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An Investigation of Extinction Induced Vocalizations

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**Abstract**

Children with autism have significant communication delays. Although some children develop vocalizations through shaping and differential reinforcement, others rarely exhibit vocalizations, and alternative methods are targeted in intervention. However, vocal language often remains a goal for caregivers and clinicians. Thus, strategies to increase frequency of vocalizations are needed. In the present study we examined the effect of extinction of previously acquired signed mands on vocalizations in three children diagnosed with autism. Experiment one examined the effects of differential reinforcement of vocalizations and extinction of signed mands combined. In experiment one, it was unknown whether reinforcement of vocalizations alone could have produced the effects; therefore, experiment two isolated the effects of reinforcement and extinction by reinforcing vocalizations in baseline. An increase in rate of vocalizations occurred following application of extinction of signed mands and differential reinforcement of vocalizations in experiment one; and following extinction of signed mands in experiment two.

**DESCRIPTORS:** autism, extinction, communication training, verbal behavior, behavioral variability

### An Investigation of Extinction Induced Vocalizations

Deficits in speech development have been identified as one of the most common presenting complaints of parents of children diagnosed with autism (De Giacomo & Fombonne, 1998). Although much research supports the use of reinforcement and shaping procedures for teaching vocal imitation (Baer, Peterson, & Sherman, 1967; Garcia, Baer, & Firestone, 1971; Lovaas, Berberich, Perloff, & Schaeffer, 1966; Schroeder & Baer, 1972), there is a lack of procedures for producing vocalizations in children who do not respond to shaping and differential reinforcement. Shaping may not be effective for children who emit a low rate of vocalizations because there is very little behavior to reinforce and shape. Thus, lack of methods for producing vocalizations in individuals who emit a low rate of or no vocalizations represents a critical gap in behavioral literature.

A relatively new area of study has incorporated the use of extinction procedures to induce vocalizations and other novel responses (Grow, Kelley, Roane, & Shillingsburg, 2008). Research has shown that responding during extinction is often characterized by an initial increase in response frequency, duration, and variability (Galbicka, 1988). This effect is referred to as an extinction burst and is generally described as a negative result of extinction (Lerman, Iwata, & Wallace, 1999). However, extinction bursts may have clinically beneficial applications.

Several studies have investigated use of extinction to increase behavioral variability and thereby produce the emergence of novel appropriate behavior. Duker and Van Lent (1991) demonstrated an increase in the variety of gesture requests emitted by six children with developmental delays by withholding reinforcement for the most frequently used gestures. Additionally, Lalli, Zanolli, and Wohn (1994) induced untrained toy play responses in two children with developmental delays by first teaching one toy play response and subsequently

placing that response on extinction. Results indicated that both participants emitted a wider range of responses when the trained response was placed on extinction. Novel responses that emerged were then reinforced.

In a recent article (Grow et al., 2008) effects of extinction on novel communicative behaviors were specifically examined in children with developmental disabilities. In this article, the authors evaluated the efficacy of exposing problem behavior to extinction as a means of inducing response variability and subsequent emergence of appropriate responses. During baseline, no consequences were provided for appropriate communication and problem behavior was reinforced. During the treatment phase, problem behavior was placed on extinction and the first appropriate request that emerged was reinforced. Exposure to extinction for problem behavior produced response variability and high levels of appropriate behaviors occurred and maintained once the response contacted reinforcement.

Although this emerging body of literature shows advantageous outcomes of the extinction burst, no research has been conducted assessing the effectiveness of the extinction burst in producing vocalizations in individuals who emit low rate or no vocalizations. The overall purpose of the present investigation was to assess the effect of extinction of previously acquired signed mands (requests) on vocalizations in children with limited vocal repertoires. The purpose of experiment one was to assess the effects of differential reinforcement of vocal mands and extinction of signed mands on the rate of vocalizations in two children with autism. The purpose of experiment two was to determine whether the effects obtained in study one could have been obtained through reinforcement of vocalizations or whether the effects were due to extinction. Therefore, experiment two examined effects of extinction of signed mands only after

reinforcement of vocalizations during baseline was ineffective in increasing rates of vocalizations.

## **Experiment 1**

### **Method**

#### **Participants and Setting**

One male child diagnosed with Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS) and one male child diagnosed with autism attending an intensive behavioral intervention program participated in the study. At the start of the study Oliver was 3-years 4-months old and Sam was 5-years 6-months old. Oliver and Sam each received a diagnosis of autism by outside agencies prior to their admission to the intensive behavioral program. Both participants imitated motor movements and followed simple one-step instructions, but exhibited little to no vocal imitation (echoic behavior), and no vocal requesting skills (mands), expressive labeling (tacts), or conversational speech (intraverbal behavior). Both had acquired a mand repertoire using sign language and consistently used at least three signs. All sessions were conducted by an instructor in a private therapy room. The therapy room contained tables, chairs, shelves, and other teaching materials typically found in a classroom setting. Only the child, instructor, and data collectors were present during sessions.

#### **Measures**

Frequency of vocalizations were recorded and defined as any individual sound, blend, or word in the English language. A new occurrence of a vocalization was recorded following a 1 second pause between vocalizations. Vocalizations excluded those that were above a normal conversation level (i.e., screaming), crying, and whining.

A second independent observer also collected data during at least 20% of sessions. Assessment was distributed equally across all experimental phases. The desired level of overall agreement was 80% or greater. Interobserver agreement (IOA) was calculated for each session by dividing the number of agreements by the number of agreements and disagreements and multiplying by 100%. An agreement was defined as both the primary and reliability data collector recording that a vocalization was emitted. A disagreement was defined as one data collector recording a vocalization and the other recording no vocalization. Mean IOA for Oliver was 94% (range 25%-100%) and was collected during 89% of sessions. Mean IOA for Sam was 94% (range 77%-100%) and was collected during 56% of sessions.

### **Procedure**

**Preference assessment and prerequisite mand training.** Items and the corresponding sign included in the extinction procedure were previously acquired mands in each participant's verbal repertoire (data not included but available upon request). Prior to mand training, highly preferred items were selected using a paired-stimulus preference assessment (Fisher et al., 1992). Once stimuli were selected to target as signed mands, single stimulus preference assessments were conducted prior to each mand trial. That is, the item was presented and if the child approached the item within five seconds of presentation, prompts were provided for the child to emit the correct signed mand or the item was provided immediately if an independent correct signed mand occurred.

**Baseline.** During baseline the preferred item was in sight but out of reach. Access to the item was provided during a 10-second reinforcement interval contingent upon correct emission of the previously taught signed response. No behaviors were reinforced or recorded if emitted during the reinforcement interval. No consequences were provided following vocalizations.

Prior to conducting baseline sessions a multiple-stimulus without replacement preference assessment (MSWO; DeLeon, & Iwata, 1996) was conducted to ensure current preference for the item and increase the likelihood that an establishing operation (i.e., motivation) was present. If the item needed for the next scheduled session was not in the top 3 choices, the session was postponed until preference for the item was indicated during an MSWO. Subsequent MSWO assessments were conducted 1 hour to 24 hours later.

**Extinction plus differential reinforcement condition.** Similar to baseline the preferred item was in sight but out of reach. Access to the item was provided during a 10-second reinforcement interval contingent upon emission of any vocalization. No behaviors were reinforced or recorded if emitted during the reinforcement interval. No consequences were provided following signed responses. That is, signed responses were placed on extinction. Prior to treatment sessions assessment of current preference for each item was conducted identical to those described in the baseline condition.

### **Experimental Design**

A multiple baseline design across responses was used to evaluate treatment effects. As is common in multiple baseline designs, a varying time schedule for baselines was utilized to determine if the change in behavior was due to the addition of treatment. If behavior changes when treatment is applied, the researcher can conclude the change was due to treatment effects and not due to a confounding variable.

Three preferred items to which a corresponding sign had previously been taught were selected for each participant. The preferred items with corresponding signs for Oliver were popcorn, movie, and book. The preferred items selected for Sam were chip, movie, and coke. Only one preferred item was present during each session and each session lasted 10 minutes.

Following baseline one item was selected for treatment while the other two items remained in baseline.

### Results

Sam's results are depicted in Figures 1 and 2. Figure 1 shows baseline and treatment conditions for chip and movie and the baseline condition for coke. During baseline for the targeted item chip limited to no vocalizations occurred. Upon implementation of extinction plus differential reinforcement of alternative behavior (DRA), rate of vocalizations increased and remained elevated during subsequent treatment sessions. During baseline for the targeted item movie limited to no vocalizations occurred. Upon implementation of the extinction plus DRA procedure, the rate of vocalizations increased immediately. The third panel in Figure 1 represents the baseline condition for the targeted item coke. Initially, limited to no vocalizations occurred during baseline similar to that observed in the first two targeted items (i.e., chips and movie). An increase in vocalizations during baseline sessions for coke was observed following implementation of the extinction plus DRA procedure with chips. A larger increase in vocalizations was observed in the baseline sessions for the targeted item coke following initiation of the extinction plus DRA procedure with movie. Due to increase in vocalizations during baseline the extinction plus DRA procedure was never implemented with the targeted item coke.

Figure 2 depicts Sam's average rate of vocalizations during the baseline and treatment conditions for the targeted items chip and movie. Average rate during sessions with the targeted item coke is not included in Figure 2 since this target remained in baseline. For each targeted item, average rate of vocalizations was higher in treatment compared to baseline. In baseline, average rate of vocalizations for chip was low ( $M = 0.075$  responses per min; range 0 to 0.10 per

min). Sam's responding increased in the treatment condition to 1.588 vocalizations per min (range 0.7 to 2.7 per min). During baseline for movie, average rate of vocalizations was 0.10 (range 0 to 0.20 per min). Sam's responding increased in the treatment condition to an average rate of 1.275 vocalizations (range 1.0 to 1.7 per min).

Results of Oliver's training are depicted in Figures 3 and 4. Figure 3 shows baseline and treatment conditions for popcorn, movie, and book. During baseline for the targeted item popcorn Oliver emitted limited to no vocalizations. Upon implementation of the extinction plus DRA procedure rate of vocalizations gradually increased. During baseline for the targeted item movie Oliver emitted limited to no vocalizations. Upon implementation of the extinction plus DRA procedure rate of vocalizations increased immediately. During baseline for the targeted item book Oliver emitted limited to no vocalizations with the exception of two sessions in which Oliver emitted higher rates of vocalizations. Upon implementation of the extinction plus DRA procedure rate of vocalizations increased and remained elevated with subsequent treatment sessions.

Figure 4 depicts average rate of vocalizations during baseline and treatment conditions for the targeted items for Oliver. For each targeted item average rate of vocalizations was higher in treatment compared to baseline. During baseline for the targeted item popcorn the rate of vocalizations remained low ( $M = 0.1$  responses per min; range 0 to 0.50 per min). Oliver's responding increased in the treatment condition to 2.11 vocalizations per min (range 0 to 9.30 per min). During baseline for movie the average rate of vocalizations was 0.21 (range 0 to 2.20 per min). Oliver's responding increased in the treatment condition to an average rate of 3.16 vocalizations (range 0.10 to 4.40 per min). During baseline for the targeted item book the

average rate of vocalizations was 0.34 (range 0 to 5.10 per min). Oliver's responding increased in the treatment condition to an average rate of 2.52 vocalizations (range 0.70 to 3.80 per min).

### **Discussion**

We evaluated the effects of an extinction plus DRA procedure in which signed mands were put on extinction and subsequent vocalizations were reinforced. Results for both participants showed an increase in vocalizations once signs were put on extinction and vocalizations subsequently contacted reinforcement. These results are significant because there is a paucity of research regarding effective intervention strategies to increase vocalizations in children with autism who emit limited vocal behavior.

There was one limitation in experiment one that warranted specific further investigation. Extinction of the signed mands and differential reinforcement of the alternative response (vocalizations) were implemented at the same time. Thus, it is not possible to determine if the effects are due to a combination of extinction and differential reinforcement or if reinforcement alone could have produced these effects. Although procedures used in this study are in line with those implemented in previous research, future research could resolve this limitation by providing reinforcement for vocalizations and signed mands during the baseline condition, while in treatment only providing reinforcement for vocalizations after the sign was placed on extinction. Therefore, the purpose of experiment two was to resolve this limitation by providing reinforcement for vocalizations and signed mands during baseline and only providing reinforcement for vocalizations after extinction of the signed mand in treatment.

## Experiment 2

### Method

#### Participant and Setting

Ethan, a 4-year 11-month old male diagnosed with autism attending an intensive behavioral intervention program, participated in the study. Ethan received a diagnosis of autism by an outside agency prior to his admission to the intensive behavioral program. Ethan imitated gross motor movements and followed simple one-step instructions, but exhibited no vocal imitation (echoic behavior), vocal requests (mands), expressive labels (tacts), or conversational speech (intraverbal behavior). Ethan had acquired a mand repertoire using sign language and consistently used at least five signs. All sessions were conducted by an instructor in a private therapy room containing a table, chairs, and the targeted preferred item. Only the child, instructor, and data collectors were present during sessions.

#### Measures

Vocalizations and signed mands were the primary dependent variables. Vocalizations were defined exactly as described in experiment 1. Signed mands were defined as motor movements that corresponded with the preferred item that was present during the session. Data were collected using paper and pencil and frequency was calculated into rate before graphing.

A second independent observer collected data during at least 20% of sessions.

Interobserver agreement (IOA) was calculated identically to experiment 1. Mean IOA was 93.8% (range 82.1-100%) and was collected during 31.3% of sessions.

#### Procedure

**Baseline.** During baseline the preferred item was in sight but out of reach. Contingent upon correct emission of the previously taught signed response, access to the item was provided for 10

seconds or until consumed. Additionally, contingent upon emission of any vocalization, access to the item was provided for 10 seconds or until consumed. Prior to conducting each baseline session, a MSWO was conducted as described in experiment 1. If movie was not selected as one of the top 3, an alternative measure of preference for the movie was conducted in which the television was on but turned in such a way as to be out of site. If the participant approached the television and accessed the screen, it was deemed to be sufficiently preferred at that time. This alternative assessment was conducted with the movie itself instead of the movie case, which was the item included in the MSWO. Using the movie itself was thought to be a better indicator of preference for that particular item because the movie itself better represented what item was available compared to the movie case alone. Subsequent MSWO or the alternative assessments were conducted 1 hour to 24 hours later.

**Extinction.** Similar to baseline the preferred item was in sight but out of reach. Contingent upon emission of any vocalization access to the item was provided for 10 seconds or until consumed. No consequences were provided following signed responses. Prior to each treatment session assessment of current preference for each item was conducted identical to those described in the baseline condition.

### **Experimental Design**

A multiple baseline across responses design was used to evaluate treatment effects, identical to the procedures described in experiment 1. The preferred items with corresponding signs were cracker, juice, and movie. Only one preferred item was present during each session and each session lasted 10 minutes.

### **Results**

The results are depicted in Figure 5. Figure 5 shows baseline and treatment conditions for cracker and juice and the baseline condition for movie. Low rates of vocalizations and high rates of signed mands were observed during baseline for the targeted items cracker and juice. Upon implementation of extinction of the signed mand rate of vocalizations for these two items increased and remained elevated during subsequent treatment sessions. Prior to treatment introduction for the targeted item “juice,” vocalizations were on an increasing trend. However, after treatment implementation, vocalizations increased sharply after 5 sessions. In addition, signed mands decreased and remained low during treatment sessions. The third panel in Figure 5 represents the baseline condition for the targeted item movie. Initially, limited to no vocalizations in the movie condition occurred during baseline similar to the rate observed for the first two targeted items. Additionally, signed mands occurred at a low level. An increase in vocalizations during baseline sessions for movie was observed following implementation of extinction in the juice condition suggesting a generalization effect as seen with one participant in experiment 1. Due to the increase in vocalizations during baseline extinction was never implemented with the targeted item movie.

### **Discussion**

Ethan’s rate of vocalizations in baseline for the signed mands cracker and juice did not increase despite direct reinforcement of vocalizations. Extinction of the signed mands was necessary to obtain elevated rates of vocalizations. These results suggest that reinforcement alone may not be sufficient to increase rates of vocalizations and short sessions in which alternative communicative responses are placed on extinction may result in increased vocalizations.

### General Discussion

Results of these two experiments are important for several reasons. Failure to acquire vocalizations through shaping and differential reinforcement is a significant clinical concern for children with language deficits and interventions designed to address this concern are relatively understudied. Little is known regarding how to produce and develop vocalizations in children who do not respond to commonly used procedures making research into new methods to teach vocal language important.

Results of this study are of particular clinical significance given that a previous history of reinforcement for signed mands did not interfere with an increase in vocalizations. The fact that vocalizations increased is important given that concern is sometimes expressed by parents, caregivers, and clinicians that by implementing an augmentative communication system there will be less opportunity for vocalizations to develop. Although augmentative communication systems are often used as a means to develop vocalizations, there is limited research to demonstrate that a history of reinforcement for non-vocal communicative responses does or does not interfere with an increase in vocalizations when modifications to teaching are made. This may represent one of the first studies demonstrating that vocalizations increase, despite the history of reinforcement for communication with an augmentative communication system (specifically, sign language).

Two participants in the study (Sam, experiment 1 and Ethan, experiment 2) demonstrated increased vocalizations in the final untreated response. In addition, Sam's vocalizations were on an upward trend in the juice condition prior to treatment implementation. Clinically, this is a desirable outcome and suggests generalization of treatment. Therefore, extinction may not need to be applied to every signed mand for vocalizations to increase. However, increases in

vocalizations that did not correspond directly with treatment are a notable experimental limitation. Future research may wish to resolve this issue by examining the use of different experimental designs.

Extinction procedures are often characterized by an extinction burst which has historically been viewed as a negative feature of the procedure. In the current study, exposure to extinction resulted in high levels of vocalizations for three participants with autism. Use of extinction plus DRA for appropriate vocalizations has previously been shown to be effective in reducing problem behavior and increasing appropriate communication (Grow et al., 2008). The present study represents the first study to apply extinction procedures to signed mands and subsequently to provide reinforcement for appropriate vocalizations that emerged during the extinction burst. The current study further isolates the role of extinction on vocalizations by providing reinforcement for vocalizations in baseline which was ineffective for one participant. These results add to the literature on the desirable clinical outcomes of the extinction burst and a possible alternative method of producing and increasing vocalizations.

A limitation of the current study is that the current procedures appear to be most beneficial for children with low overall rates of vocalizations. Thus, this procedure may not be appropriate for children who emit higher baseline rates of vocalizations. The procedure may need to be examined with children who do not respond to vocal imitation training but emit a high frequency of vocalizations. Furthermore, the small sample size in the current study limits the ability for the results to generalize to other individuals, particularly those who may not present with similar characteristics as the children described in this study. The current study should be replicated with additional individuals with different characteristics.

Results of this study leave room for future research on the use of extinction in developing vocalizations in individuals with limited vocal repertoires. Future research may wish to examine whether extinction of signed mands tends to produce the same vocalization or a variety of vocalizations. If a limited variety of sounds are emitted it may be interesting to then apply a similar extinction procedure to the highest frequency sound and examine subsequent variation in sound production. Emission of vocalizations more similar to the vocal mand would be advantageous and future research could involve differential reinforcement of closer approximations of vocalizations during extinction.

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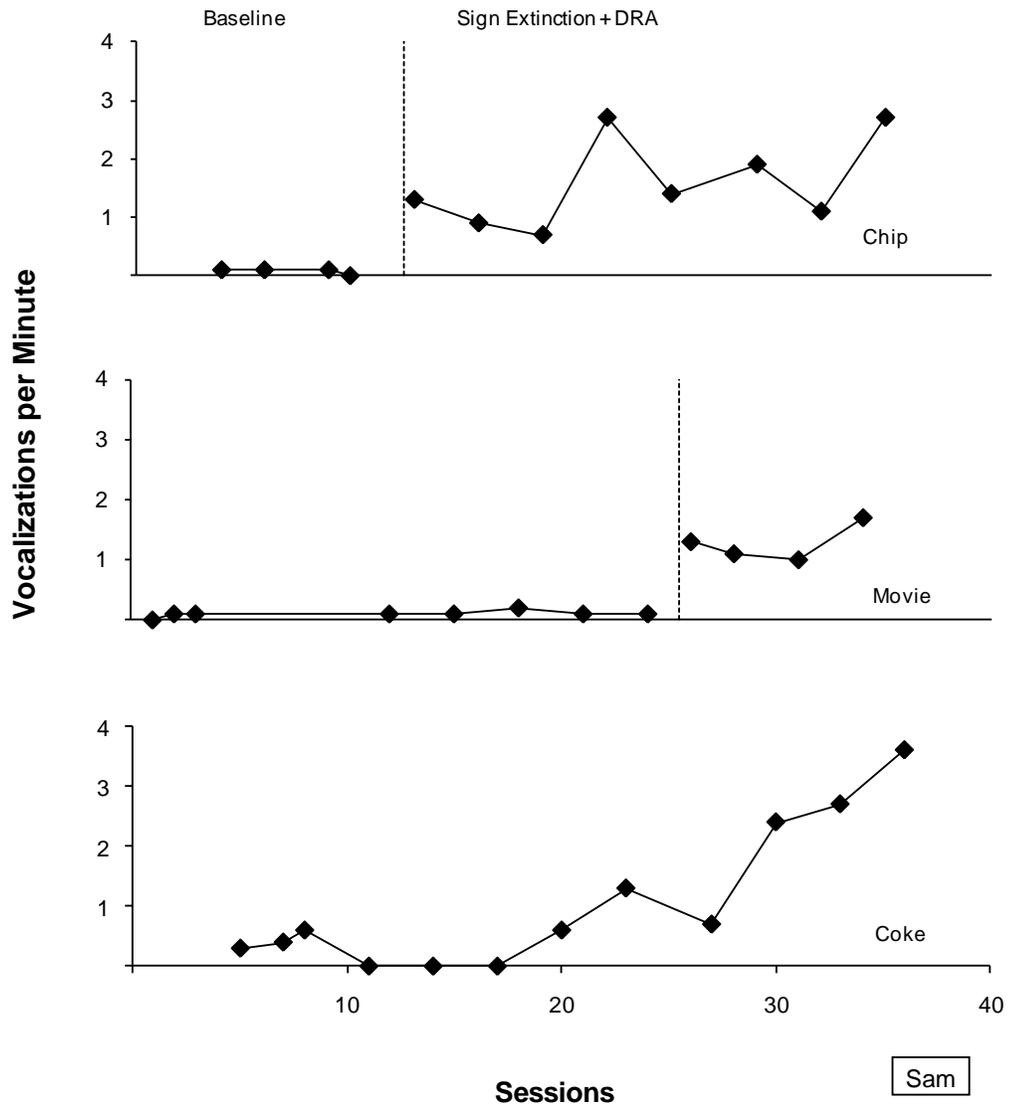
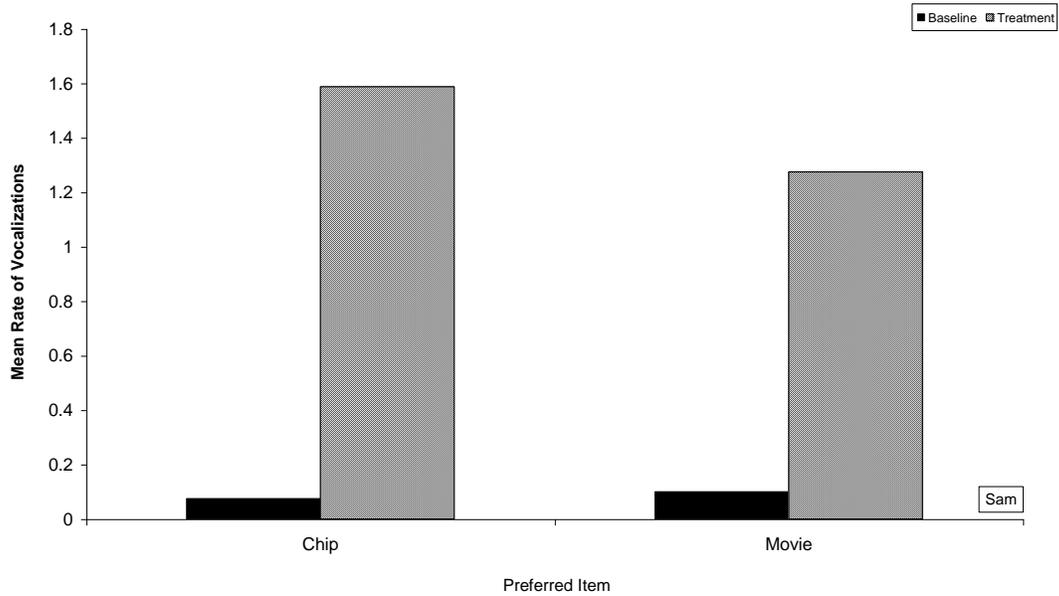
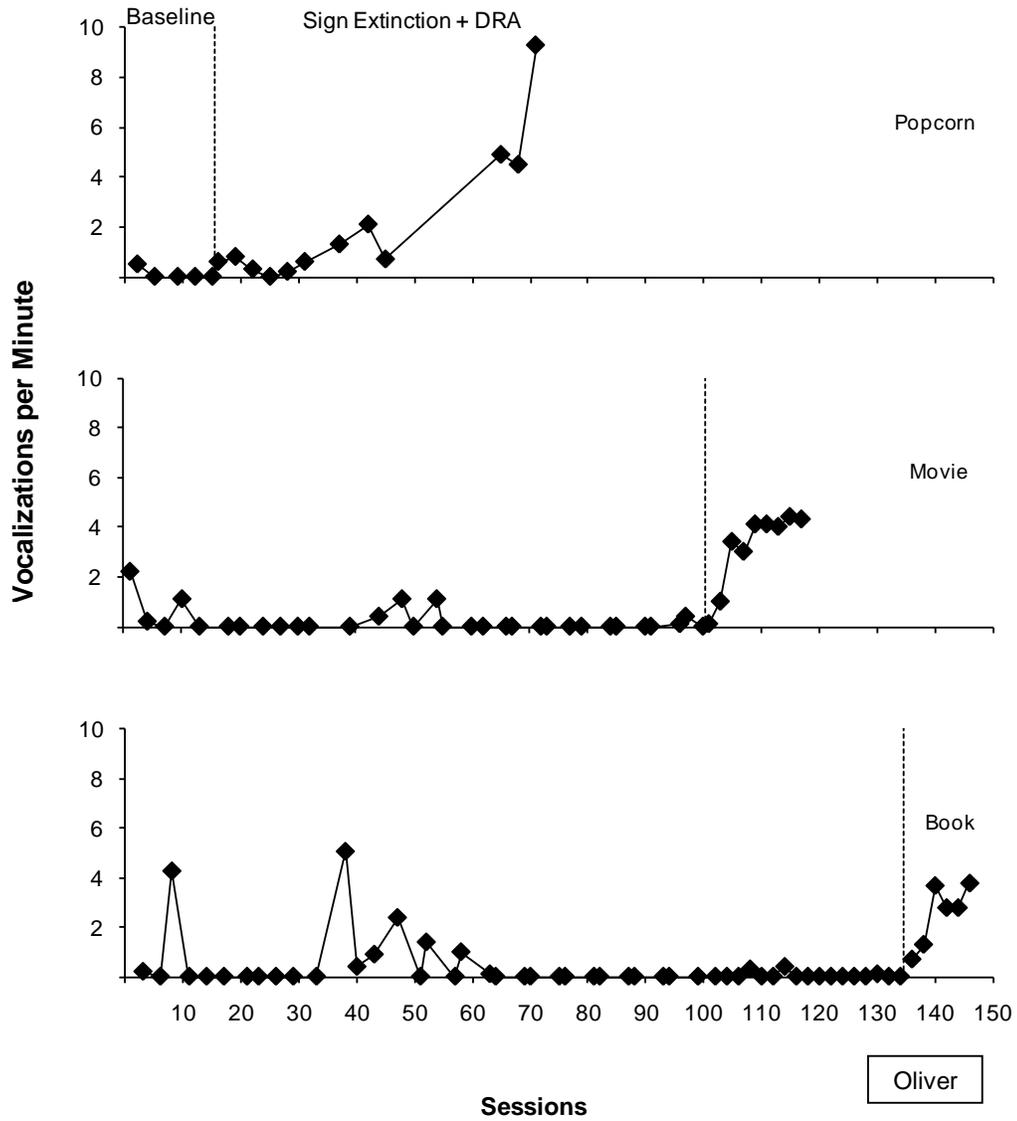
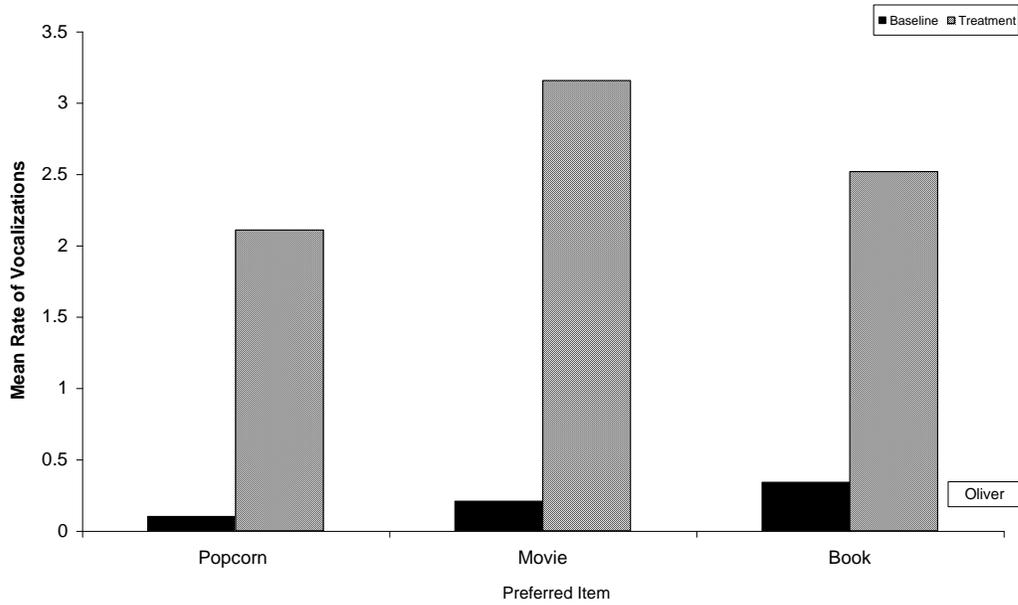


Figure 1. Sam’s baseline and treatment sessions for the targeted items “chip,” “movie,” and “coke” are depicted.



*Figure 2.* Sam's mean rate of vocalizations for the targeted items "chip" and "movie" are depicted. The dark bars represent the average rate of vocalizations per min in the baseline conditions for "chip" and "movie." The striped bars represent the average rate of vocalizations per min in the treatment conditions for "chip" and "movie."





*Figure 4.* Oliver’s mean rate of vocalizations for the targeted items “popcorn,” “movie” and “book” are depicted. The dark bars represent the average rate of vocalizations per min in the baseline conditions for each of the three targeted items. The striped bars represent the average rate of vocalizations per min in the treatment conditions for each of the three targeted items.

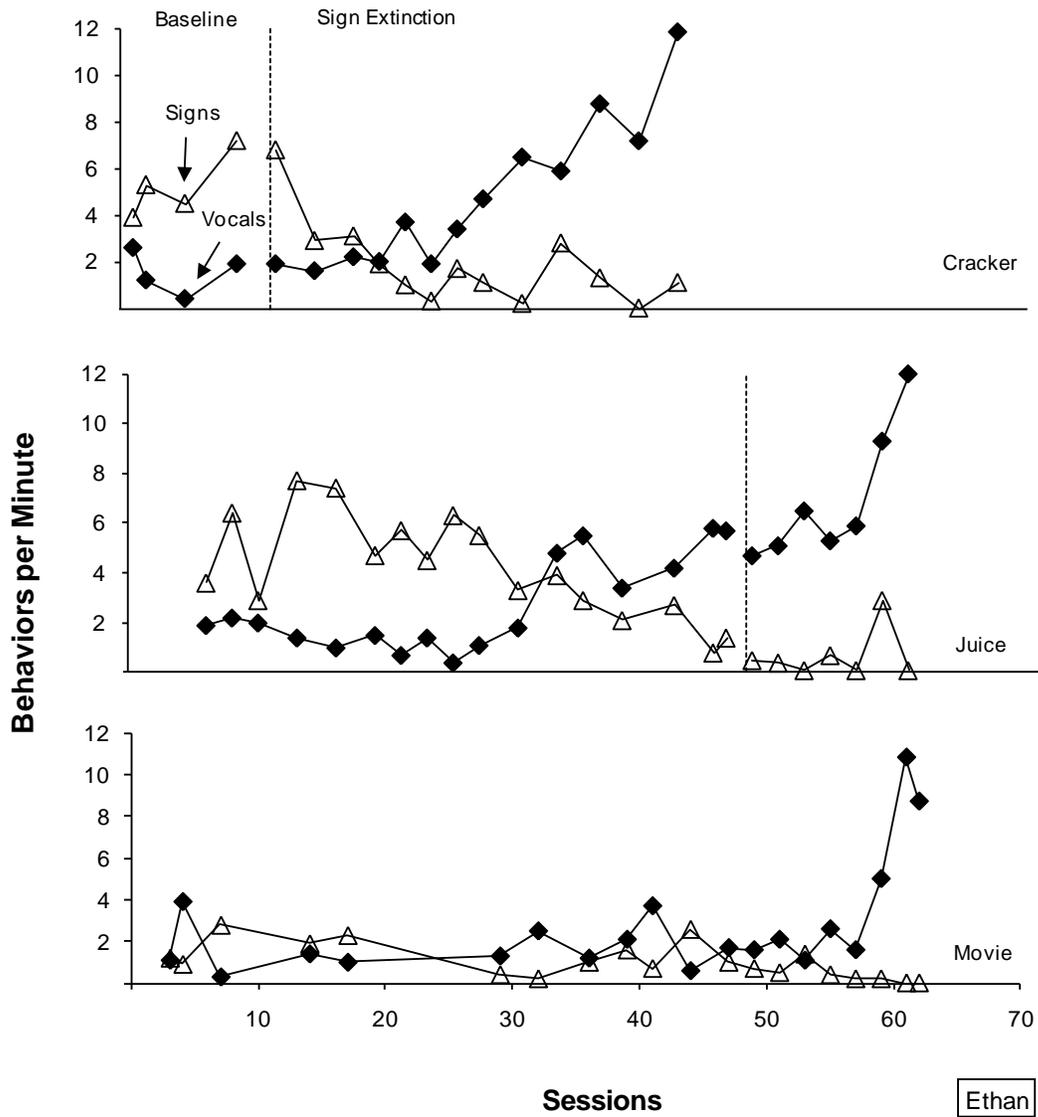


Figure 5. Ethan’s baseline and treatment sessions for the targeted items “cracker,” “juice,” and “movie” are depicted.