing feature of Skinner’s analysis of verbal behavior. Beyond its conceptual contribution, Skinner’s analysis has informed language intervention by delineating antecedent and consequent

conditions that should be presented when teaching verbal behavior. Skinner's analysis has influenced many forms of language intervention, including investigations of sign language acquisition among those with limited vocal capabilities.

A large body of research has focused on evaluating procedures for teaching children and adults with developmental delays to use sign language (Braam & Sundberg, 1991; Bryen & Joyce, 1986; Carr, Binkoff, Kologinski, & Eddy, 1978; Partington, Sundberg, Newhouse, & Spengler, 1994; Sundberg, Endicott, & Eigenheer, 2000). For example, Carr et al. simultaneously presented nonverbal stimuli (e.g., apple, milk) and their corresponding vocal stimuli (e.g., said "apple," said "milk"), and presented those items contingent upon signing for 4 participants (10- to 15-years-old) diagnosed with autism. Acquisition of signed mands was demonstrated for all participants.

Partington et al. (1994) presented a nonverbal stimulus (e.g., orange, cracker) with the verbal prompt "what is that" to occasion signed tacts with a 6-year-old female diagnosed with autism. Partial verbal prompts ("what") were provided following a progressive delay (2 to 5 s), and model prompts were delivered following incorrect responding. Correct signing resulted in praise and tangibles nonspecific to the target sign, and signed tacts were acquired within 3, 9-trial sessions.

Sundberg et al. (2000) trained signed tacts with 2 boys (4- and 5-years-old) diagnosed with autism. A verbal vocal prompt ("sign shoe") was presented in the presence of a S^D (a shoe). Praise was provided for correct responding, whereas no

response or incorrect responses were followed by a model and vocal prompt. Participants acquired signed tacts within 8 and 6, 10-trial sessions.

Researchers have also trained individuals with developmental disabilities to use sign language as part of treatment packages to decrease problem behavior (e.g., Derby et al., 1997; Fisher, Kuhn, & Thompson, 1998; Wacker et al., 1990) by arranging reinforcers previously delivered for problem behavior (e.g., attention) contingent upon signing. In addition, increases in appropriate collateral behavior such as social behavior (e.g., the appropriate solicitation of attention) have been shown to emerge following sign training (e.g., Derby et al., 1997).

This success in teaching sign language in populations with limited vocal language has lead to marked interest in teaching sign language to typically developing children. Recent research with typically developing children suggests that signs can be acquired prior to vocal communication. When parents were asked to pair vocal words with target gestures (e.g., palms-up for “where is it”), children acquired gestures an average of 0.69 mos prior to vocal communication (Goodwyn & Acredolo, 1993).

Acquiring a signing repertoire may also facilitate the development of vocal communication. In a study by Goodwyn, Acredolo, and Brown (2000), parents in an experimental group were asked to train their children to use symbolic gestures through pairing vocal words with target gestures, while another group of parents and their children were not involved in training. Subsequent assessments of expressive and receptive vocal communication indicated that the children in the experimental

group scored higher than those in the control group, suggesting that sign language may facilitate vocal communication. The results of Goodwyn and Acredolo (1993) and Goodwyn et al. (2000) are promising; however, in both studies parents were instructed to pair vocal words with target gestures, but were not observed during interactions with their children. Thus, specific methods for training signs were not well described or assessed.

By contrast, Thompson, McKerchar, and Dancho (2004) and Thompson, Cotnoir-Bichelman, McKerchar, Tate, and Dancho (2007) demonstrated the effectiveness of delayed prompting and reinforcement to train mands in 7 children (6- to 13-months-old) of typical and atypical development. Initially, the children received model and/or physical prompts to emit the signed mand (e.g., requests for toys) following a 5 s delay from the start of the 10-min session. Subsequent delays to physical prompts were progressively increased from 5 s to 4 min. Independent and physically guided signs (e.g., “more”) were reinforced (e.g., with access to toys). Approximations to the target signs resulted in physical guidance to perform the entire sign accurately and were reinforced as well. Children acquired signed mands in 2 to 4 hours of training (Thompson et al., 2004). In addition, whining and crying were replaced with signing for 2 children (Thompson et al., 2007).

These studies identify an effective set of procedures for training mands with typically developing children. However, a limitation of the Thompson et al. (2004, 2007) studies is that children learned only single mands. Language involves multiple responses under the control of multiple stimuli. Manding is thus a small part of a

language repertoire. Moreover, it cannot be assumed that children who are trained to emit a sign under mand control will spontaneously emit the same sign under tact control. For example, a demonstration that a child has learned to mand “milk,” does not guarantee that he or she will tact “milk” in its presence.

Several studies have provided empirical support for the functional independence of verbal responses (Hall & Sundberg, 1987; Lamarre & Holland, 1985; Lerman et al., 2005; Reichle, Barrett, Tetlie, & McQuarter, 1987; Sigafoos, Doss, & Reichle, 1889; Twyman, 1995). For example, Lerman et al. (2005) conducted a functional analysis of vocal verbal operants emitted by children diagnosed with autism and/or developmental delays. Four children were exposed to experimental conditions that included the antecedents and consequences controlling mands, tacts, intraverbals, and echoics. Performance in test conditions was compared to vocal responses in control conditions designed to remove the controlling contingencies for each verbal operant. Two children emitted responses in several experimental conditions. One child emitted vocal responses only in the mand condition (i.e., said “toy” when it resulted in access to a toy, but not when asked “what is that” in the presence of the toy), and one child emitted vocal responses only in the tact condition, suggesting that different parts of an individual’s language repertoire (in these cases, manding and tacting) may need to be trained separately. This finding highlights the need to evaluate procedures for training signed tacts with typically developing children.

The purpose of this study was to evaluate the effects of a set of sign training procedures designed to produce signing under the control of relevant stimuli (i.e., tacts). In Experiment 1 and 2, we evaluated the effectiveness of delayed model and physical prompts and praise on the acquisition of independent signs trained in the presence of relevant stimuli (i.e., tacts). Based on the findings of Experiment 1, sign training procedures were modified in Experiment 2 in an attempt to improve the efficiency of the procedures and to increase child attention to stimuli.

EXPERIMENT 1

Method

Participants, Setting, and Materials

Participants were 4 children who attended a full-day infant and toddler program at the University of Kansas and displayed limited vocal and sign communication. Betty (14 months) and George (17 months) were developing typically. Betty said a few simple words like “ball,” “dada,” and “baba,” and exhibited the signed mand, “more.” George vocalized some one and two syllable words (e.g., “mama,” “bus,” “ball”) and exhibited signed mands such as “more,” “all done,” “please,” and “eat.” His mother also reported he knew the sign, “dog.” Hilda (21 months) and Eddy (28 months) were diagnosed with Down syndrome. Hilda said a few simple words like “hi” and “da,” and exhibited a few signed mands such as “more,” “please,” and “all done.” Eddy said a few simple words like “baby” and “ball,” and exhibited a few signed mands such as “more” and “eat.” Signs were selected based on parent and teacher reports of the children’s interests.

All sessions were conducted in a hallway adjacent to the children's classroom. Each session included materials designed to occasion the target sign. The target stimulus used for Betty, Eddy, and George was a tape player and songs. Hilda was presented with a 2D picture of her father's car. For George's second sign, five identical toy giraffes were presented.

Response Measurement and Interobserver Agreement

Observers recorded the occurrence or nonoccurrence of independent signs during each trial. Target signs were based on American Sign Language (ASL), but were modified in accordance with the children's fine motor abilities. The sign "music" was taught to Betty, George, and Eddy and was defined as touching one hand against the opposite arm and swiping it up or down. Hilda was taught the sign for "car," defined as moving two fists in an up and down motion as if moving a car's steering wheel. George was also taught the sign for "giraffe," defined as touching one hand against his neck. The occurrence of a prompted sign was recorded if the target sign was completed with any model or physical assistance by the experimenter. Those signs emitted in the absence of these prompts were scored as independent.

A second observer simultaneously, but independently, recorded data during a mean of 50% of sessions for each child (range, 42% to 60%). Observer's records were compared on a trial by trial basis. Agreements were scored if both observers recorded the occurrence or nonoccurrence of independent and prompted signs. Agreement percentages were calculated by adding the total number of trial agreements minus the total number of trial agreements plus disagreements, then

multiplying by 100. Mean agreement across participants for independent signs was 99.1% (range, 98% to 100%), and 98.9% for prompted signs (range, 97.8% to 99.8%).

Procedure

All sessions consisted of five trials. Trials began when the target stimulus entered the child's line of sight and ended after 10 s (baseline) or when prompted or independent signing occurred (training sessions). For Betty and Eddy, the nonverbal stimulus was placed approximately 0.30 m in front of the child at the start of the trial, where it remained throughout the delivery of praise. During sessions with Hilda and George, the child was taken on a walk in a hallway in which the targeted nonverbal stimuli were arranged approximately 1.83 m apart. Trials began when the child and experimenter happened upon a target nonverbal stimulus. If the child did not pick up the stimulus and manipulate it, the experimenter held the stimulus approximately 0.30 m in front of the child. Again, the target nonverbal stimulus was present through the delivery of reinforcement. Sessions were conducted 5 days a week, 1 to 7 times a day, and were scheduled so as not to interfere with children's regularly scheduled classroom activities.

Baseline. The child was allowed to manipulate the target stimulus for 10 s, and the experimenter provided 3 to 5 s of attention (e.g., "Wow, you're such a good boy.") at the initiation of the trial, independent of child responding.

Tact training. If the child did not independently sign within 5 s of the start of the trial, the experimenter modeled the sign while saying, "(insert name), do this."

Children were physically prompted to complete the sign after a 10 s delay from the start of the trial. If the child performed an approximation to the sign, the experimenter provided the least amount of assistance necessary to complete the sign accurately. Brief attention (e.g., “Hey look at you, great job.”) was provided contingent upon both prompted and unprompted signs. Attention contingent upon prompted signs (independent signs continued to result in attention) was discontinued for Betty (sessions 71 to 82) and Eddy (sessions 84 to 133) in an attempt to increase motivation for independent signs.

Tact training extension (Betty and George). These sessions were conducted to determine whether independent signing taught under experimental conditions would occur in the presence of novel stimuli, settings, and listeners. Sessions were similar to tact training sessions; however, stimuli present during training were replaced with novel stimuli in the presence of which the trained sign would be appropriate, and sessions were conducted in novel settings. For example, following the conclusion of “music” training sessions, a novel tape player and song were presented in sessions with Betty and George. Next, independent signing was assessed in another room with the same stimuli for Betty, whereas extension to another room was assessed with a novel set of songs for George (see Table 1 for treatment extension conditions and results).

Discrimination test (George). Despite efforts to provide generalized reinforcement (in this case praise), signing may function as a mand if, for example, children’s signing was controlled primarily by consequent attention. If children

signed in the presence of the target stimulus and other stimuli, one might conclude that signing was mand-like. By contrast, if children exhibited discriminated responding, signing in the presence of the target stimulus and *not* in the presence of other stimuli, this demonstration would provide evidence of singing under stimulus control; thus, it would be appropriate to label these responses “tacts.” After teaching George the signs “music” and “giraffe,” discrimination sessions were conducted to determine whether George would sign “music” only in the presence of music and “giraffe” only in the presence of a toy giraffe or a 2D picture of a giraffe. Procedures were similar to tact training sessions; however, each session included 10 trials (5 random presentations of music and 5 random presentations of giraffe).

Experimental Design

The effects of sign training were evaluated in an ABAB reversal design for all participants.

Results and Discussion

Figure 1 presents the number of independent signs exhibited by Hilda during baseline and sign training. Hilda never signed during the initial baseline when attention was provided for 3 to 5 s at the start of each trial. Sign training was then initiated, and Hilda began to sign independently by session 13, with high and stable levels of independent signing thereafter. Independent responding decreased immediately following a reversal back to baseline, and a return to sign training produced high levels of independent signing immediately.

Eddy's data are depicted in Figure 2. Eddy never signed during the initial baseline when attention was provided for 3 to 5 s at the start of each trial. Following the initiation of signing, Eddy began to independently sign by session 25; however, independent signs were highly variable. Therefore, in session 84, reinforcement for prompted signs was discontinued and Eddy received reinforcement only following independent signs. A high and stable level of independent signing was exhibited shortly thereafter (sessions 98 through 104). Independent signing decreased immediately following a reversal to baseline, and a return to sign training produced high levels of independent signing immediately.

Figure 3 displays Betty's data. Betty's baseline performance was similar to Hilda and Eddy's. Following the initiation of sign training, Betty exhibited high and stable levels of independent signs by the session 29. Upon reversal back to baseline, signing immediately decreased to zero. Following the return to sign training, independent signing again increased. However, shortly thereafter (session 61), independent signing began to decrease. Therefore, reinforcement for prompted signs was discontinued in session 71, and Betty again exhibited independent signs at high and stable levels.

Because sign training was programmed during treatment extension sessions, signs emitted following prompting and/or reinforcement of signs may simply provide evidence that sign training was effective under a variety of stimulus conditions, and thus do not provide evidence of the spread of the effects of the intervention to novel stimulus conditions (i.e., generalization). The only evidence of generalization is the

occurrence of an independent sign at the start of the first trial under each novel assessment condition, prior to any prompting or reinforcement for signing. During treatment extension sessions (sessions 79-82), Betty signed “music” independently on the first trial of session number 79, in which signing was assessed with novel stimuli (refer to Table 1), and in session 80 in which signing was assessed with novel stimuli, in a novel setting. However, she did not independently sign on the first trial of session 81 in the presence of novel stimuli and a novel listener.

George’s data are depicted in Figure 4. The top panel shows the number of times George signed “music” (out of five trials) and the bottom panel shows the number of times he signed “giraffe.” George never signed “music” during the initial baseline when attention was provided for 3 to 5 s at the start of each trial. Sign training was then initiated and George began to sign independently by session 29, with high and stable levels of independent signing in sessions 40 through 43. Independent responding decreased immediately following a reversal to baseline; however, a return to sign training produced high levels of independent signing. In sessions 67 through 70, novel listeners, settings, and stimuli were presented. George did not independently sign “music” on the first trial in session 67, in which a novel tape player was introduced. However, he signed music independently on the first trials of sessions 69 and 70, when we introduced novel songs, music players, and different listeners, and conducted sessions in other locations. Results of sign training were similar with the “giraffe” sign, except that signing was acquired more quickly. Novel stimulus conditions were presented in treatment extension sessions 28 through

31, and George did not independently sign “giraffe” on the first trial of session 29 when signing was assessed in a novel setting. However, he did sign independently on the first trial of sessions 28 and 31, when generalization to novel stimuli, and listeners was assessed.

Figure 5 displays George’s signing “music” and “giraffe” in the presence of the corresponding nonverbal stimuli. Correct independent signing is indicated when George displayed the sign corresponding to the stimulus presented (a) prior to an experimenter prompt and (b) in the absence of the alternative sign (music). That is, when giraffe was presented, signing was considered incorrect if George signed “music” and then “giraffe.” With the exception of session 4, George emitted the sign “music” in the presence of a music player on each trial. George emitted the sign “giraffe” in the presence of corresponding stimuli on three of five trials during session one. However, correct responses increased to five of five trials in sessions 4, 5, and 6, suggesting that limited discrimination training was necessary to establish control by relevant stimuli.

Together, the results of Experiment 1 demonstrate the utility of delayed prompting, and generalized reinforcement for training signed tacts in children. One child, George, learned two signs, and his second sign was acquired more quickly than the first. Following sign training, Betty and George signed on the first trial of treatment extension sessions during which novel settings, listeners, and stimuli were introduced. And, in a separate test, George exhibited discriminated responding between nonverbal stimuli corresponding to trained signs with limited training.

Table 1

Treatment Extension Conditions and Results

		Introduction of Novel Stimuli			
Child	Session	Listener	Setting	Materials	Sign on 1st Trials*
Betty	79			CD player/song	Yes
	80		Classroom	CD player/song	Yes
	81	Experimenter 2			No
George (music)	67		Office	Tape player/song	No
	69			5 songs on PC	Yes
	70	Experimenter 2		5 songs on PC	Yes
George (giraffe)	28			3 non-identical 2D pictures	Yes
	29		Office	2 non-identical pictures on PC	No
	31	Experimenter 2		2 non-identical pictures on PC	Yes

*Yes indicates that children independently signed during the first trial in sessions under novel conditions.

Despite the fact that all children acquired signs using these procedures, we sought to improve our sign training procedures to address several concerns that arose during Experiment 1. First, sign training is most appropriate during a relatively brief period during which children display adequate manual control for signing, but limited oral motor control necessary to effectively communicate vocally. Thus, we sought to shorten the amount of time devoted to sign training and the evaluation of sign training procedures to decrease the likelihood training would continue during periods in which children were developmentally ready for greater emphasis on teaching vocal communication. Additionally, during Experiment I, some children did not readily orient to the target stimuli and others displayed interfering behavior (e.g., playing with their clothes), which may be one reason why sign training was lengthy. Therefore, in Experiment 2 the procedures were altered in an attempt to make the assessment more efficient and increase child attention to target stimuli.

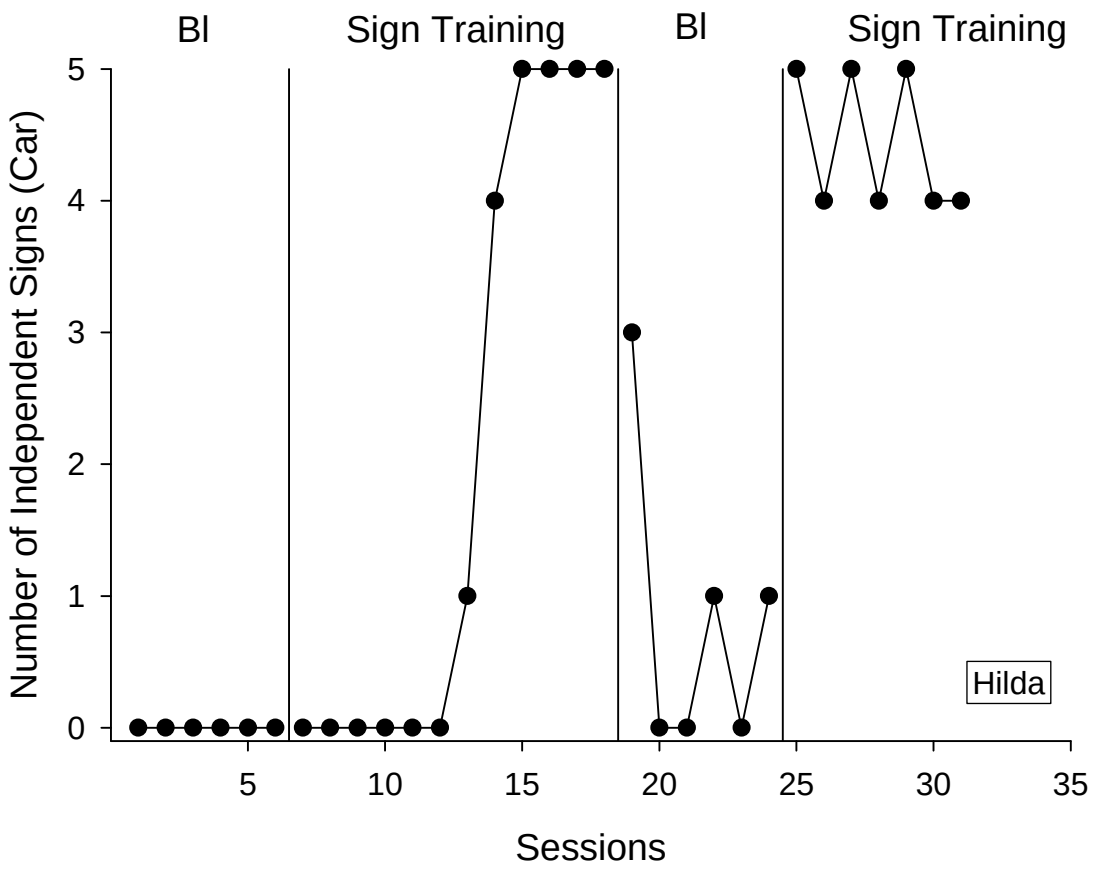

Figure 1. The number of Hilda's independent signs during baseline and sign training.

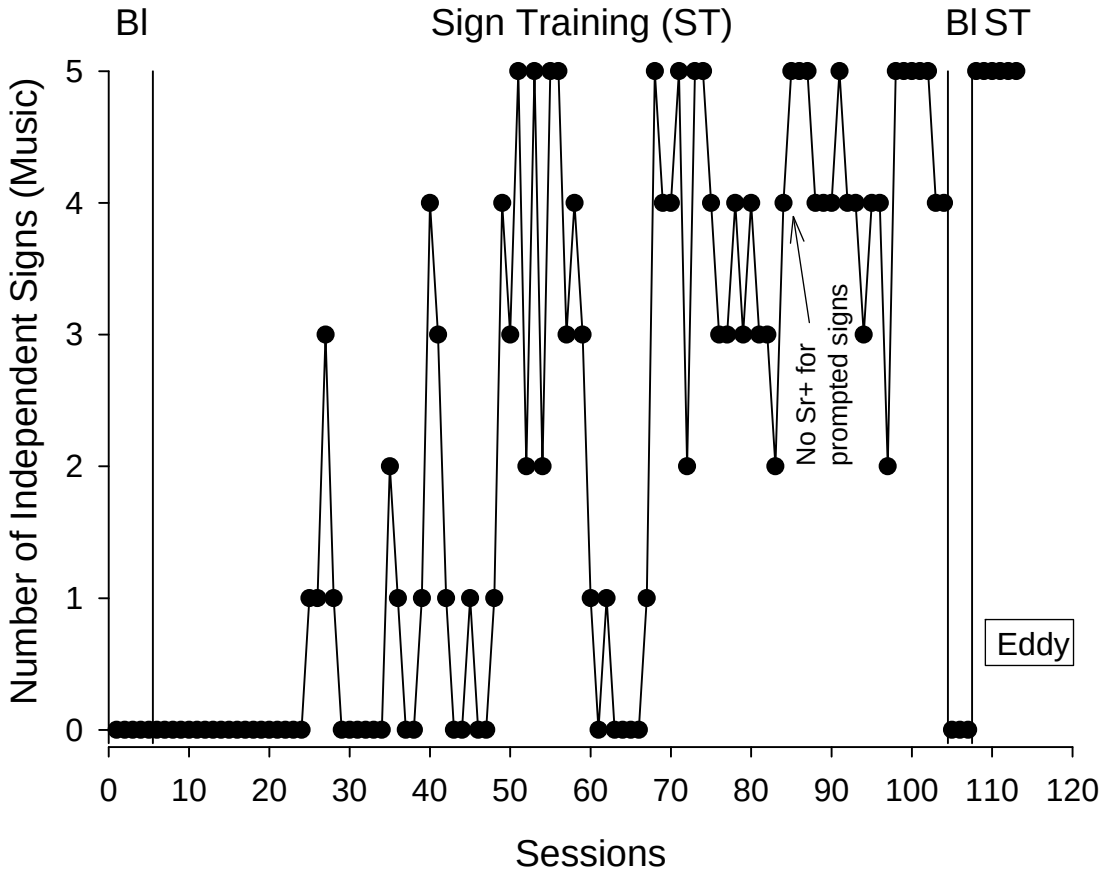

Figure 2. The number of Eddy's independent signs during baseline and sign training.

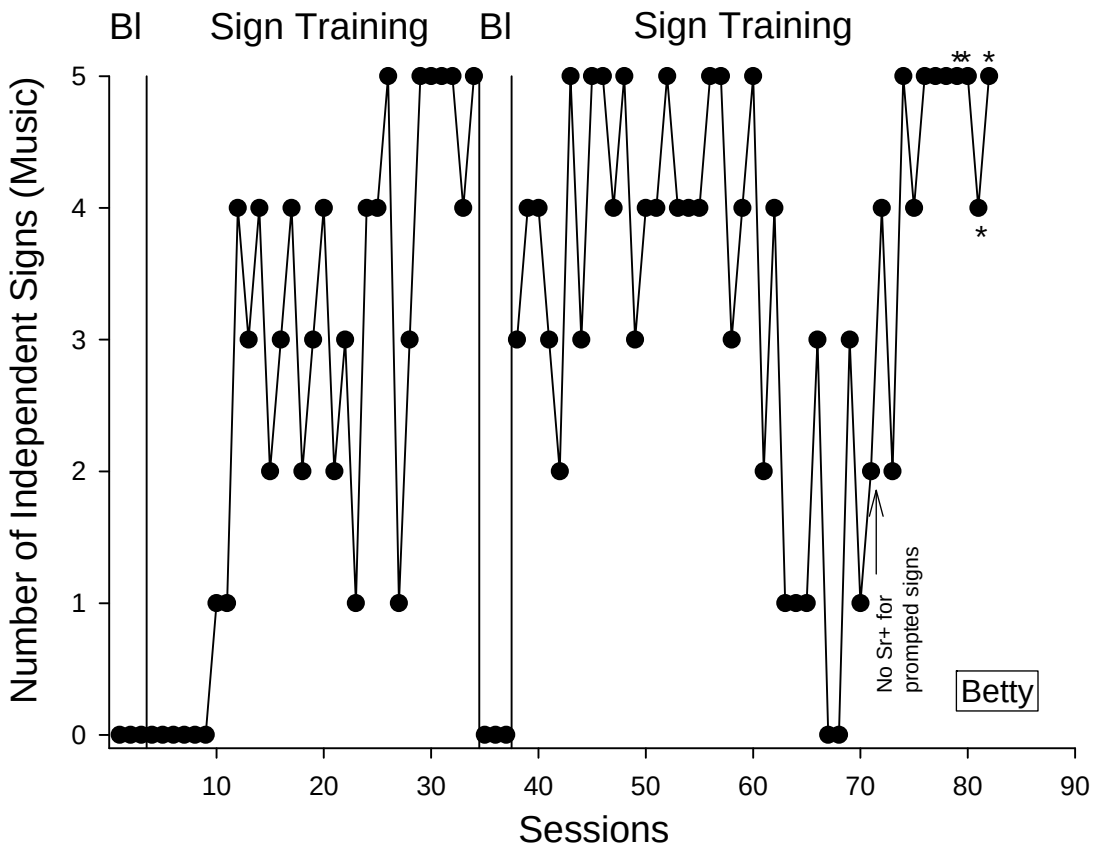

Figure 3. The number of Betty's independent signs during baseline and sign training. The asterisks indicate treatment extension sessions.

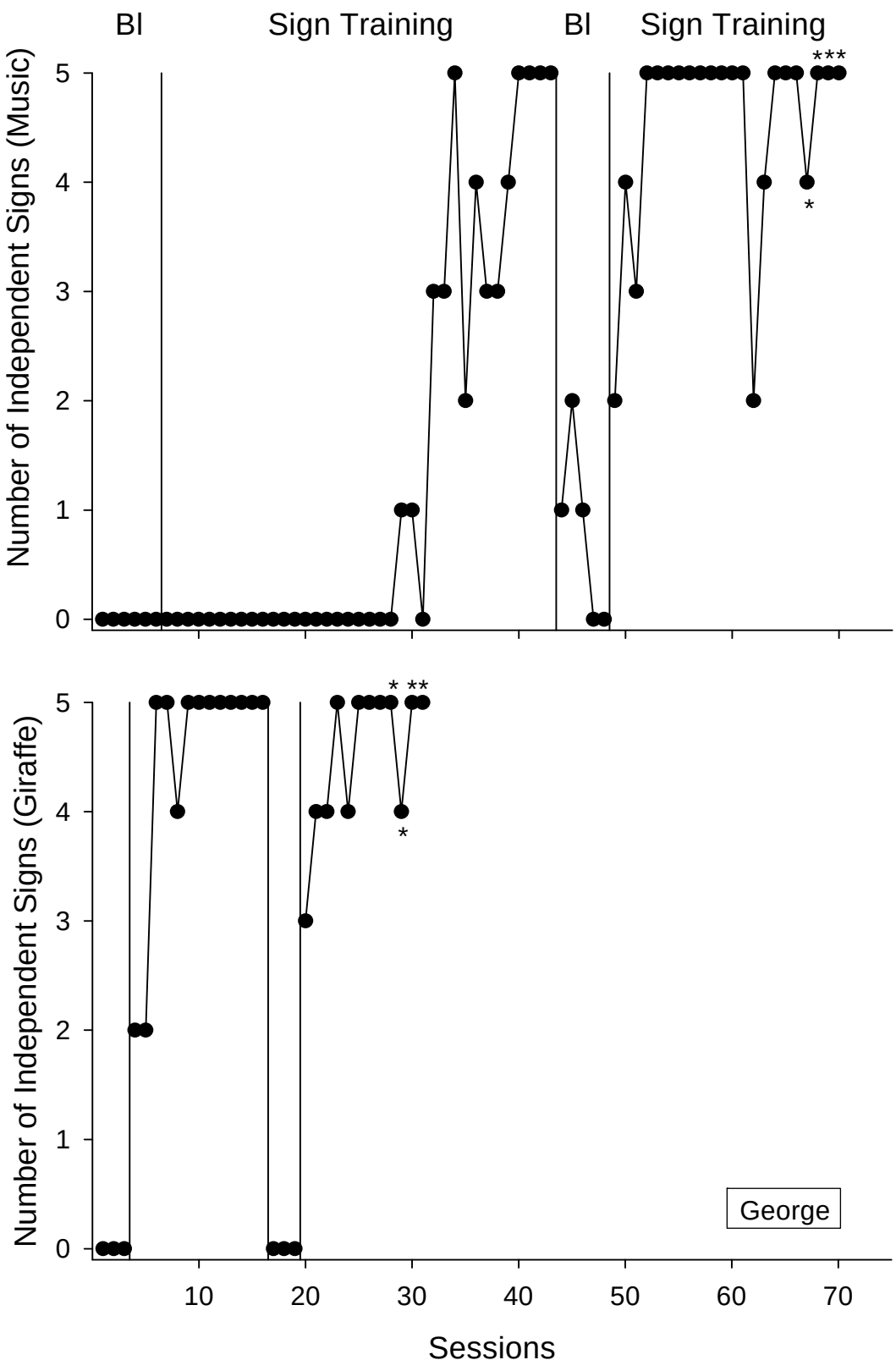
Bl
Sign Training
Bl
Sign Training
Number of Independent Signs (Music)
Number of Independent Signs (Giraffe)
0
1
2
3
4
5
10
20
30
40
50
60
70
Sessions
George

Figure 4. The number of George's independent signs "music" (top panel) and "giraffe" (bottom panel) during baseline and sign training. The asterisks indicate treatment extension sessions.

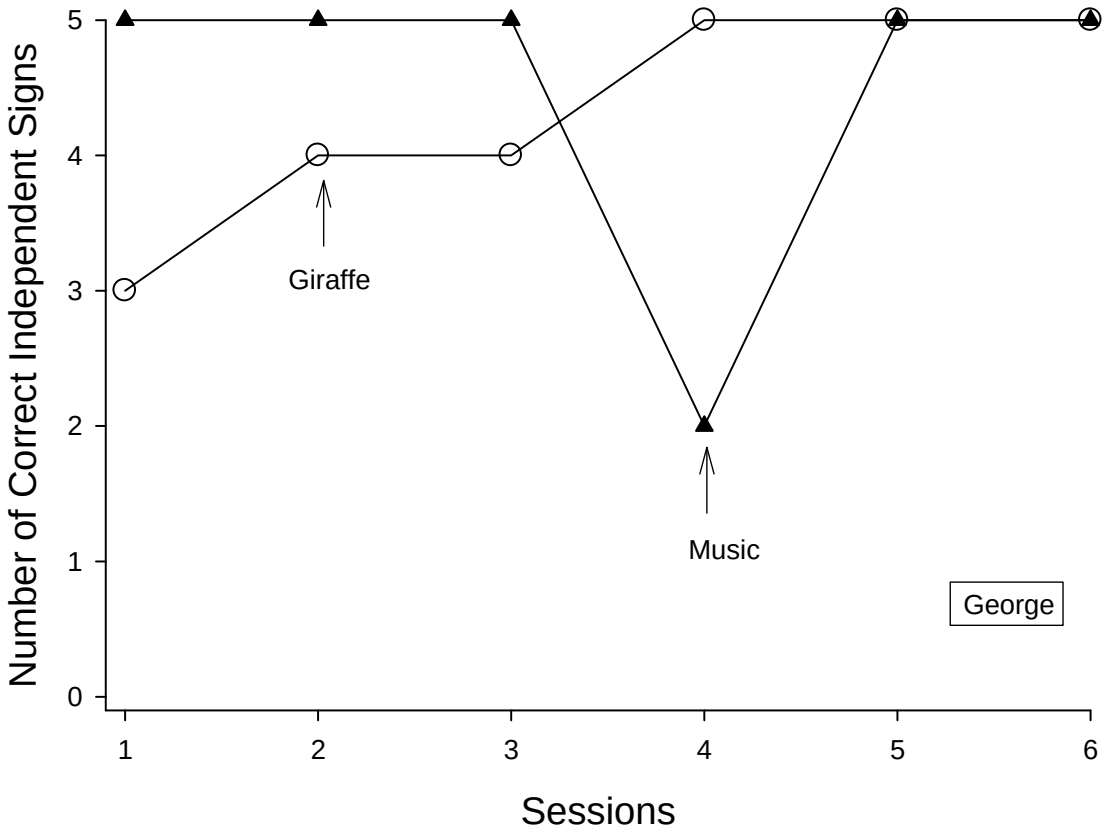

Figure 5. George's correct independent signs "giraffe" and "music" in the presence of the corresponding stimulus.

EXPERIMENT 2

Method

Participants, Setting, and Materials

Participants were 5 children who attended the same full-day infant and toddler program at the University of Kansas and displayed limited vocal and signed communication. Rita (11 months), Andy (12 months), Amy (13 months), and Ivan (13 months) were developing typically. Rita and Andy said a few simple words like “hi” and “bye,” and exhibited the signed mand, “more.” Amy said the word “bye-bye,” and exhibited a few signed mands such as “more,” “please,” and “all done.” Ivan said the word “mama,” but did not exhibit any signs. Lauren (15 months) was born with a cleft palate and was diagnosed with failure to thrive. Lauren said a few simple words like “hi” and “bye” and exhibited a few signs such as “more,” “eat,” and “bed.”

Sessions were conducted in the child’s classroom, or in rooms or a hallway adjacent to each child’s classroom. Signs were selected based on parent and teacher reports of child’s interest. Each session included materials designed to occasion the target sign. Lauren and Amy were presented with five booklets with and without pictures of fish. Toy giraffes were used as target stimuli for Rita and Andy. Target stimuli used for Ivan were play hats, baseball hats, and winter hats. Andy was also presented with toy dogs when training the sign “dog.”

Response Measurement and Interobserver Agreement

Observers recorded the occurrence or nonoccurrence of independent and prompted signs on each trial. Target signs were based on ASL, but modified in

accordance with children's fine motor abilities. The sign "fish" was taught to Lauren and Amy and was defined as holding either hand away from the body and moving it left to right. Ivan was taught the sign for "hat," which was defined as touching both hands on the top or sides of his head. Rita and Andy were taught the sign for "giraffe," which was defined as in Experiment 1 for George. Andy was also taught the sign for "dog," defined as either hand, but not both hands, slapping his lap. The occurrence of a prompted sign was recorded if the target sign was completed with any model or physical assistance by the experimenter. Independent signs were recorded if the child emitted an accurate sign in the presence of a corresponding nonverbal stimulus without prompting by the experimenter.

A second observer simultaneously, but independently, recorded data during a mean of 50% of sessions for each child (range, 40% to 62%). Agreements were scored if both observers recorded the occurrence or nonoccurrence of independent and prompted signs. Agreement percentages were calculated by adding the total number of trial agreements minus the total number of trial agreements plus disagreements, then multiplying by 100. Mean agreement across participants for independent signs were 99.71% (range, 98% to 100%), 99.9% for prompted signs (range, 98.5% to 100%), and 99.3% for signs during S^- trials (range, 80% to 100%).

Procedure

This experiment differed from Experiment I in that a target stimulus (S^+) and a nontarget stimulus (S^-) were presented during all sessions. All sessions consisted of ten trials, with five S^+ presentations (consisting of one to five different non-identical

stimuli) and five S^- presentations (consisting of five different non-identical stimuli). The order of the S^+ and S^- stimuli was randomized prior to sessions. Thus, an assessment of discrimination was embedded within sign training sessions. For example, we trained the sign "dog" with Andy. Therefore, sessions included S^+ trials that consisted of the presentation of five non-identical toy dogs and S^- trials that consisted of the presentation of five non-identical classroom toys (toy cars, toy people).

These procedures also differed from Experiment 1 in the manner in which stimuli were presented. With Lauren and Amy, five booklets containing pictures of five non-identical fish and five empty booklets were placed in random order approximately 0.9 m apart along a hallway. The experimenter and child walked through the hallway together and stopped in front of each booklet. If the child did not open the booklet, the experimenter opened it. Rita, Ivan, and Andy were provided with various containers (plastic bin, large purse) containing ten toys (five S^+ and five S^-). The experimenter placed the container in front of the child and said "pick one." If the child did not pull a toy from the container within 5 s, the experimenter pulled a toy out and held it approximately 0.3 m in front of the child.

Each trial started when an S^+ or S^- entered the child's line of sight (child either manipulated the toy while looking at it, or the experimenter held it in front of the child for the duration of the trial and throughout reinforcement) and ended after 10 s (baseline) or when the child was prompted to sign or signed independently (training sessions). Sessions were conducted 5 days a week, 1 to 4 times a day and were

scheduled so as not to interfere with children's regularly scheduled classroom activities.

Baseline. During S^+ trials, the experimenter provided 3 to 5 s of attention (e.g., "Hey, what a great job.") at the initiation of the trial, independent of child responding. No programmed consequences were provided during S^- trials.

Tact training. If the child did not independently sign within 5 s of the start of each S^+ trial, the experimenter modeled the sign while saying, "(insert name), do this." Children were physically prompted to complete the sign after a 10 s delay from the start of the trial. If the child performed an approximation to the sign, the experimenter provided the least amount of assistance necessary to complete the sign accurately. Brief attention (e.g., "wow, great job") was provided contingent upon both prompted and unprompted signs. No programmed consequences were provided during S^- trials.

Tact training extension (Ivan and Andy). These sessions were conducted to determine whether independent signing taught under experimental conditions would occur in the presence of novel stimuli. Sessions were conducted as in tact training; however, signing was assessed in the presence of novel target (S^+) and nontarget (S^-) stimuli. (see Table 2 for modifications in treatment extension and results).

Discrimination test. The assessment of discrimination was included in tact training sessions for all 5 children. In addition, after teaching Andy the signs "dog" and "giraffe," discrimination sessions were conducted as in Experiment 1 to determine whether Andy would sign "dog" only in the presence of a toy dog, and

"giraffe" only in the presence of a toy giraffe. Sessions were conducted similar to tact training sessions and included ten trials (five random presentations of toy dogs and five random presentations of toy giraffe).

Experimental Design

The effects of sign training were evaluated by comparing levels of signing in the presence of the S^+ with those emitted in the presence of the S^-. That is, if sign training was responsible for the increases in the target sign, one would expect higher levels of signing in the presence of the stimuli associated with training.

Results and Discussion

Figure 6 displays Lauren's data. Lauren never signed during baseline when attention was provided for 3 to 5 s in the presence of the S^+ and no attention was provided in the presence of the S^-. Sign training was then initiated and Lauren began to independently sign in the presence of the S^+ by the 2nd session and signed in the presence of the S^- a limited number of times.

Amy also never signed during baseline in the presence of the S^+ and S^- (Figure 7). Sign training was then initiated and Amy began to independently sign in the presence of the S^+ by the 18th session; however, high levels of signing were not observed until session 39. Signing in the presence of the S^- decreased to zero for the last five training sessions. Training was terminated despite the fact that Amy did not sign "fish" on every S^+ presentation. Given Amy's young age, we found independent signing on the majority of S^+ trials, with no signing on S^- trials to be a desirable performance.

Rita's data are depicted in Figure 8. Rita never signed during baseline, signed on the majority of S^+ trials beginning in session 14, and signed in the presence of the S^- a limited number of times.

Ivan's data are depicted in Figure 9. Ivan never signed during baseline, signed on the majority of S^+ trials beginning in session 5, and signed in the presence of the S^- on only two occasions (in sessions 7 and 9). During the tact training extension session, Ivan independently signed for five of five trials in the presence of five non-identical novel $S^+$and not in the presence of five non-identical novel S^-. It should be noted that Ivan was the only participant without an existing signing repertoire.

Figure 10 displays Andy's sign training data. Andy was first trained to sign "dog" (top panel). He never signed during baseline, signed "dog" in the presence of the S^+ consistently beginning at session 15, and signed "dog" only three times in the presence of the S^-. In session 23, five non-identical novel S^+ were presented and Andy independently signed on five of five trials in the presence of the S^+ and once in the presence of the S^-. In session 24, an additional five non-identical novel S^+ and five non-identical novel S^- were presented. Andy independently signed on five of five trials in the presence of the S^+ and did not sign in the presence of the S^-. Similar results were obtained when training the sign "giraffe." However, Andy never signed "giraffe" in the presence of the S^-. In session 18, an additional two non-identical novel S^+ and five non-identical novel S^- were presented. Andy independently signed five of five trials in the presence of the S^+, and not in the presence of the S^-.
Figure 11 displays Andy's discriminated responding "dog" and "giraffe" in the

Table 2

Treatment Extension Conditions and Results

		Introduction of Novel Stimuli			
Child	Session	Listener	Setting	Materials	Sign on 1st Trials*
Ivan	11			5 non-identical hats (S^+)/ 5 non-identical books (S^-)	Yes
Andy (dog)	23			5 non-identical dogs (S^+)	Yes
	24			5 non-identical dogs (S^+)/ 5 non-identical toys (S^-)	Yes
Andy (giraffe)	17			5 non-identical giraffe (S^+)/ 5 non-identical toys (S^-)	Yes

*Yes indicates that children independently signed during the first trial in sessions under novel conditions.

presence of the corresponding nonverbal stimuli. Correct independent signing is indicated when Andy displayed the sign corresponding to the stimulus presented (a) prior to an experimenter prompt, and (b) in the absence of the alternative sign. With the exception of sessions 1 and 4, Andy emitted the sign “dog” in the presence of all five corresponding stimuli. Andy emitted the sign for “giraffe” in the presence of corresponding stimuli on three of five trials during the first session; however, correct responses increased to five of five trials for the last two sessions, suggesting that limited discrimination training was necessary to establish control by relevant stimuli.

The results of Experiment 2 demonstrate the efficacy of delayed prompting and generalized reinforcement for training signed tacts in young children. No child signed during the initial baseline when attention was provided for 3 to 5 s at the start of each trial. During tact training, levels of independent signing in the presence of the S^+ increased, while signing during S^- trials remained near zero. The amount of training time prior to acquisition of signs varied for each child. For example, Andy was exposed to 17 training sessions (roughly one hr of training) before displaying independent signing in the presence of the S^+ for five of five trials, whereas Ivan independently signed for all S^+ trials after only three training sessions (roughly 12 min). Due to the intersubject variability observed in this experiment and in Experiment 1, it is difficult to draw conclusions regarding the efficiency of the Experiment 1 training procedures relative to those implemented in Experiment 2.

Independent signing in the presence of novel stimuli was demonstrated during the first trial of treatment extension sessions for Ivan and Andy, and in a separate test Andy exhibited discriminated responding between nonverbal stimuli corresponding to trained signs with limited discrimination training. In addition, all 5 children demonstrated discriminated responding between nonverbal stimuli that did and did not correspond with taught signs.

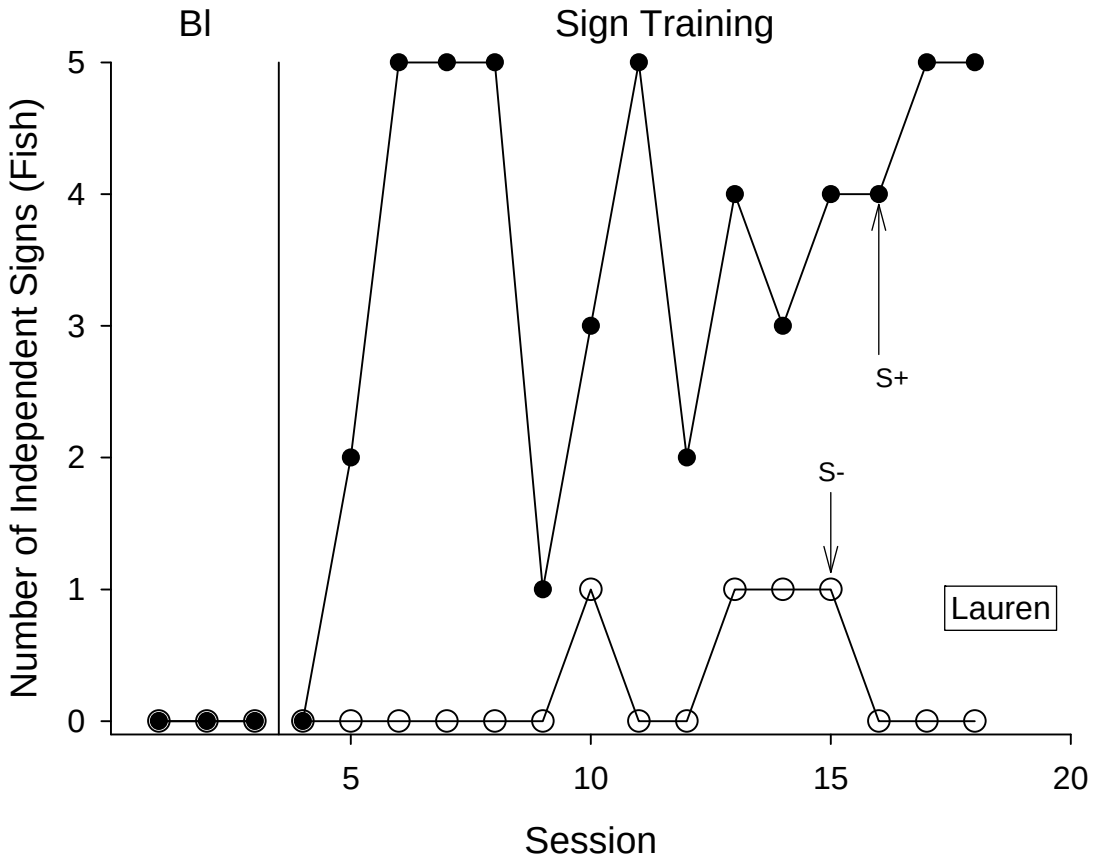

Figure 6. The number of Lauren's independent signs during baseline and sign training in the presence of exemplars (S^+) and non exemplars (S^-).

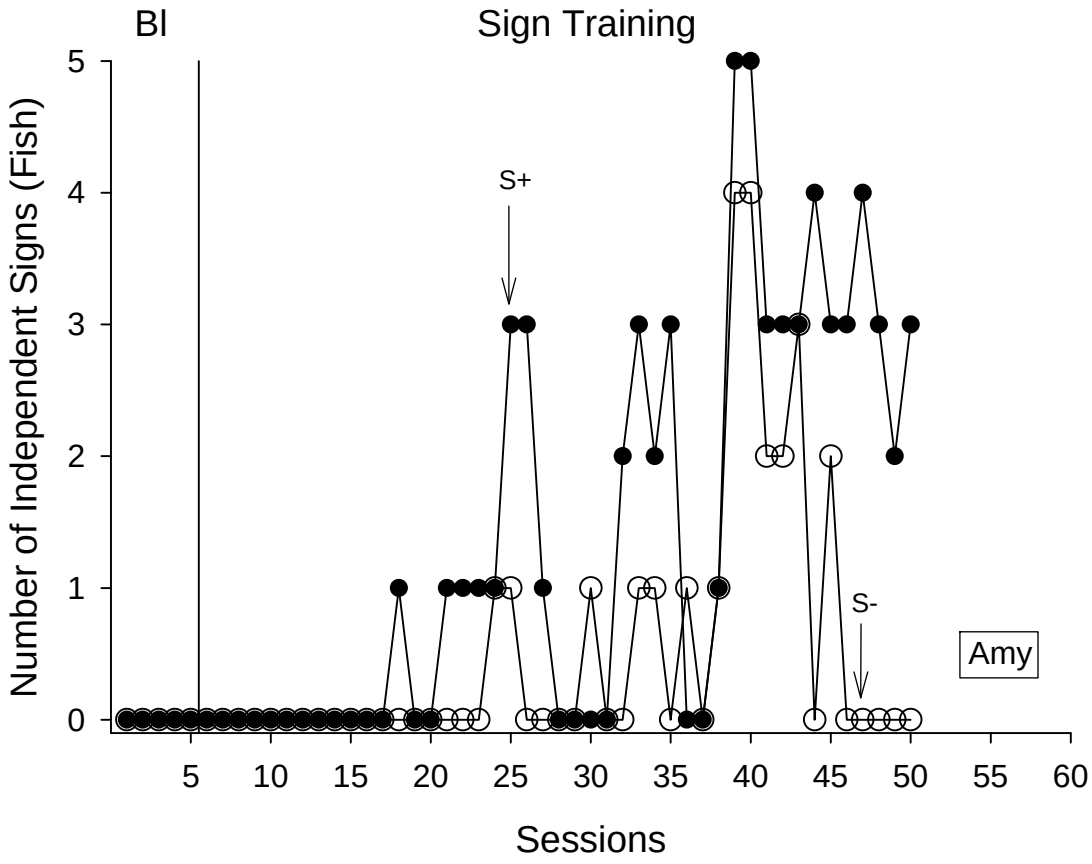

Figure 7. The number of Amy's independent signs during baseline and sign training in the presence of exemplars (S^+) and non exemplars (S^-).

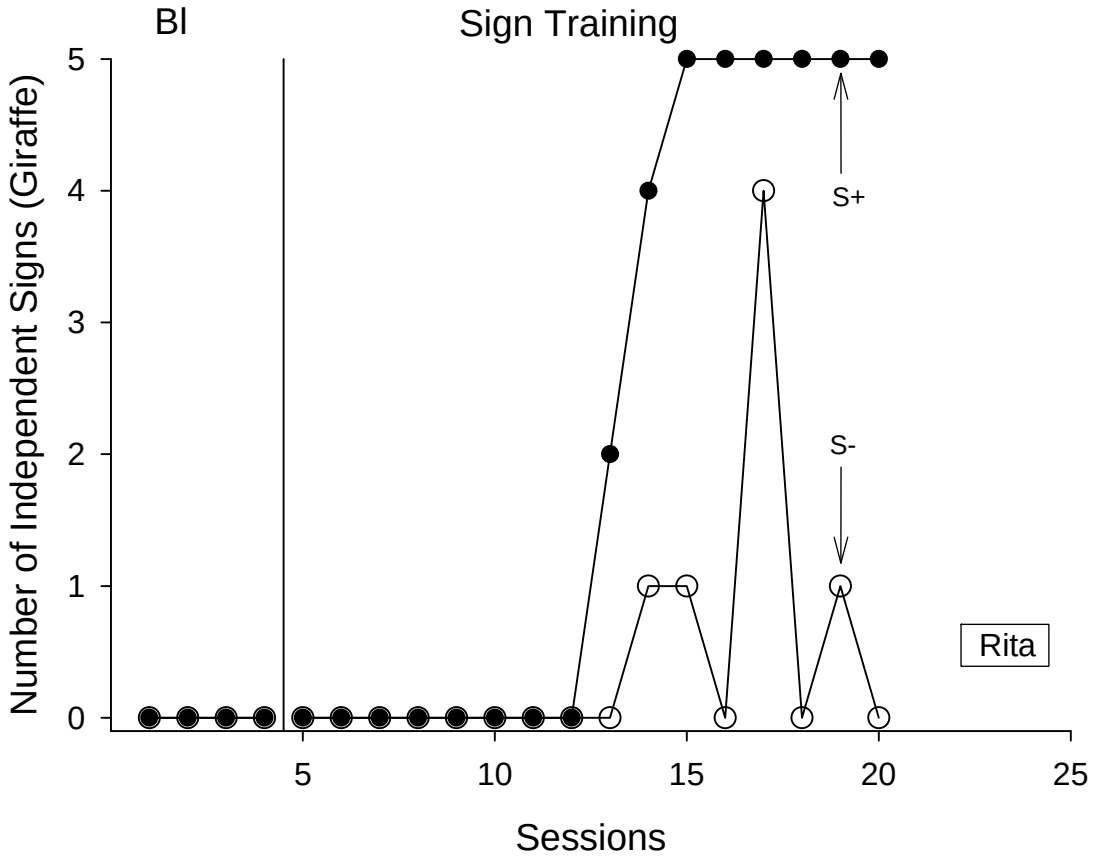

Figure 8. The number of Rita's independent signs during baseline and sign training in the presence of exemplars (S^+) and non exemplars (S^-).

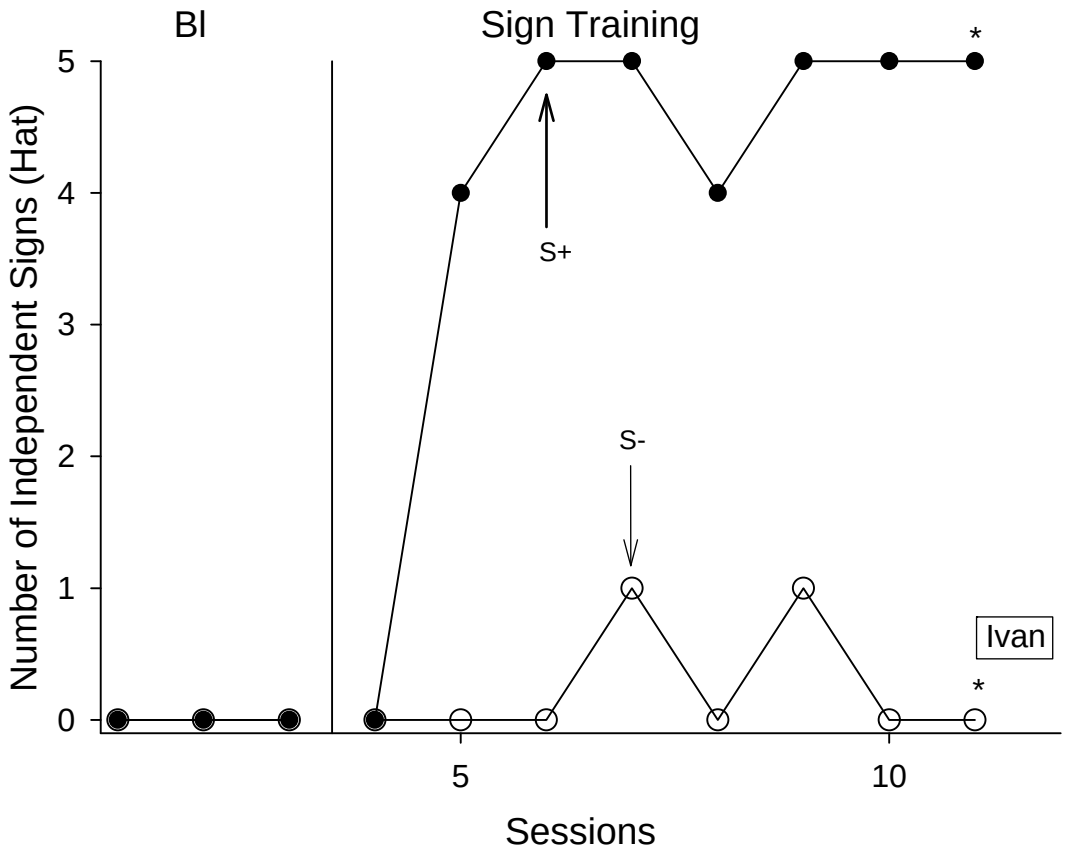

Figure 9. The number of Ivan's independent signs during baseline and sign training in the presence of exemplars (S^+) and non exemplars (S^-). The asterisks indicate treatment extension sessions.

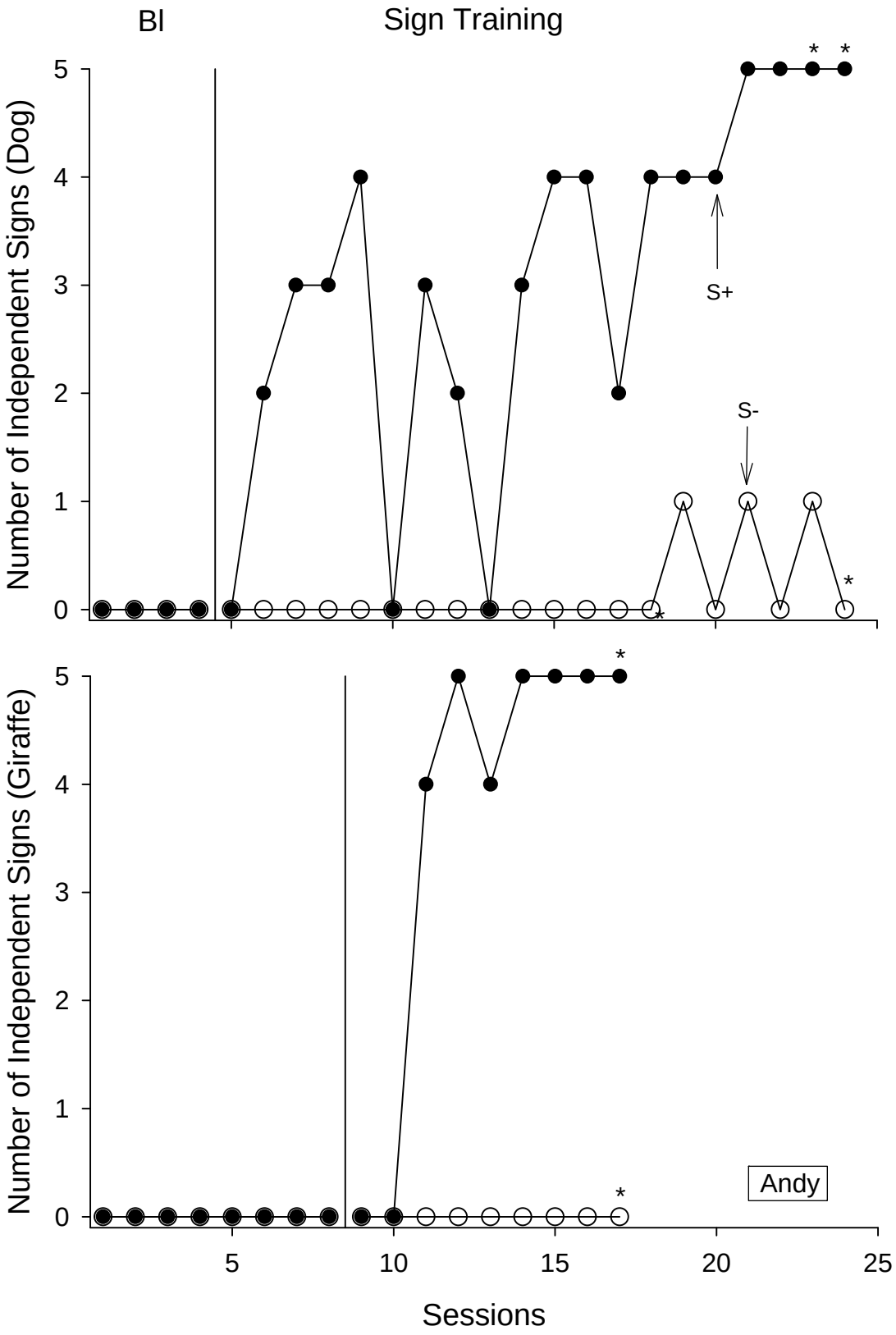
BI
Sign Training
Number of Independent Signs (Dog)
S+
S-
Number of Independent Signs (Giraffe)
Andy
Sessions
0
1
2
3
4
5
10
15
20
25

Figure 10. The number of Andy's independent signs "dog" (top panel) and "giraffe" (bottom panel) during baseline and sign training in the presence of exemplars (S^+) and non exemplars (S^-). The asterisks indicate treatment extension sessions.

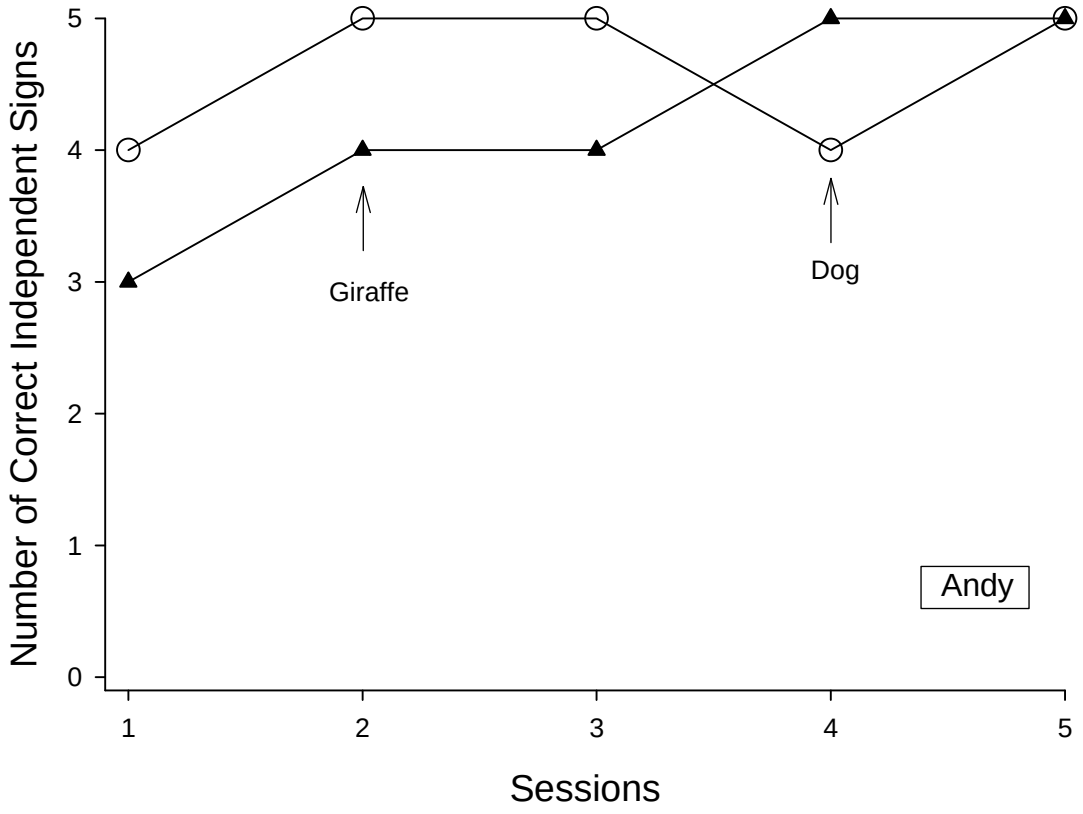

Figure 11. Andy's correct independent signs "giraffe" and "dog" in the presence of the corresponding stimulus.

GENERAL DISCUSSION

In Experiments 1 and 2, all 9 children acquired signed tacts when taught using delayed prompting and reinforcement. Thus, procedures similar to those developed by Thompson et al. (2004, 2007) to teach signed mands were effective in teaching signed tacts with young children. However, because our aim was to teach signed tacts rather than mands, the Thompson et al. procedures were modified such that (a) a discriminative stimulus was presented in the presence of which signing was prompted and reinforced, and (b) signing resulted in praise rather than access to the item controlling signing.

Given the design of the current study, and the high degree of intersubject variability in Experiments 1 and 2, it is difficult to determine which set of procedures is more efficient in producing signing among young children. Nonetheless, the efficiency of the evaluation of sign training procedures was improved in Experiment 2 by eliminating the need for a reversal design and by including a demonstration of discriminated responding within tact training sessions.

In both Experiments of this study and in the Thompson et al. (2004, 2007) mand training studies, reinforcement was programmed following both prompted and unprompted signs. Data for Betty and Eddy (Experiment 1) suggest that reinforcement of prompted signs may have interfered with performance of independent signs. With these two participants, independent signing increased when reinforcement for prompted signs was eliminated. With the remaining 7 participants, independent signing occurred at high levels despite programmed reinforcement for

prompted signs. Future research should be devoted to identifying the conditions under which reinforcement for prompted signs is facilitative and those under which this practice is counterproductive.

A limitation of the Thompson et al. (2004) study was that each child displayed mands only under a single set of training conditions, with one listener. The Thompson et al. (2007) study and the current study address this limitation by demonstrating that, after training, children displayed signed mands and tacts under a variety of stimulus conditions. A limitation of both studies is that sign training was programmed during treatment extension sessions; therefore, signs emitted following prompting and/or reinforcement of signs may simply provide evidence that sign training was effective under a variety of stimulus conditions. In addition, baseline data were not collected under all stimulus conditions presented during treatment extension. Thus, results cannot be considered definitive evidence of the spread of the effects of the training to novel stimulus conditions (i.e., generalization). Nevertheless, Betty, George, Ivan, and Andy, each exhibited independent signing during first trials of treatment extension session, prior to contacting prompting or reinforcement under those stimulus conditions. In addition, given that no signing occurred during baseline, and these signs were reportedly not in the children's repertoires, it seems implausible that signing would have occurred if baseline sessions were conducted under additional assessment conditions.

Participants in Experiments 1 and 2 displayed signs on the first trial in 6 of 9 and 7 of 7 treatment extension sessions, respectively. Thus it appears that the

inclusion of multiple exemplars during sign training in Experiment 2 facilitated signing in the presence of novel stimuli (Stokes & Baer, 1977) without prolonging training. However, the current study was not designed to evaluate the effects of this variable; thus, future research is needed to determine the optimal number of exemplars to present during training.

Despite efforts to provide nonspecific reinforcement (i.e., praise) in the current study, signing may have functioned as a mand if, for example, signing was controlled primarily by consequent attention. However, results of discrimination tests from Experiments 1 and 2 provide evidence of signing under stimulus control, a requirement for tacting. In Experiment 1, George displayed the signs "music" and "giraffe" under discriminative control, and in Experiment 2, control by relevant stimuli was demonstrated during sign training for all 5 children. In addition, Andy exhibited discriminated responding with respect to two trained signs ("dog" and "giraffe").

Skinner's (1957) focus on the environmental determinants of language is often considered at odds with more traditional accounts of language (Chomsky, 1959; MacCorquodale, 1970). Yet, the analyses conducted here allow children's signing to be considered as examples of symbolic language. From the traditionalist perspective, a distinguishing feature of human language is its symbolic nature. Symbolic language has been defined as the "comprehension or use, inside or outside communicative situations, of a relationship between sign[1] and its referent, such that the sign is treated as belonging to and/or substitutable for its referent in a variety of contexts: at the same

[1] Here the term "sign" is used to refer to language in any form including vocal language and manual signs.

time, the user is aware that the sign is separable from its referent, that is, not the same thing (Bates, 1979, p. 43)."

Thus, a key aspect of symbolic language is the relation between a verbal response and its referent, whereby the verbal response belongs to or is substitutable for its referent. In a behavior analysis of language, the process of discrimination provides one account of the development of this close association between verbal responses and relevant stimuli. Symbolic language is also said to be "context flexible" in that it is not constrained to any particular set of circumstances (e.g., a particular setting, listener, form of stimulus; Acredolo & Goodwyn, 1988; Snyder, Bates, & Bretherton, 1981). Context flexibility could be compared to the behavioral process of generalization in which a response initially reinforced in the presence of one stimulus (S^+) and not in the presence of another (S^-) and occurs spontaneously in the presence of other exemplars (S^+) not present during training (Catania, 1998). The present study addressed these determinants of language by demonstrating that (a) acquired tacts occurred under novel stimulus conditions (generalization), and (b) signing was under the stimulus control of relevant events (discrimination).

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