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Using Stimulus-Stimulus Pairing and Direct Reinforcement to Teach Vocal Verbal Behavior to Young Children With Autism

Regina A. Carroll and Kevin P. Klatt
University of Wisconsin, Eau Claire

In this study the effect of a stimulus-stimulus pairing procedure was used as part of a clinical investigation to increase vocalizations for two young children diagnosed with autism. This procedure involved pairing a vocal sound with a preferred stimulus (e.g., toy) to condition automatic reinforcement. In addition, this study assessed the effects of a direct reinforcement procedure to bring a vocalization under echoic control following the pairing procedure for 1 of the participants. The results showed the pairing procedure was used successfully to increase a vocalization for one of the participants, and the vocalization was brought under echoic control.
Key Words: autism, stimulus-stimulus pairing, automatic reinforcement

All children with autism have some level of difficulty communicating with other children and adults. The level of communication skill varies across children, however, in many cases children never learn to talk (i.e., lack vocal verbal behavior). Teaching vocal verbal behavior to young children with autism is difficult because many of the children initially do not have the ability to imitate vocal sounds (echoic control). When children with autism do not begin imitating vocal sounds, parents and teachers often begin teaching the child to communicate via sign language or picture symbols. Although these alternative forms of verbal behavior can be used to communicate effectively, it does not necessarily lead to an increase in vocalizations for children with autism. Moreover, few procedures exist for teaching a child with autism to imitate vocal sounds. A lack of a technology for teaching vocal imitation presents a challenging situation to teachers who are not able to get children to produce sounds so that they can be shaped and directly reinforced.

Although few procedures exist for teaching vocal imitation to nonvocal children, the process by which children begin producing vocal sounds has been theorized by Skinner (1957) and later by Vaughan and Michael (1982). This process could involve an infant receiving an initially neutral stimulus (parent's vocal sounds) at the same time as an already established reinforcer (e.g., food, rocking). The parent's vocal sounds may acquire reinforcing properties as a result of being paired with the reinforcing stimulus. The infant may begin to say similar vocal sounds, despite never being directly reinforced for saying the sounds, engaging in vocalizations because saying them produces reinforcing stimuli. This process might begin to explain why infants can be heard to engage in vocal sounds with no apparent reinforcement (e.g., upon waking in a crib).

Research has been conducted to investigate whether vocalizations can be conditioned through automatic reinforcement. For example, Smith, Michael, and Sundberg (1996) evaluated the vocal verbal behavior of two typically developing infants. In this study, vocal sounds were paired with a reinforcing stimulus for one participant and with neutral or aversive stimuli for another participant. The results showed an increase in the frequency of vocalizations when a reinforcing stimulus was presented, and a decrease when an aversive stimulus was presented. The frequency of the vocalization did not increase when the neutral stimulus was used; thereby demonstrating the vocalization was not under echoic control.

A number of studies have found that a stimulus-stimulus pairing procedure, in which a preferred stimulus is paired with a vocal sound, effectively increases the frequency of vocalizations in the absence of social consequences

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(Sundberg, Michael, Partington, & Sundberg, 1996; Yoon & Bennett, 2000; Miguel, Carr, & Michael, 2002). Sundberg et al. investigated the effects of an adult pairing a vocal sound with the delivery of a reinforcing stimulus on the frequency of vocalizations for young children with language delays and a typically developing child. The target sounds identified for pairing were novel vocalizations (or had not been emitted during a prepairing condition). The results of this experiment showed that all of the children spontaneously emitted new vocal responses after pairings, although not necessarily the target vocalizations. The researchers concluded that the new vocal responses occurred due to automatic reinforcement because the new vocal responses were not directly reinforced.

Yoon and Bennett (2000) conducted two experiments to further investigate the stimulus-stimulus pairing procedure. In the first experiment, the effects of pairing a reinforcing stimulus with novel and low-frequency vocalizations was investigated for preschool children with severe language and communication delays. The results showed that the pairing procedure was effective in conditioning target vocalizations as reinforcers, although the increase in the frequency of vocalizations was shown to be temporary. In the second experiment, the pairing procedure was compared to direct reinforcement of the vocalization (echoic training) using the same reinforcing stimulus. The results from this study showed the pairing procedure was more effective than echoic training to increase the frequency of vocalizations.

Similarly, Miguel et al. (2002) investigated the effects of a pairing procedure on the frequency of vocalizations for three young children with autism. The target sounds were low-frequency vocalizations emitted by participants during previous observations. The results of this experiment showed a temporary increase in vocalizations for 2 of the 3 participants. The participant for whom the pairing procedure was ineffective had a more complex vocal verbal repertoire prior to the beginning of the study. The researchers speculated that the pairing procedure might not work as well with children who have some vocal verbal abilities such as manding.

Although the results of previous studies suggest that stimulus pairing may be an effective procedure for increasing vocal verbal behavior, two recent studies have failed to replicate these effects for children with autism (Esch, Carr, & Michael, 2005; Normand & Knoll, 2006). Esch et al. attempted to increase vocal sounds, using a pairing procedure, for three participants diagnosed with autism. In Experiment 1, the researchers paired a vocal stimulus with a reinforcing stimulus and planned to immediately reinforce the vocalizations. In this experiment, however, vocal sounds did not increase through pairing, thus vocal sounds could not be directly reinforced. A second experiment involving pairing without direct reinforcement was then conducted and, again, vocal sounds did not increase.

More recently, Normand and Knoll (2006) investigated the effects of stimulus-stimulus pairing on spontaneous vocalizations for a young child diagnosed with autism. The investigators repeatedly paired preferred stimuli with two low-frequency target sounds and recorded the frequency of the target sounds immediately prior to and immediately following the pairing sessions and during a follow-up period. Results from this study showed phonemes did not increase following the pairing sessions.

The results from these experiments suggest that vocal sounds can be increased through an unidentified automatic reinforcement mechanism for some but not all participants. Although results from the previous studies indicate that stimulus-stimulus pairing may increase vocalizations for children with autism and typically developing children and infants, none of the experiments have included young children diagnosed with autism under the age of 3. One purpose of the present experiment, therefore, was to investigate the use of a stimulus-stimulus pairing procedure to increase both low-frequency and novel vocalizations for two children under age 3 diagnosed with autism. Each child had a different verbal repertoire as assessed by the Behavioral Language Assessment (BLA) (Sundberg & Partington, 1998). A second purpose of the present study was to investigate the use of the stimulus-stimulus pairing procedure as part of clinical services provided to young children diagnosed with autism, as opposed to a purely systematic evaluation of the procedure's effectiveness.

GENERAL METHOD

Participants

The participants in this study were Mary, age 22 months, and Max, age 23 months. Both children had been diagnosed with autism by a pediatrician independent of the study. The BLA (Sundberg & Partington, 1998) was used to assess participants' verbal repertoires and determine a classification profile from Level 1 (low verbal repertoire) to Level 5 (high verbal repertoire). The language repertoire of Mary was at Level 1. She occasionally emitted a few vocal sounds, but had no vocal imitative skills. She did not have a mand nor tact repertoire at the start of the study. The language repertoire of Max was at Level 3. At the start of the study Max had strong echoic and mimetic imitative skills, was able to mand for preferred stimuli and could tact simple objects, but had a limited intraverbal repertoire.

Setting and Materials

Training sessions were conducted in a 3.5 m x 3.5 m therapy room. The room contained a child sized table and chairs. The materials used throughout the session included preferred stimuli (e.g., food, toys, and videos).

Preference Assessment

Each participant was observed for 45 min in the therapy room with a variety of foods and toys available to them. The percentage of 1-min intervals that the participants were engaged with each particular item was recorded. Engagement in an item was defined as anything the participant touched, picked up, manipulated, consumed, or an occasion of looking at the television (for at least 2 s) in a 1-min interval. The five items that Max engaged in for the highest percentage of 1-min intervals were selected for a stimulus preference assessment. Mary did not engage with the toys or activities that were available to her. Repeated observations revealed the two stimuli Mary would engage with were edibles and videos. Thus, both edibles and videos were paired together and used as preferred stimuli throughout the pairing sessions.

Prior to each session for Max, a single-array multiple-stimulus preference assessment was conducted (Higbee, Carr, & Harrison, 2000). The experimenter placed the five items selected through direct observation in front of Max. The first item that Max touched or pointed to was selected as the preferred stimulus for the subsequent session. Two independent observers in an adjoining observation room recorded the preferred stimulus selected by the participant during the preference assessment.

Target Response and Measurement

In order to identify target responses, Max and Mary were observed during 1-hr behavioral therapy sessions (unrelated to the study). Max was observed for six 45-min sessions and Mary was observed for eight 45-min sessions. During these sessions, two independent observers recorded all vocalizations emitted by the participants. For both participants, the target vocalizations selected for the study included both a known and novel target sound. The known target sound was the lowest frequency one-syllable vocalization produced by participants throughout observations and the novel target sound was a sound that the participant never emitted during observations. Throughout the study, target sounds were defined as the production of any target syllable that matched or was a close approximation to the model presented. For Mary the known target sound was /ts/ and the novel target sound was /buh/. For Max, the known target sound was /m/ and the novel target sound /I/.

In Experiment 1, the frequency of target sounds emitted by the participant before and after each stimulus-stimulus pairing session was measured to evaluate the effects of a stimulus-stimulus pairing procedure on the occurrence of known and novel target sounds. In addition, for Max the effects of a direct reinforcement procedure on the frequency of target sounds were also evaluated. In Experiment 2, echoic control of the known and novel target sounds for Mary was evaluated using variations of a direct reinforcement procedure. The percentage of correct vocal responses (Procedures 1, 2, 4, and 5) and the frequency of target sounds (Procedures 1 and 3) emitted by Mary were recorded during direct reinforcement sessions.

Interobserver Agreement

To assess interobserver agreement on the occurrence of the dependent variable, two independent observers recorded data during 77% of randomly selected sessions for Mary and 100% of sessions for Max. Interobserver agreement on frequency of target sounds was calculated by dividing the number of observer agreements on response occurrence recorded in each session by agreements plus disagreements and multiplied by 100 to yield a percentage of agreement. For direct reinforcement sessions, interobserver agreement on the percentage correct of target sounds was calculated by dividing the number of observer agreements on correct target sounds in each session by agreements plus disagreements and multiplied by 100 to yield a percentage of agreement. The interobserver agreement averaged 91% for Mary (range 82% to 100%) and was 100% for Max.

Independent Variable Integrity

Two independent observers recorded the implementation of the stimulus-stimulus pairing, control, and direct reinforcement procedures in 54% of sessions for Mary and 100% of sessions for Max. Each session was scored as either correct (100% accuracy) or incorrect (less than 100%). In general the experimenter's presentation of the target sound and preferred stimulus were scored. For example, a stimulus-stimulus pairing session was scored as correct if the experimenter (a) presented 5 target sounds during a trial, (b) presented the sounds within 5 s, (c) presented the preferred stimulus after the presentation of the first 3 target sounds, and (d) did not present any other stimulus during a trial. The number of correct sessions was divided by the number of incorrect plus correct sessions and multiplied by 100 to generate a percentage of independent variable integrity (IVI). The independent variable integrity was 96% for Mary and 100% for Max.

EXPERIMENT 1: STIMULUS-STIMULUS PAIRING

The purpose of Experiment 1 was to assess the effects of stimulus-stimulus pairing on the frequency of target sounds. The frequency of the known target sound for Max did not increase following stimulus-stimulus pairing; therefore, the effect of a direct reinforcement procedure on the frequency of target sounds was also assessed for Max.

Experimental Design

A multiple-baseline design across target vocalizations was used to assess the effects of stimulus-stimulus pairing on target sounds.

Procedure

Presession and postsession observations. Pre- and postsession observations (5 min each) were conducted immediately before and after each baseline, control, stimulus-stimulus pairing, and maintenance conditions. During these observation sessions, participants were allowed to walk around the room and have access to various toys while the frequencies of the target sounds were recorded. There was minimal interaction between the experimenter and participant during these observations.

Baseline. Baseline sessions were conducted the same as pre- and postsession observations and were 5 min in duration. The baseline condition was conducted to record participants' vocal repertoires in the absence of an independent variable.

Control. During control sessions a trial consisted of the experimenter saying the target sound five consecutive times and then waiting 20 s to present a preferred stimulus to the participant. The participant was then allowed to engage with the preferred stimulus for 20 s before it was removed and a new trial began. If the participant emitted the target sound during the 20 s interval, the timer was reset and the presentation of the preferred stimulus was delayed 20 s. This correction procedure was used to control for adventitious reinforcement of target sounds. Each session consisted of 20 trials for Max. Since Mary engaged in problem behavior during the control condition, an average of 10 trials were presented throughout each control session. The control sessions for Mary were terminated if she engaged in problem behavior (e.g., crying, screaming) for three consecutive trials. For Mary, 50% of the control sessions were terminated before 20 trials were presented.

Stimulus-stimulus pairing. During stimulus-stimulus pairing sessions a trial consisted of the experimenter saying the target sound three consecutive times, then immediately presenting the preferred stimulus while simultaneously saying the target sound two more times. The participant was allowed access to the preferred stimulus for 20 s and then the next pairing trial was presented. A correction procedure was also implemented in this condition to control for adventitious reinforcement. If the participant emitted the target sound the next trial was delayed 20 s. Each session consisted of 20 stimulus-stimulus pairing trials.

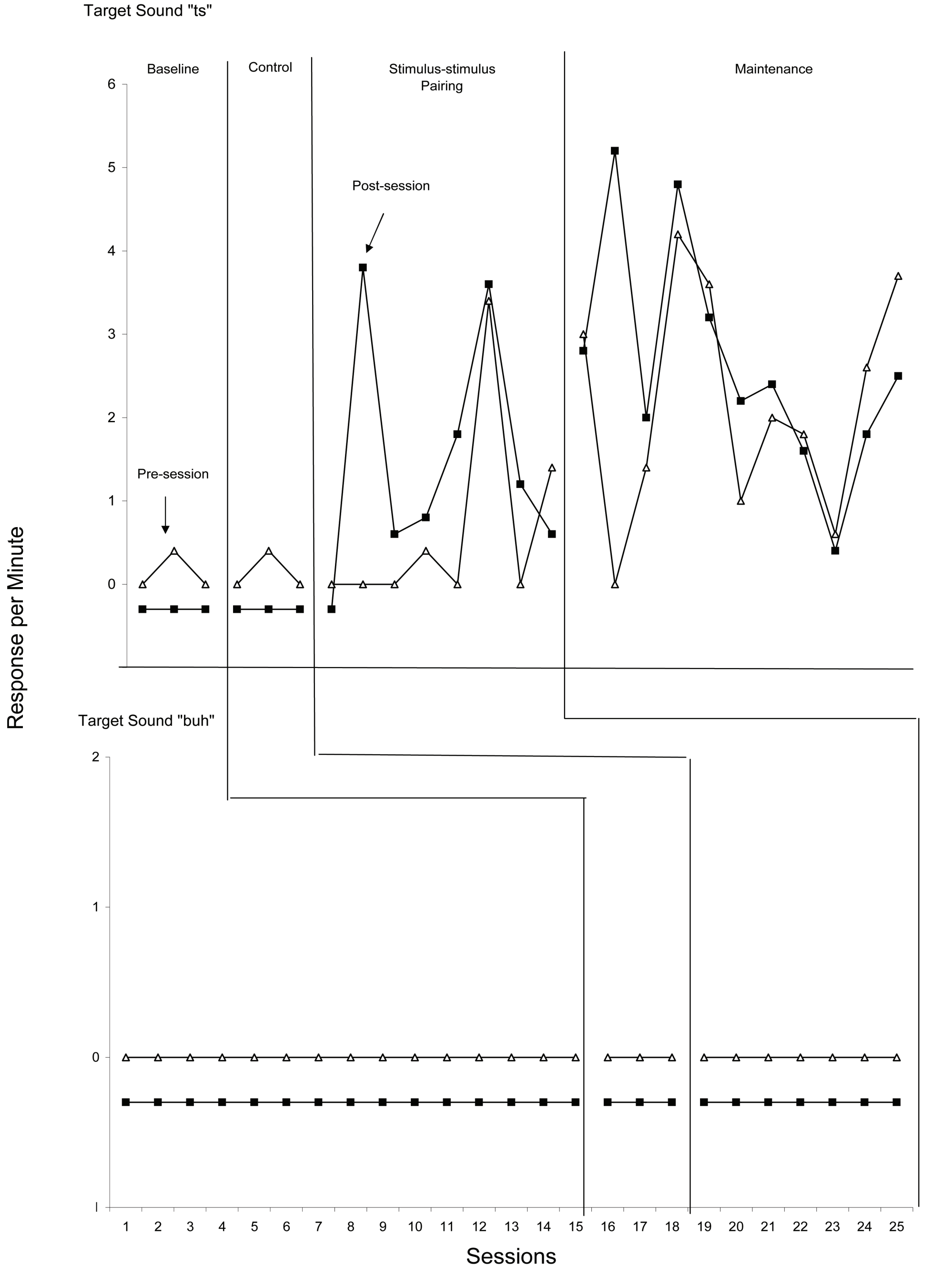

Figure 1. The response per minute of Mary's target sounds (/ts/ in upper panel and /buh/ in lower panel) during pre- and postsession observations.

Maintenance. Following the stimulus-stimulus pairing condition for Mary, maintenance sessions were conducted to record the frequency of the target sound /ts/ in the absence of the independent variable. During maintenance sessions, pre- and postsession observations, 5 min each, were conducted immediately before and after a 1-hr therapy session that was conducted independent of the study.

Direct reinforcement of echoic responses. The stimulus-stimulus pairing procedure did not result in an increase in the frequency of Max's target sound. Therefore a direct reinforcement procedure was implemented to assess its effects on the frequency of his target sound. During the direct reinforcement condition, an echoic trial began by the experimenter saying the target sound once (e.g., "say m"). If the participant emitted the target sound within 3 s a preferred stimulus was immediately delivered. The participant was given access to the preferred stimulus for 20 s. After 20 s had elapsed, the stimulus was removed and the next trial was presented. If the participant did not emit the target sound within 3 s the preferred stimulus was not delivered and the next trial was presented. A total of 20 trials were presented in each session. Response frequency of the target sound /m/ was recorded during pre- and postsession observations immediately before and after each direct reinforcement session. The percentage correct of vocal responding within each session (the 20 direct reinforcement trials) was also recorded.

Results

The frequency of Mary's target vocalizations during pre- and postsession observations is shown in Figure 1. In the baseline and control conditions the known target sound, /ts/ (upper panel), averaged 0.13 responses per minute (range, 0 to 0.4) during presession observations and did not occur during postsession observations. During the stimulus-stimulus pairing condition the target sound /ts/ averaged 0.65 responses per minute (range, 0 to 3.4) during presession observations and 1.55 responses per minute (range, 0 to 3.8) during the postsession observations. In the maintenance condition the target sound averaged 2.17 responses per minute (range, 0 to 4.2) during presession observations and 2.63 responses per minute (range, 0.4 to 5.2) during the postsession observations. The lower panel of Figure 1 shows no increase in the novel target sound /buh/ following the baseline, control, and stimulus-stimulus pairing conditions.

The frequency of Max's target vocalizations during pre- and postsession observations are shown in the top two panels of Figure 2. In the baseline and control conditions the known target sound, /m/ (upper panel), averaged 0.03 responses per minute (range, 0 to 0.2) during presession observations and did not occur during postsession observations. During the stimulus-stimulus pairing condition, the frequency of the target sound increased to 1.0 response per minute during postsession observations for one session, but then returned to zero for the subsequent sessions. The upper panel of Figure 2 also shows that there was no increase in the frequency of the known target sound /m/ following the direct reinforcement condition; therefore, the frequency of the novel target sound /I/ was not assessed following the baseline sessions.

The percentage of correct vocal responses for the target sound /m/ in the direct reinforcement condition for Max is shown in the bottom panel of Figure 2 (these data correspond directly to the four data points in the direct reinforcement condition in the first panel). In this condition, the average percentage of correct responses was 90% (range, 75% to 100%). These data show that although Max was responding accurately in the direct reinforcement condition (Panel 3), there was no increase in the frequency of the sound during pre- or postsession observations (Panel 1).

EXPERIMENT 2: ECHOIC CONTROL

The stimulus-stimulus pairing procedure resulted in an increase in the known target sound /ts/ for Mary in Experiment 1. The next question, then, was whether the target sound could be brought under echoic control. The purpose of Experiment 2 was to assess whether the known target sound previously increased with stimulus-stimulus pairing could be brought under echoic control through direct reinforcement.

Participant

Mary participated in Experiment 2. Max did not participate in Experiment 2 because an increase in the frequency of the known target sound was not obtained after the stimulus pairing procedure and the target sound was already demonstrated to be under echoic control.

Experimental Design

A comparison design was used to investigate the effects of several variations of a direct reinforcement procedure on echoic control of the target sounds.

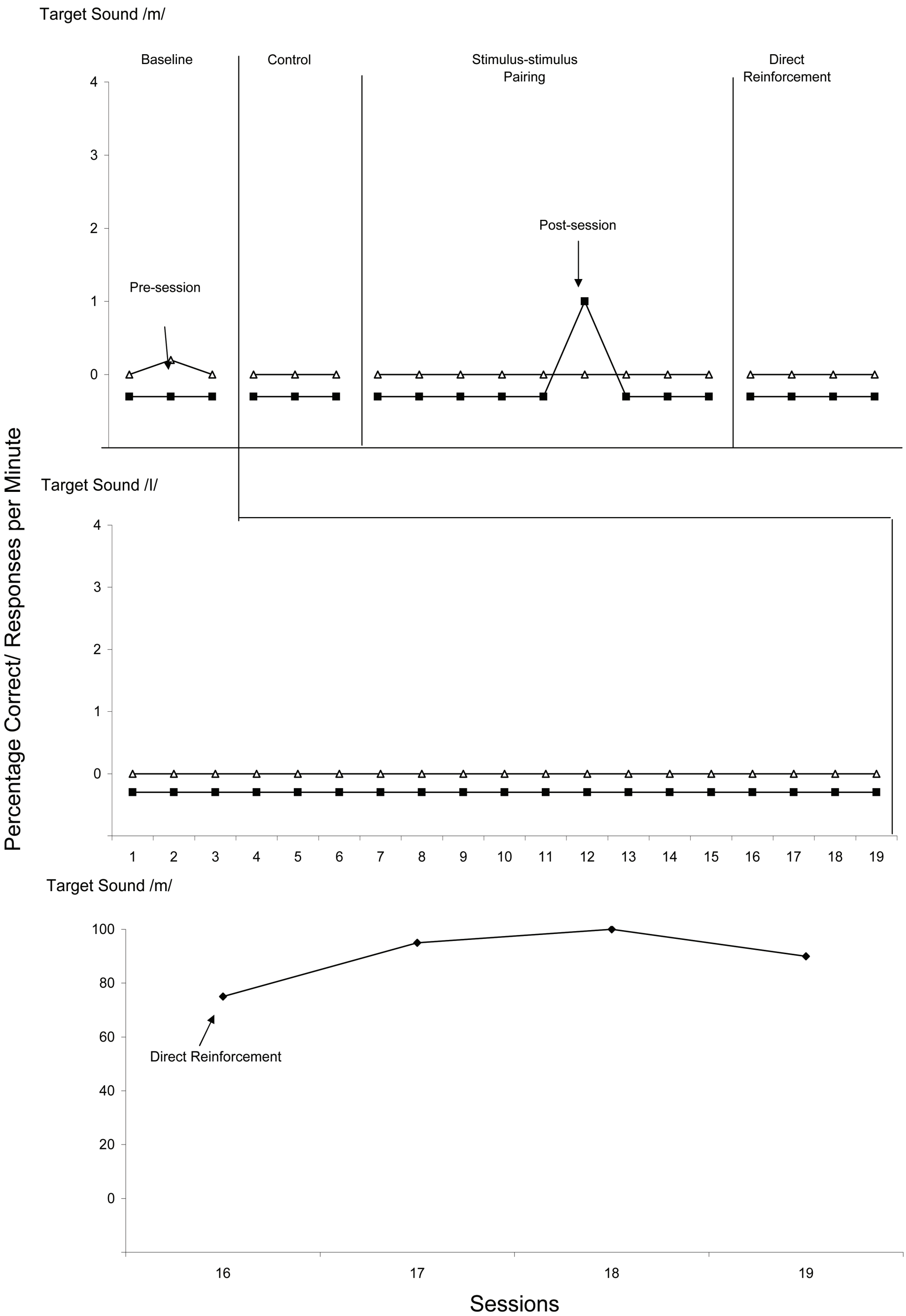

Figure 2. The response per minute of Max's target sound during pre- and post-session observations (panels 1 & 2) and percentage correct of direct reinforcement trials (panel 3).

Procedure

Baseline: Direct reinforcement probes. The purpose of the baseline condition was to assess Mary's ability to imitate the experimenter's presentation of the target sound prior to the implementation of direct reinforcement procedures. Each baseline session consisted of 20 probe trials. Each trial consisted of the experimenter presenting the target sound once (e.g., "say ts"). If Mary approximated or matched the target syllable within 5 s (i.e., emitted the sound /t/ or /s/ separate or in combination), the probe was recorded as correct and the next probe was presented. If Mary did not emit the target sound within 5 s, the probe was recorded as incorrect.

Following the intervention for the known target sound, the baseline procedures were slightly revised for the novel sound. The procedure was revised to provide Mary with a longer interval of time in which to respond to an echoic trial. For /buh/, the experimenter presented the target sound every minute in a 5-min block during the baseline condition. A total of five trials were presented throughout the baseline session. If Mary approximated or matched the target sound within 15 s the probe was recorded as correct and the next probe was presented. If Mary did not emit the target sound within 15 s the probe was recorded as incorrect. No preferred stimulus was delivered for correct or incorrect responses during the baseline condition.

Direct reinforcement procedures. Five variations of a direct reinforcement procedure were implemented in Experiment 2 (the direct reinforcement procedures were altered by changing the antecedent stimulus when a change in behavior was not observed). In general, a direct reinforcement trial began with the experimenter saying the target sound once (e.g., "say ts"). If Mary emitted the target sound within 5 s (Procedures 1 and 2) or 15 s (Procedures 4 and 5) a preferred stimulus was immediately delivered. Mary was given access to the preferred stimulus for 20 s. After 20 s had elapsed the item was removed and the next trial was presented. If Mary did not emit the target sound within 5 s (or 15 s) of the experimenter's presentation of the sound the preferred stimulus was not delivered and the next trial was presented.

Procedure 1: Stimulus-stimulus pairing and direct reinforcement. In this condition the 5-min pre- and postsession observations and stimulus-stimulus pairing trials were conducted the same as in Experiment 1. The procedure consisted of presenting five stimulus-stimulus pairing trials followed by 20 direct reinforcement trials. The percentage correct of vocal responding during the 20 direct reinforcement trials and the frequency of target sound during pre- and postsession observations was recorded.

Procedure 2: Direct reinforcement without pairing. In this condition 20 direct reinforcement trials were presented without stimulus-stimulus pairing. The percentage correct of vocal responding during the direct reinforcement trials was recorded.

Procedure 3: Direct reinforcement contingent on the target sound. This condition included a 5-min pre- and postsession observation and a 30-min (on average) direct reinforcement session in which all target sounds emitted by Mary were directly reinforced with edibles. If the target sound was emitted by Mary at any time throughout the session, the experimenter immediately delivered the preferred stimulus while simultaneously presenting the target sound once. The frequency of the target sound during pre- and postsession observations and during the direct reinforcement sessions was recorded.

Procedure 4: Direct reinforcement of any vocalization. In this condition the experimenter presented 15 direct reinforcement trials. A trial was presented every minute, in three 5-min blocks distributed throughout an hour long therapy session (e.g., a block was presented in the beginning, middle and end of the therapy session). If Mary emitted any vocalization within 15 s of the experimenter's presentation of the target sound (e.g., "say ts") she immediately gained access to a preferred stimulus.

After the fourth session of this condition, a 5-s delay to reinforcement for nontarget vocalizations was added. If Mary emitted the target sound at any time she gained immediate access to the preferred stimulus. If Mary emitted a nontarget vocalization, however, the response was not reinforced for 5 s. Thus, Mary was provided immediate access to a preferred stimulus for emitting the target sound and delayed access to the preferred stimulus for saying any other vocal sound following the experimenter's presentation of the sound. In this condition the percentage correct of vocal responding during the 15 direct reinforcement trials was recorded.

Procedure 5: Direct reinforcement of the target sound. In this condition Mary could gain access to the preferred stimulus only if she emitted the target sound following the experimenter's presentation of the sound. A total of 20 direct reinforcement trials were presented in a session and the percentage correct of vocal responding during the 20 direct reinforcement trials was recorded.

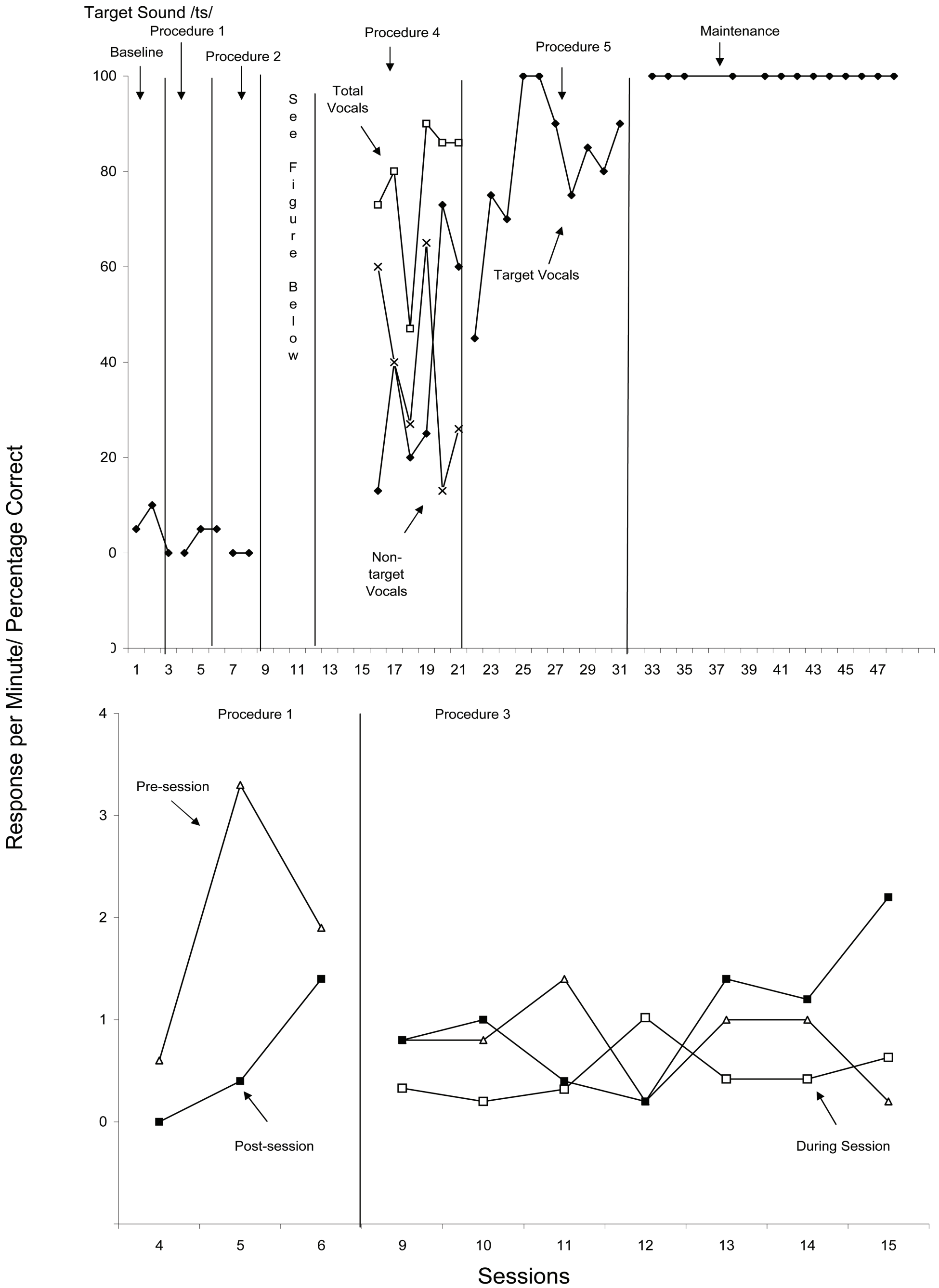

Figure 3. The percentage correct of direct reinforcement trials for the target sound /ts/ during baseline, direct reinforcement procedure 1, 2, 4, and 5, and maintenance conditions (upper panel) for Mary. The response per minute of the target sound /ts/ during direct reinforcement Procedure 1 and Procedure 3 (lower panel) for Mary.

Results

The upper panel of Figure 3 shows the percentage correct of vocal responses for the target sound /ts/ during baseline, direct reinforcement Procedure 1, Procedure 2, Procedure 4, Procedure 5, and maintenance sessions. During the baseline condition and direct rein-

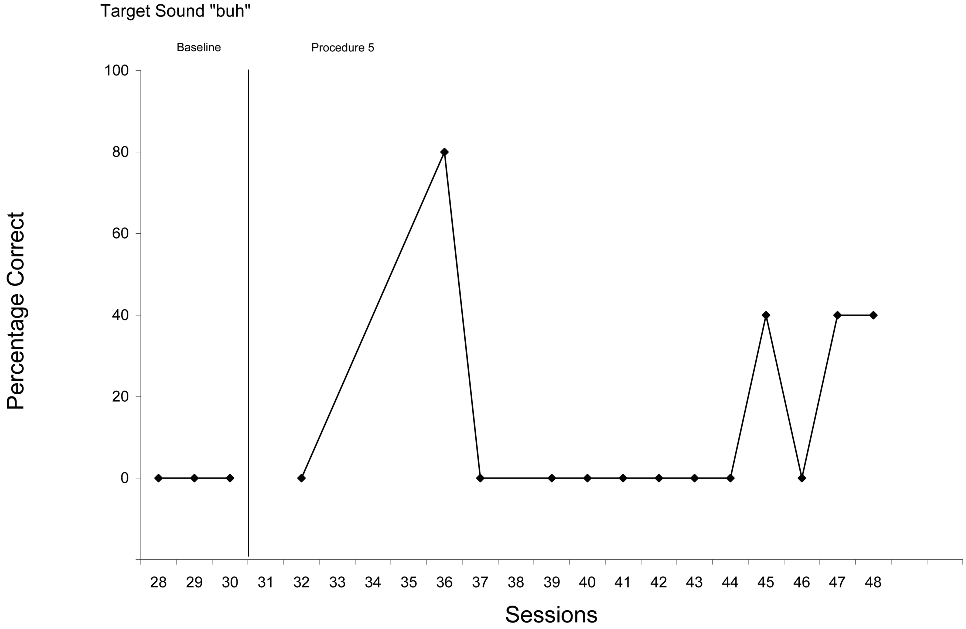

Figure 4. The percentage correct of direct reinforcement trials for the target sound /ts/ during direct reinforcement Procedure 5 for Mary.

forcement Procedures 1 and 2, the average percentage of correct target responses was 3.13% (range 0% to 10%). During Procedure 4 Mary emitted target and nontarget vocal responses for an average of 77% (range 47% to 90%) of trials. In this condition the average percentage of target vocal responses was 38.5% (range 13% to 73%) and the average percentage of nontarget vocal responses was 38.5% (range 13% to 65%). After the implementation of Procedure 5, the average percentage of correct target responses increased to an average of 81% (range 45% to 100%). The upper panel of Figure 3 also shows the percentage of trials with correct target responses for the 10 weeks that maintenance sessions were conducted. During maintenance sessions, responding remained at 100% correct across all trials.

The bottom panel of Figure 3 shows the frequency of the target sound /ts/ during direct reinforcement Procedures 1 and 3. During Procedure 1, the target sound averaged 1.93 responses per minute (range 0.6 to 3.3) during presession observations and averaged 0.6 responses per minute (range 0 to 1.4) during postsession observations. During Procedure 3, the target sound averaged 0.77 responses per minute (range 0.2 to 1.4) during presession observations, 0.48 responses per minute (range 0.2 to 1.02) during the direct reinforcement session, and 1.03 responses per minute (range 0.2 to 2.2) during postsession observations.

Figure 4 shows the percentage of correct vocal responses for the novel target sound /buh/ during baseline and direct reinforcement Procedure 5. During baseline, the target response did not occur and during Procedure 5 the average percentage of correct target responses was 15.4% (range 0% to 80%).

GENERAL DISCUSSION

The purpose of these two experiments was to investigate whether a low-frequency and novel vocalization could be increased using a stimulus-stimulus pairing procedure, and then brought under echoic control for 2 young children diagnosed with autism. The results of Experiment 1 show the stimulus-stimulus pairing procedure produced an immediate increase in the frequency of the known target sound / ts/ for Mary. These results are consistent with previous studies in which the use of a stimulus-stimulus pairing procedure was followed by an increase in unprompted target vocalizations (Sundberg et al., 1996; Miguel et al., 2002; Yoon & Bennett, 2000).

Conversely, the frequency of Mary's target vocalizations in Experiment 1 maintained in both the pre- and postsession observations well after the pairing procedure was removed. This result differs from previous research in which the frequencies of target vocalizations returned to baseline levels once stimulus-stimulus pairing was removed (Miguel et al., 2002). Determining why Mary's vocalization maintained, however, is difficult considering the maintaining reinforcer was not identified. Her target vocalization may have maintained because saying the sound now produced nonsocially mediated reinforcement. Another explanation is that Mary engaged in the vocalization because it was inadvertently reinforced on an intermittent schedule of reinforcement by family members or therapists.

The stimulus-stimulus pairing procedure was ineffective in increasing the frequency of the novel sound /buh/ for Mary. Although the novel sound did occur within a few sessions when a direct reinforcement procedure was used, it remained inconsistent across sessions. Miguel et al. (2002) suggested the need for further investigation of the differential effects of stimulus-stimulus pairing with already existing vocalizations compared to novel vocalizations. The results from these experiments suggest it may be easier to increase existing rather than novel vocalizations.

The stimulus-stimulus pairing procedure did not produce an increase in the frequency of Max's target sound /m/ in Experiment 1. This failure to increase a low-frequency vocalization is similar to the results obtained by Miguel et al. (2002) in which a pairing procedure was ineffective in increasing target vocalizations for one of the participants. Given that the stimulus pairing procedure did not increase the low-frequency target sound for Max, no attempt was made to use the pairing procedure on the novel sound.

The results from these two experiments verify what has been reported in previous experiments, namely that the stimulus-stimulus pairing procedure can be used effectively to increase vocalizations for some but not all children with autism. Miguel et al. (2002) speculated the pairing procedure might work differently depending on the pre-existing verbal repertoire of the child. For example, in their study, the stimulus-stimulus pairing procedure increased the frequency of target vocalizations for participants with no existing vocal imitation repertoire; however, it did not increase the frequency of target vocalizations for the participant that had a vocal imitation repertoire at the start of the study. This finding is consistent with the results of the study conducted by Normand and Knoll (2006) in which a pairing procedure did not increase vocalizations for a participant that was assessed at a Level 4 on the BLA (Sundberg & Partington, 1998) prior to implementing stimulus pairing. The results from the current study also found the pairing procedure worked for the child with the most limited vocal imitation repertoire. To illustrate, prior to the study Max demonstrated vocal imitation skills and was assessed at Level 3 on the BLA, whereas Mary had no verbal imitation skills and assessed at Level 1 on the BLA. Further research needs to be conducted to conclude that the pairing procedure works better for children with very limited repertoires.

In addition to an increase in the low-frequency target vocalization for Mary, the results of Experiment 2 showed the target sound /ts/ also came under echoic control. Anecdotally, once the target sound was brought under echoic control, 12 other vocalizations were then also brought under echoic control, although this was not a formal part of either study nor experimentally controlled. Nonetheless, this result suggests that future research should continue to investigate whether generalization of vocalizations can be obtained once a target vocalization has been brought under echoic control.

The results from these two experiments should be interpreted with caution due to several limitations. First, the preferred stimuli used for Max in Experiment 1 were determined from a multiple-array stimulus preference assessment. The stimuli were not established reinforcers because a stimulus-response relationship was never directly assessed. The preferred stimuli used for Mary were determined through direct observation, so whether those stimuli functioned as reinforcers is unknown. It should be noted, however, that for Mary the stimuli used during pairing had been used to increase other behaviors unrelated to this study as part of her overall therapy.

Another limitation to this study was the lack of experimental control with the multiple baseline design in Experiment 1 and the use of a comparison design in Experiment 2 to investigate variations of a direct reinforcement procedure to establish echoic control over Mary's target sound. A comparison design was used because the study was conducted in a clinical setting and family members preferred trying various direct reinforcement procedures to quickly identify what would bring the target sound under echoic control. To bring the target sound under echoic control, several variations were implemented until the vocalization increased. There are, however, several drawbacks to a comparison design including the lack of experimental control necessary to conclude that the direct reinforcement procedure was responsible for the behavior change (Bailey & Burch, 2002). In Experiment 2, Mary's correct responses to direct reinforcement trials increased during direct reinforcement Procedures 4 and 5. The results suggest these procedures could be beneficial in establishing echoic control; however, further investigation is needed to identify which direct reinforcement procedures are most effective in establishing echoic control over vocalizations.

A third limitation of this study, or more accurately identified as a potential limitation of the stimulus-stimulus pairing procedure, is the potential for setting the occasion for problem behavior. In this study, for example, the control condition involved the experimenter saying the target sound several times and then waiting 20 s before presenting a preferred stimulus. Furthermore, in the pairing procedure condition the experimenter repeatedly removed a preferred stimulus at the end of each trial. In this case a preferred stimulus is either delayed or removed, which could produce problem behaviors that have a history of being reinforced by access to tangible items. Future research should be conducted to verify this relation.

These experiments extend the current understanding of the role of automatic reinforcement in the development of vocal verbal behavior. The results of this study provided preliminary support for the use of a stimulus-stimulus pairing procedure to increase an existing, but low-occurring vocalization for a child as young as 2 years. Furthermore, and perhaps more importantly, the results were obtained for the participant who initially began with the most limited verbal skills. The implications from these findings is potentially great as teachers and parents most likely teach alternative forms of communication to children with the most limited verbal skills. The pairing procedure could conceivably be used in addition to alternative forms of communication to increase a vocalization that could then be brought under echoic control.

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