THE EFFECTS OF A DELAY OF NONCONTINGENT REINFORCEMENT DURING A PAIRING PROCEDURE IN THE DEVELOPMENT OF STIMULUS CONTROL OF AUTOMATICALLY-REINFORCED VOCALIZATIONS

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Children with autism and related disabilities frequently fail to develop echoic repertoires. Among the ways in which treatment approaches vary is the extent to which automatic reinforcement is utilized. The present experiment was designed to test the efficacy of a procedure that incorporates automatic reinforcement and socially mediated reinforcement in the development of an echoic repertoire. The implementation of this treatment package resulted in an increase in the vocal play and echoic behavior for 2 participants, each of whom had very limited verbal repertoires. The study was conducted as a multiple probe across sounds design. Vocal play for Participant 1 increased from baseline rates as low as .2 per minute to 4.5 per minute during treatment, and her percent correct echoic behavior increased from 0% to at least 90% on both sounds. Participant 2 showed rapid gains in echoic control on 1 sound before requiring dismissal from the study. Interobserver agreement on the occurrence of target vocals equaled 100%. The results of this study have implications for which procedures to use in the establishment of echoic, echoic mand, and mand repertoires.

Keywords: echoic, mand, automatic reinforcement

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Introduction

Several studies (e.g., Smith, Michael, & Sundberg, 1996; Sundberg, Michael, Partington, and Sundberg, 1996; Yoon, 1998; Yoon & Bennett, 2000) have demonstrated that vocal behavior can be strengthened by the effects of automatic reinforcement. These researchers paired specific vocalizations with reinforcers, and observed increases in the rates of those vocalizations after pairing sessions. Emphasis was placed on withholding direct reinforcement of vocal behavior, so that the increases in rate could be attributed only to the effects of automatic reinforcement. Miguel (2001) added a condition in which experimenters vocalized and did not deliver reinforcers for 15 seconds, contingent only upon the participant not echoing the auditory stimulus, to further isolate the automatic reinforcement variable.

In contrast to the component isolation targeted in much research, typical childhood experiences involve a co-mingling of contingencies of automatic reinforcement and socially mediated reinforcement. As vocal play begins to approximate sounds familiar to caretakers (e.g., baba, mama, etc.), caretakers tend to repeat what the child said and provide powerful reinforcers (e.g., tickles, coddling, etc.) if the child echoes. The rate and variety of the child’s vocal behavior increases as a result of both automatic and direct reinforcement, strengthening the vocal musculature and further increasing opportunities for direct reinforcement.

Given this analysis, why do many children with autism not develop significant vocal behavior? The answer may lie in the functions of typical childhood experiences. According to the “behavior interference theory” of autism (Bijou & Ghezzi, 1999), stimuli that serve as reinforcers for most children may not function as reinforcers for autistic children, and may even function as punishers. For example, most typical children like to be picked up. Some children with autism are averse to physical contact (Lord, 1993; Ornitz & Ritvo, 1986), so vocal stimuli paired with being picked up may become conditioned aversives rather than conditioned reinforcers. Child vocal behavior may be automatically punishing and remain low.

It is not surprising, then, that echoic behavior sometimes fails to develop. Echoic behavior is recognized as critical to the development of verbal behavior, and is targeted in most treatment programs. Yet, even within the field of behavior analysis, treatment approaches vary widely. Among the ways these approaches will be analyzed will be the degree to which each takes advantage of automatic reinforcement.

Echoic Training. In standard echoic training, an instructor presents a vocal stimulus and reinforces student imitation. While echoic training is sometimes successful, it sometimes impedes vocal behavior (Koegel, O'Dell, & Koegel, 1987).

Standard echoic training ignores the contribution that can be made by automatic reinforcement. Target sound selection is sometimes based on baseline measures of vocal play and sometimes on a pre-established curriculum (Drash, High, & Tudor, 1999). Reinforcement is contingent upon vocal imitation, with a decrease in the automatic reinforcement value of that vocal form if the child is not successful.

Standard echoic training does not closely resemble typical child development. As parents of typical children begin to target echoics, they generally reinforce after a few attempts non-contingently, and with greater enthusiasm if the child echoes. Further, parent vocals are already conditioned reinforcers (Bijou & Baer, 1965), so the procedure is not aversive and takes advantage of automatic reinforcement.

Prompting is rarely an option and student failure frequently leads teachers to increase opportunities to echo (i.e., increase failure). Stimuli associated with the training session can become reflexive CEO's (Sundberg, 1993), and any echoic responses may be maintained by escape from the session.

Motor imitation training. Training gross, fine and oral motor imitation can facilitate the development of an echoic repertoire (Ross, 1998), presumably as a generalized duplic repertoire. Gross motor imitation can be prompted and shaped, so extensive student failure is not likely. Once the student is able to imitate oral motor behavior, echoic behavior can be more-easily taught. Thus, while this method does not increase the automatic reinforcement value of vocal behavior, it also does not weaken the value.

Mand training. In vocal mand training, target sounds and reinforcers are selected based partly upon the student's frequent establishing operations (Hall & Sundberg, 1987; Michael, 1993; Sundberg, 1993) and partly upon sounds heard in vocal play. This procedure requires the presence of, and establishes the value of, other people.

Prompts remain a virtual impossibility. Drash, High, & Tudor (1999) overcame this problem with an innovative shaping procedure. Mands (e.g., whining) were reinforced specific to the establishing operation. These mands were shaped into appropriate mands, then brought under the stimulus control of a vocal antecedent.

Vocal mand training can err in several ways: target mand selection (Sundberg & Partington, 1998) capturing/contriving EO's, concurrently available reinforcers (Thompson, 2001), number of daily opportunities, response forms chosen and responses accepted during shaping, among others. Unsuccessful mand training can result in dilemmas similar to those encountered in unsuccessful echoic training.

Sign language can be chosen as a mand form, allowing teachers to prompt correct responses, thereby increasing student success. An instructor will prompt (physically, if necessary) the correct sign while vocally tacting the reinforcer, then will deliver the reinforcer while tacting it once more. Also, sign language constitutes a topography based response form and, as each vocal auditory stimulus is paired with each specific sign topography, emission of the sign can exert partial control over emission of the corresponding vocal topography. (The reader interested in a demonstration of this effect should nod their head and say “no” at the same time.)

A limiting factor in training sign language is that listeners must be trained (Sundberg & Partington, 1998). If listeners are not trained, the student will not learn to mand with the correct signs, or will at least fail to generalize those signs across people.

Mands can also be trained with selection-based responses. Among the topographies used are pointing, touching, or in some other way identifying a stimulus from an array of stimuli (McDonald & Schultz, 1973) and selecting pictures to deliver to a teacher, as in the Picture Exchange Communication System (Bondy & Frost, 1993). These procedures can help keep a student successful who is both unable to echo vocalizations and lacks sufficient motor coordination to produce differentiated sign topographies. Another advantage of these systems is that the listener requires no special training (Sundberg & Partington, 1998). However, when compared with topography based mand forms, acquisition tends to be slower (e.g., Sundberg & Sundberg, 1990; Wraikat, et al., 1991). Further, communication is dependent upon the presence of both a listener and the communication board. Finally, while the sound is paired during the picture exchange and reinforcer delivery, that sound is not paired with a specific motor topography, so proprioceptive feedback cannot exert control over the correct vocalization.

Pairing procedures. Pairing procedures (Smith, Michael, & Sundberg, 1996; Sundberg, Michael, Partington, & Sundberg, 1996; Yoon, 1998; Yoon & Bennett, 2000) frequently increase vocal play and sometimes lead incidentally to echoic or mand repertoires (e.g., Sundberg, Michael, Partington, & Sundberg, 1996). Spontaneous mand repertoires can sometimes be used to develop a generalized echoic repertoire by differentially reinforcing echoic/mands vs. spontaneous mands[1].

Yoon & Bennett (2000) compared echoic training and pairing procedures, and found that the pairing procedure was superior in inducing novel vocalizations. They did not investigate procedures for bringing these vocalizations under echoic control.

Pairing procedures can be seen as developing a response form independent of the ultimately targeted stimulus control. When a response form has been sufficiently increased in strength (i.e., response-locus), the maintaining context can then be targeted (i.e., stimulus-locus) (Engelmann & Carnine, 1982). Thus, the present study focuses on the development of stimulus control over automatically-reinforced vocal behavior.

Pairing and transfer protocol. The protocol written for this study was designed for use with very early learners (i.e., five or fewer phonemes in vocal play, a rate of less than two

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[1] This innovative procedure was demonstrated by Vince Carbone, Ed.D.

vocalizations per minute, or five or fewer forms under echoic control). Included in the analysis is the premise that unsuccessful echoic or mand trials constitute unpairings (Michael, 1993), and decrease the automatic reinforcement value of vocal behavior. Another assumption is that children fitting this learner profile may be unable to echo sounds that they emit during vocal play, even under optimally-motivating conditions.

This protocol is a multi-component package, including the pairing of a sound with a reinforcer (or a variety of reinforcers), direct reinforcement of vocal play and reinforcement of incidental echoic responses. Initially, pairings are almost simultaneous, in that the teacher vocalizes less than a half-second before reinforcer delivery. This temporal proximity of sound and reinforcer increases the likelihood that the sound will be conditioned as a reinforcer, and decreases the opportunity for incorrect mands or inappropriate behavior to occur prior to reinforcement.

As vocal play increases, a delay is introduced between teacher vocalization and reinforcer delivery. This delay allows an opportunity for echoics to be differentially reinforced by increasing the speed and magnitude of reinforcer delivery.

Following development of the first echoic (i.e., 90% correct) other sounds are probed as echoics. If the echoic repertoire is not yet generalized, a second sound is run through the protocol while the first sound is maintained as an echoic or a mand.

There are potential advantages to this protocol. First, because the protocol sometimes calls for the pairing of one sound with a variety of reinforcers, the sound can be paired with any stimulus for which an EO is in effect, allowing for more pairings in a shorter period of time than other protocols. Second, because of the progressive nature of the transfer procedure, opportunities for echoic/mands are available while unpairings of the target sound and reinforcers are minimized.

There are potential disadvantages to the protocol. If teachers enter the transfer phase before the target vocal is at sufficient strength (what constitutes sufficient strength remains an empirical question), the student will be more likely to emit an alternative response form (e.g., reaching, waiting, etc.). Also, if teachers pair one sound with a variety of reinforcers, it may later be more difficult to develop specific mand forms.

This study tested the efficacy of a relatively scripted teaching protocol for the gradual transfer of vocal play to echoic behavior. It extends previous research in the area by bridging from the conditioning of vocal stimuli as reinforcers, with subsequent increases in the rate of vocal play (e.g., Smith, Michael, & Sundberg, 1996) to the establishment of an echoic/mand repertoire (Drash, High, & Tudor, 1999).

Method

Participants. Participant 1 began the study at the age of 3 years, 4 months. She had no echoic repertoire and low vocal play (i.e., approximately one vocalization per minute). She was able to sign for “eat”, “movie”, and “open”, and could not tact or make receptive discriminations. She was able to imitate a few gross motor movements. Reinforcers were limited to swinging and the consequences of the mands listed above, with “open” sometimes resulting in access to a variety of simple toys. Social stimuli did not function as reinforcers, as she chose to spend most of her time alone.

Participant 2 was 3 years, 5 months old and had acquired two signs as mands, but did not vocalize with her signs. Vocal play and variety were high, with 16 different sounds emitted at an average rate of 2.2 per minute. She did not reliably echo any sounds (1 out of 32 during baseline). A variety of stimuli functioned as reinforcers, including edibles, music, movies, swinging, physical play (e.g., being picked up, etc.), bubbles, and balls.

Settings and Materials. Participant 1 worked at a clinic containing a small tv, preferred foods and drinks, and self-stimulatory objects stored in transparent bins, as well as a playground with swings and a jungle gym. Treatment was also delivered at a lower intensity at home by her parents, for the majority of this Participant's waking hours.

Participant 2 received an average of 20 minutes per week of treatment at a private school with a 2:1 student-to-staff ratio. Materials for both participants included those necessary for reinforcer delivery, a clipboard, paper, pen, and a timer.

Response definition and reinforcer system. During observations of vocal play, observers set a timer for 10 minutes and sat within 5 feet of the participant. Observers recorded occurrences if separated by other occurrences by at least 1 second. For example, if the student said "bababababa", paused for a second, then said it again, this would be scored as two occurrences of the phoneme "ba".

Vocal play was tallied prior to pairing and during/post-pairing for durations of 10 minutes. Free operant vocalizations were defined as any occurrence of the target vocalization not occurring after the teacher vocalization. During sessions, vocal play was scored if it occurred during reinforcement and prior to the next teacher level. Echoic probes were conducted for target phonemes throughout the study.

Procedure. Target sounds were selected based upon baseline rates. Whereas this study was clinical in nature, the sounds that occurred at the highest baseline rates were targeted for pairing. Echoic probes were conducted on the 3-4 most frequently heard phonemes.

For Participant 1, “ahmm” was initially paired with food, drink, movie, and swing. Reinforcement was essentially no contingent, only withheld if she emitted an inappropriate mand form (e.g., sign, hand push, crying, etc.).

During pairing sessions, staff said “ahmm” approximately 10 times per minute. Vocal play of “ahmm” was reinforced directly. As vocal play increased, researchers introduced delays after saying “ahmm” prior to the delivery of the reinforcers. “Ahmm” was also reinforced as an over-generalized mand. When “ahmm” was a strong mand and had occurred several times as an echoic/mand, echoics were differentially reinforced over spontaneous mands. Pairing was used to increase local rates of “ahmm” and a delay of at least 2 seconds was used between staff vocal and reinforcer delivery. Regardless of the delay scheduled, reinforcers of increased magnitude always immediately followed echoic responses. If researchers had been no contingently delivering a piece of pretzel after a 2 second delay, an echoic response would be immediately reinforced with a large pretzel. Therefore, two forms of differential reinforcement were used for echoic behavior.

As “ahmm” became strong as an echoic/mand, pairing began on “ee” with occasional maintenance trials on “ahmm”. The same protocol was used with “ee”.

With Participant 2, “doh” was paired with swing, tickles, singing, and being picked up. Apart from the differences in reinforcers used and the proportion of time spent in treatment, the protocol was the same as for Participant 1.

Design. This study used a multiple probe design across sounds and participants. Two sounds were studied for Participant 1, and one sound was studied for Participant 2. All target sounds were probed as echoic/mands prior to pairing on the first sound.

Reliability. Observers only scored a response if they both agreed on the occurrence. Thus, agreement for echoic probes and vocal play was 100%. This method was used in-situ whenever multiple observers were present, or approximately 50% of observed samples. While this method is inconsistent with the general guideline that there must be independence of observation, the measures are viewed as conservative. Further, the volume of vocal behavior emitted by the participants made it difficult for observers to accurately record data if they were more than 5-6 feet away, and impossible to accurately record data that was recorded on video tape.

Results

Participant 1 was in treatment for most of her waking hours. The days on which data were collected do not correspond to calendar days, but are never separated by more than five days. For Participant 2, treatment occurred an average of 20 minutes per week. Thus, while the “Days” on Figure 2 do not correspond to calendar days, they do correspond to those occasions on which treatment was implemented.

Figure 1 represents the changes in the rate of vocal play and the percent of correct echoics on two sounds for Participant 1. Baseline rates of vocal play were variable, but generally low for all sounds. The pairing of “ahmm” with reinforcers did increase the rate of vocal play “ahmm”, thus supporting the research on stimulus-stimulus pairing (e.g., Sundberg, et al., 1996). The replication was not exact because the sound was paired with a variety of reinforcers, for longer periods of time and included direct reinforcement of free operant occurrences of the target phoneme.

On the first day of pairing, “ahmm” increased from a baseline rate of 0.2 per minute to approximately 3 per minute. By Day 18, “ahmm” occurred at a pre-pairing rate of 4.5 per minute. Percent correct echoic “ahmm” remained at 0% throughout baseline and increased to 80% by Day 18 during data collection samples.

Baseline rates of vocal play “ee” were approximately 1.3 per minute. When pairing began on “ahmm”, data samples of “ee” were consistently 0 per minute until Day 16. Apparently, “ahmm” had become predominant. When pairing occurred exclusively on “ee”, on Day 20, the during/post pairing rate climbed to 4.5 per minute.

Progress on the percent correct echoic “ee” was much more rapid than it had been on percent correct echoic “ahmm”, presumably due to the learning history involved in the development of “ahmm” as an echoic. Echoic “ee” reached 100% during the data sample taken on Day 25.

Rather than begin pairing on a third sound, the researchers began instruction on alternating “ahmm” and “ee” as echoics. An attempt was made to teach these echoics independent of context. As displayed on Figure 1, the percent correct on either sound was variable during this phase, with “ahmm” frequently being predominant.

It became apparent during this phase of the experiment that variety was a factor in the reinforcing effectiveness of staff vocals. At this point, it was frequently unnecessary to actually pair sounds with other preferred stimuli. Instructor vocal behavior had taken on a generalized reinforcing value. Participant 1 responded with varying levels of emotion to different staff vocals, frequently showing obvious pleasure when a new sound was made for the first time. The variety of spontaneous echoics increased (e.g., “oo,” “na,” “go,” “dee,” “wa,” “ya,”, “ba”), as did the rate.

Data for Participant 2, displayed in Figure 2, reflect relatively high rates of baseline vocal play, with the first target sound “doh” occurring at a rate of 2.2 per minute during one sample observation. Baseline percent correct echoic “doh” was 0%.

Pairing began on Day 3, and the during/post pairing rate of “doh” was approximately 5 per minute by Day 6. The percent correct increased from 0% during baseline to 95% by Day 15. During this same period of time there was no consistent increase in the vocal play or percent correct echoic “ju”. Due to situations not related to this study, Participant 2 was dismissed from the study prior to pairing “ju.”

Discussion

The results of this study support prior research (e.g., Sundberg, et al., 1996), in that stimulus-stimulus pairing did contribute to an increase in the rate of vocal play on a phoneme. Unlike prior studies, the component of stimulus-stimulus pairing was not isolated.

While the data suggest that there is a functional relation between the treatment package and the establishment of echoic behavior, it is not possible to attribute this effect solely to the delay procedure. Several subtle program modifications were necessary throughout this study. For example, at one point Participant 1 was beginning to echo “ahmm” for food. It became apparent during one session at home that the position in which her mother held her hand was a critical variable. Manipulations of her mother’s hand position demonstrated that waiting, hand-leading, and echoing were controlled by her mother’s hand being in the bag, palm-up on the table, and palm down on the table, respectively. In this case, the delay was not the critical variable, but discriminative stimuli for a variety of different responses was temporarily the most critical variable controlling echoic or alternative responses. Participant 2 learned more rapidly, and her results were more clearly due to the pairing and delay procedure.

One possible problem with the present protocol relates to the pairing of one sound with a variety of reinforcers. This is contrary to standard recommendations (Sundberg & Partington, 1998), in which the importance of using one type of reinforcer for each mand form is strongly recommended. Yet, it is probably that Participant 1 would not have learned to echo “ahmm” if it were paired with only one reinforcer. Thus, for some children, difficulties may arise both by pairing one sound with one reinforcer (i.e., not enough pairing) and by pairing one sound with a variety of reinforcers (i.e., over-generalized mands).

The results demonstrated by Participant 1 suggest that a transfer from automatically reinforced behavior to echoic/mand behavior is possible with rates of vocal play as low as three per minute. For Participant 2, the transfer to echoic control occurred when the rate of vocal play was approximately four per minute.

The stimulus control for echoic/mand behavior, or for alternative operants, is clearly a critical variable in the establishment of echoic behavior. It would be difficult to isolate the delay variable from the stimulus control variable, since a delay of some sort would be necessary to determine which stimuli had control over echoic and related operants.

In summary, it is encouraging to see that vocal play can be strengthened and echoic behavior can be established using a combination of automatic reinforcement and direct reinforcement. The students selected for this study had not developed any echoic behavior despite extensive practitioner efforts. Yet researchers were able to establish echoic behavior with a minimum of frustration, while increasing the value of social stimuli as reinforcers. Given the necessary social component of verbal behavior, it would be difficult to over-estimate the significance of establishing the value of social stimuli. It could be argued that the participants in the present study not only acquired some echoic behavior, but that the groundwork was laid for future acquisition of vocals to occur without threatening the automatic reinforcement value of vocal behavior or the value of social stimuli as reinforcers.

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