Stimulus-Stimulus Pairing and Subsequent Mand Acquisition of Children with Various Levels of Verbal Repertoires

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Effects of a stimulus-stimulus pairing procedure on the subsequent acquisition of mand operants were investigated. An attempt was made to shape novel sounds that emerged through the pairing procedure into a mand. Six children, aged two to five years, with moderate to severe language and communication delays, participated. Two conditions were used following the pairing condition: postpairing and direct reinforcement. The emergence of mands was compared across these conditions. An additional analysis was made of the relation between participants' baseline verbal repertoires and the effects of the pairing and the emergence of mands. Results indicate the possibility of stimulus control from a stimulus-stimulus pairing to mand as shown in two of the participants who had demonstrated high rates of vocal play and low to no verbal repertoire prior to this study. Target vocal sounds during postpairing and direct reinforcement condition remained at zero to low levels for participants with high verbal repertoire and little vocal play, warranting future studies on relations between the pre-existing verbal repertoire and the effectiveness of stimulus-stimulus pairing.

Key words: stimulus-stimulus pairing, automatic reinforcement, verbal repertoire, vocal play, mand acquisition, overt vocalization, severe language delays.

Infants engage in vocal play and young children sometimes expand their array of vocal sounds and words without the apparent presence of direct parental reinforcement and correction (Schlinger, 1995; Moerk, 1983, 1990; Kravitz & Boehm, 1971; Bijou & Baer, 1965; Mowrer, 1954; Nakazima, 1962). The apparent lack of direct reinforcement has challenged behaviorists to provide a more complete account of the role of indirect reinforcement in language acquisition. Automatic reinforcement

has been suggested as a possible explanation of this phenomenon and as an interpretation of language acquisition (Bijou & Baer, 1965; Skinner, 1957; Vaughan & Michael, 1982). In particular, automatic reinforcement has been suggested when exploring the acquisition of novel sounds and words, as well as for increasing the amount of vocalizations for some children (Miguel, Carr, & Michael, 2002; Smith, Michael, & Sundberg, 1996; Sundberg, Michael, Partington, & Sundberg, 1996; Yoon, 1998; Yoon & Bennett, 2000).

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Automatic reinforcement does not require the mediation of consequences by another organism (Vaughan & Michael, 1982). Some behavior has stimulus products that can themselves function as reinforcers. Driving, singing, playing musical instruments, painting, and swimming are examples of behaviors that may be reinforced by their own products and thus are susceptible to a process of automatic shaping. Vocal sounds can also be conditioned as automatic reinforcers when such sounds are paired with reinforcing stimuli (Bijou & Baer, 1965; Skinner, 1957). For example, when a mother produces the sound /yeah/ while cuddling a baby, the baby may later produce a similar sound without the presence of the mother. Reinforcement may also come from exercising the vocal musculature, from emotional arousal that is associated with a sound, or by

achieving parity (Palmer, 1996) within a particular verbal community.

Automatic reinforcement, especially for vocal sounds in a language, may be established through a stimulus-stimulus pairing, which involves an adult-generated vocal sound being paired with an existing reinforcer in the presence of a child (Skinner, 1957; Sundberg, et al., 1996; Vaughan & Michael, 1982). When pairings are provided, the child may start to vocalize the sound or the approximation of the sound heard during pairings. Vocal play increases opportunities to strengthen vocal muscles as well as the chance that vocal behavior will receive further reinforcement (Sundberg, et al., 1996). It also provides a basis for a shaping process in which contingencies are devised in an effort to bring these vocalizations under operant control (Bijou & Baer, 1965).

Several studies have demonstrated that a stimulus-stimulus pairing procedure can evoke and shape vocalizations in children (Miguel, et al., 2002; Smith, et al., 1996; Sundberg, et al., 1996; Yoon, 1998; Yoon & Bennett, 2000). Sundberg, et al. (1996) demonstrated that a stimulus-stimulus pairing can lead to an increase of vocal sounds, words, or phrases that had not been in the participants' repertoires. The effect of the pairing procedure was evaluated with four children with severe to moderate language delays between the ages of 2 and 4 years who demonstrated a range of 100 to 300 mands and tacts.

Smith et al., using two typically developing infants between the ages of 11 and 14 months, paired a neutral stimulus with reinforcing stimuli, punishing stimuli, and neutral stimuli. Pairing with reinforcing stimuli resulted in an increase in target sounds, and pairing with negative stimuli resulted in a decrease. It should be noted that the target sounds in their study were already in the participants' repertoire prior to the pairing, and that no novel sounds resulted from the pairing procedure.

These empirical studies demonstrated that a stimulus-stimulus pairing procedure can induce vocal sounds, words, or phrases, but the phenomenon requires further investigation. Participants in both studies were infants and children who had many forms of verbal behavior in their repertoires, or in other ways demonstrated typical development. Evaluation of these procedures with children with more severe delays,

or with major deficits in vocal play and language acquisition, is warranted. The relation between pairing effectiveness and the nature of the existing repertoire is not clear. In the study by Sundberg and his colleagues (1996), novel sounds, words, and phrases were conditioned as reinforcers, but in the study by Smith and his colleagues (1996), all the sounds paired were already in the participants' repertoires.

Yoon & Bennett (2000) extended the investigation of the effect of a stimulus-stimulus pairing procedure to four preschool children with severe developmental delays who had no oral motor or vocal verbal imitation skills and no functional vocal verbal behavior in their repertoire. In Experiment 1, novel vocal sounds were paired with preferred stimuli (e.g., tickles) approximately 36 times during a 3 minute pairing session. All participants showed an increase in the target sound immediately after the pairing session. In Experiment 2, the pairing condition was compared with an echoic condition in which a reinforcer was given only contingent upon imitation of an antecedent vocal sound. This comparison was necessary in order to determine whether the increase in the target sounds in Experiment I could have been advantageously reinforced during the pairing condition. In a comparison of pre-echoic, echoic, post-echoic, pairing and post-pairing conditions, an immediate and significant increase in the target sound occurred only after the pairing condition. These findings suggest that an automatic reinforcement contingency through a stimulus-stimulus pairing procedure may be more effective than a direct reinforcement contingency by echoic training for children with severe delays who have little to no baseline verbal behavior. It should also be noted that for three of the four participants vocal sounds eventually extinguished during the post pairing sessions. This is to be expected if the stimulus properties of the vocal responses were functioning as *conditioned* reinforcers. In the post-pairing condition, the primary reinforcer was no longer being delivered.

Miguel, et al. (2002) further evaluated a stimulus-stimulus pairing with three children at the ages of 3 to 5 with minimal vocal repertoires (a few sounds, but no mand, tact, or intraverbal skills). Data were taken on the frequencies of two target sounds for each participant during a 5-min pre-session and a 5-min post-session period. A two-tiered multiple

baseline design across vocal behaviors with a reversal to baseline was employed. During baseline, which lasted for 5 min, there were no programmed contingencies or interaction. During the control condition, a vocal sound was presented five times. A stimulus identified as a reinforcer was presented contingent upon the absence of the sounds within 20 s of the vocal antecedent. This procedure was designed to control for advantageous reinforcement and the effects of modeling and of enriched environments. This was repeated for 20 trials. During the pairing condition, a vocal sound was presented five times, and the reinforcer was given after the third vocal sound but before the last sound. This was repeated for 20 pairings, and then there was a return to the baseline. Observations were made immediately before (pre-session) or after (post-session) each baseline, control, and pairing session. The findings of this experiment supported previous work by demonstrating an immediate increase in vocalizations after the pairing sessions for two participants. The results showed that the vocal sounds eventually extinguished, suggesting that a direct reinforcement contingency may be necessary for the sound during post-pairing sessions if the behavior is to persevere.

McDonough, Shimizu, Bicard, and Yoon (2004), in their preliminary study, tested the effect of a computerized stimulus-stimulus pairing procedure with a 5-year 7-month-old male with autism and severe language delay. A reinforcer assessment was conducted to identify the pictures preferred by the participant. Based on the teacher interview, 200 pictures were selected as potentially preferred stimuli. Then each was shown to the participant through a computer. The participant was allowed to change a picture presented on the computer screen by simply touching the button on the screen. Preference in this assessment was defined as a relative duration between the presentation of a picture and the moment the participant touched the button. Fifty pictures that had longer durations were selected for this study, and the other 150 pictures were discarded. During baseline, a DVD was shown for 1 min and 10 trials of mand assessment were conducted for 4-8 min. During this mand assessment, the child was shown the DVD for 6-10 s followed by the experimenter saying "on" (the target sound). The experimenter waited for 3-6 s and said "on" one more time if the child

did not say anything. During the pairing condition, the child was shown the DVD for 1 min. Thirty pairings were programmed into the DVD. That is, the DVD showed the preferred pictures and simultaneously produced the sound "on" 36 times for 1 min. Ten trials of mand assessment followed the pairing session. During the computer pairing combined with the physical interaction condition, all procedures were the same except that the physical interaction (tickles, hugs) was provided in addition to the computer pairing. The results of their study indicated that the computer pairing did not result in an increase in the target vocalization "on" as a mand. However, there was increase in general vocalization, in particular, "mm." The occurrence of "mm" increased during mand assessment following the computer pairing sessions. It is unclear if the sound "mm" was an approximation of "on" for the child that could be shaped as a mand through the pairing. It should be noted that the child had extremely limited vocal play. He was observed to make only a few sounds such as "ah," "ee," "uh," and "gha." These results also indicated that the increase in "mm" was more evident in the computer and physical pairing condition, suggesting that the strength of the reinforcer paired may be a variable for the effectiveness of the pairing procedure.

Recently, Esch, Carr, and Michael (2005) further evaluated the role of pairing with three children with autism. In their first experiment, they compared the occurrence of target and non-target sounds in the echoic condition (control condition) and in the echoic-with-antecedent-pairings condition in which a total of 30 pairings were presented prior to the echoic probe. The results indicated that the stimulus-stimulus pairings had no effect on increasing the rate of the target vocalization, and thus a direct reinforcement contingency (in this study, echoic) could not come into play. The results from their second experiment, a systematic replication of Miguel et al. (2002), indicated that the rate of vocalizations for two participants from the first experiment did not increase over baseline levels following pairings. In their third experiment, an attempt was made to shape the vocalization using differential reinforcement. Their results showed equivocal results of differential reinforcement on the occurrence of targeted vocalizations. However, the authors noted that for one of the participants, items

Figure 1. Number of verbal forms (echoic, tacts, mands, intraverbals) and rate of vocal play in participants' repertoire prior to the onset of this study.

identified as preferred did not function as reinforcers and thus had less effect on his vocal behavior, thus warranting the importance of a thorough preference assessment prior to implementing a pairing procedure.

The current study involved six participants with varied verbal repertoires in regard to the number of verbal responses (echoic, tacts, mands, intraverbals) and vocal play (rate of vocalizations). The main purpose was to investigate whether a target vocal sound that increased through the pairing procedure could be shaped into a mand under conditions of direct reinforcement immediately following the pairing sessions. This study subsequently attempted to look at differences, if any, in mand acquisition of the varying levels of participants.

METHOD

Participants

The current study involved the behavior of six participants, ages 2 to 5 years. All attended school for at least 3 months prior to the onset of the study. Participants JO, JA, and MC attended a half-day early intervention class. Participant JI, H, and A attended a full-day pre-

school class. Although specific diagnoses of the participants were not available for the current study, all of the children were considered to be at risk and classified as children with educational disabilities by their Preschool Committee of Special Education. According to classroom observation and educational reports completed by their class teachers, JI was able to mand and tact in a few forms, follow directions, play appropriately, and begin writing letters, and he was working on self-management skills. He was also able to mand and tact, select objects and pictures when presented with an auditory antecedent, and play appropriately. JA was able to follow simple directions, and was starting to imitate sounds and words, but had not met criteria on any specific sounds and words. MC was able to appropriately mand most of his needs and wants, and had emerging reading and writing skills and self-management skills. He did, however, have some difficulties following class rules and multiple-step directions. His play and social skills were emerging. JO and A had limited discrimination skills when presented with an auditory antecedent, and limited imitation skills, but they were starting to follow simple directions.

Table 1 shows the participants' verbal reper-

Table 1
A summary of participants' pre-existing verbal repertoires.

Levels of Repertoire	Participant	Total # of Verbal Response Forms	Rate Per Minute of Vocal Play
High Verbal, Low Vocal Play	H	50	<1.0
High Verbal, Low Vocal Play	JI	29	1.0
Mid/Low Verb, High Voc Play	MC	7	3.1
Mid/Low Verb, High Voc Play	JA	0	6.0
Low Verbal, High Voc Play	JO	0	2.5
Low Verbal, High Voc Play	A	0	>3.5

toires and vocal play skills prior to the onset of this study, and Figure 1 represents the same information in a bar graph. *Verbal repertoire* was defined as the total number of observed echoics, mands, tacts, and intraverbals in the participant's repertoire; *vocal play skills* was defined as rate per minute of the number of utterances produced by the participant during an observation. (It should be noted that the terms *high* and *low* are not based on any standardized test or assessment, but used in this study as relative terms among the six participants. That is, *high* in this study only meant that the repertoire was considered at a high level compared to that of the other participants. Thus, two participants had relatively large verbal repertoires but relatively low rates of vocalization. The other participants vocalized frequently but had few, if any, effective forms in their repertoires. Participants JI, H, and MC had speaker skills that varied in their length of utterances and use of autoclitics. They were able to tact and mand some items, and had relatively stable listener repertoires. The other three participants (JO, A, JA) had limited vocal verbal repertoires and engaged in relatively higher rates of vocal play. The listener skills of JA, JO, and A varied, including their general imitation repertoires. Participant H's rate per minute (RPM) of vocal play was <1.0 and mainly included *functional* verbal operators. The experimenters observed 50 vocal verbal forms in his repertoire prior to the study. Participant JI had 29 verbal forms and also demonstrated a low rate of vocal play (1.0), mainly tacts. Participant MC at the time of the study had only 7 verbal forms in his repertoire with vocal play at the rate of >3.0. Participant JA had 0 vocal verbal forms but a rate of vocal play at 6.0. JO had 0 vocal forms with a rate of vocal play at 2.5,

and participant A also had 0 vocal verbal forms with >3.5 of vocal play.

Setting and Materials

This study took place in a private, not-for-profit school located in a suburban area outside New York City. The general teaching methods included discrete-trial training, verbal-behavior training, and small-group instruction, and were individualized according to criterion-referenced assessments and IEP goals. During the study, sessions were conducted in a room (2 m × 1.5 m) containing a small preschool size table, two chairs, simple toys and books. Two experimenters and a participant were present in the room during each session.

The materials included a tape player and a stopwatch. The audiotape presented the experimenter's voice indicating when to present the pairing trials. That is, the tape player started by saying, "Start with one," and indicated each interval by saying, "One . . . two . . . one . . . two . . ." This tape player was only used during the pairing condition. The stopwatch was used to identify time bins.

Selection of Reinforcing Events

The pairing condition required the selection and use of a reinforcing event. The stimuli chosen to be paired with the target vocal sounds were the ones that had a history of increasing the desired responses on the programs that the participants had been working on in the classroom setting. Reinforcers included physical interactions, activities, tangible items, and included edible items. Physical interactions consisted of tickling, picking up, or pushing the participant on a cart.

Response Definition

Two target sounds were selected for each participant, one for each of the two conditions—post-pairing (baseline) and direct reinforcement. For post-pairing conditions /crunchy chip/, /hug/, /toy/, /boo/, /ba/, /tuh/ were selected for all participants. For direct reinforcement conditions, /cold juice/, /cup/, /play/, /hug/, /ooo/, and /u-poo/ were the target sounds. These sounds consisted of one-syllable utterances, single words, and short phrases depending on the participants' baseline repertoires. An approximated sound of the target form was accepted for those participants with limited articulation. One utterance, word or phrase that was not followed by another utterance within 3 s was recorded as one vocal sound. Both target vocal sounds were identified during observation in the free operant setting prior to the onset of this study. The target sounds were chosen because they had an observed frequency of zero. Non-occurrence of the target sounds were confirmed during pre-pairing sessions of the study. If the target sounds had ever occurred, the experimenters would not have included them in the study.

Both experimenters individually and manually recorded each participant's vocal sounds during all sessions except the pairing and direct reinforcement conditions. In those conditions one experimenter presented the pairings or delivered the reinforcer contingent upon the occurrence of the target sound (mand) while taking data, and the second experimenter recorded any occurrence of a target vocal sound. The numbers of target vocal sounds were recorded in time bins of 30 s for all participants throughout all conditions.

Experimental Design and Measurement

Single subject designs with ABA (pre-pairing, pairing and post-pairing) for one target sound and ABC (pre-pairing, pairing and direct reinforcement) for the second target sound were used for each participant. Two target sounds were selected for each participant. One target sound was assigned for the ABA condition and the other for the ABC condition. Either the post-pairing or the direct reinforcement condition followed pairing conditions, and all conditions were presented consecutively. That is, each student underwent the post-pairing se-

quence (pre-pairing, pairing, and post-pairing consecutively) for one target sound and the mand sequence (pre-pairing, pairing, and direct reinforcement, consecutively) for the other target sound, or vice versa. Experimental sequences were randomly counterbalanced across students. Three students underwent the post-pairing sequence first, followed by the direct reinforcement sequence. The other three students underwent the direct reinforcement sequence followed by the post-pairing sequence. If participants didn't emit any target sounds for 5 min immediately after the pairing condition for the first target sound, the session was terminated. The experimenters then used the same length of time as the criterion for terminating the sessions for the second target sound. The independent variables were pairing and direct reinforcement, and the dependent variable was the cumulative number of the target sounds. (It should be noted that the sessions in post-pairing and direct reinforcement conditions were not presented simultaneously or contiguously, although Figures 2–4 represent data from both post-pairing and direct reinforcement conditions for each participant on the same graph for comparison purposes.)

PROCEDURE

Pre-pairing. There were no pairings in this condition. Toys and books were available on the floor for the participant during the session. The experimenter did not interact vocally or physically with the participant. At this time the experimenters observed the participant for the purpose of recording the frequency of the target sound. When absence of interaction was impossible (e.g., the participant reached the experimenter for attention), the experimenter discontinued the sessions. Another session was attempted 20–30 min later. This pre-pairing condition lasted for 5 min for all participants except JO and A.

Pairing. Sessions in the pairing condition started immediately after the pre-pairing condition. The experimenter emitted the target vocal sound once and simultaneously presented the predetermined reinforcing event (tangible or physical interaction) for each pairing. Approximately 12 pairings were presented per minute. The total duration of the pairing sessions was 3 min for each participant. Except for the experimenter's target vocal sound paired

with the reinforcing stimuli, there were no vocal or physical interactions between experimenter and participant during the sessions.

Direct Reinforcement. This condition immediately followed the pairing sessions. The item or activity (reinforcer) used in the pairing sessions was available and in the sight of the participant. The item or activity was delivered contingent upon the participant emitting the target sound or an approximation of the sound in an attempt to shape those sounds as a mand. If the participant reached for the item but did not vocalize the target sound, the experimenter did not give the participant an opportunity to receive the item. This direct reinforcement condition lasted for 5 min for all participants in order to correspond with the duration of the pre-pairing condition, except for JO and A.

Post-pairing. Post-pairing sessions immediately followed the pairing sessions. Data collection procedures were identical to those in the pre-pairing sessions. This post-pairing condition lasted for 5 min for all participants in order to correspond with the duration of pre-pairing condition except for JO and A.

Interobserver Agreement. One hundred percent interobserver agreement was achieved for all participants across all sessions. The two experimenters simultaneously, but independently, recorded occurrences of target vocal sounds during the pre- and post-pairing conditions. During the pairing and mand conditions, one experimenter recorded the occurrence of tar-

get vocal sounds while presenting pairings or opportunities to mand, and the second experimenter recorded all target sounds emitted by the participant.

RESULTS

The total number of the target vocal utterance or sounds emitted in all conditions may be found in Table 2.

Figure 2 shows results for JO and A. Both had zero target vocalizations in the pre-pairing and pairing conditions. For JO, target vocalizations occurred after 5.5 min in the post-pairing condition with a total of seven target sounds (RPM = .54). There was an abrupt increase in rate after 8 min with a jump from two target sounds to seven target sounds in 30 s. For Participant A, after 1 min in the post-pairing condition, target sounds occurred for three time bins, then two more vocalizations occurred after 10.5 min for total of 11 target sounds (RPM = .65).

In the direct reinforcement condition participants JO and A both had no target vocalizations in pre-pairing and pairing conditions. JO's graph shows an occurrence of the target sound after 1 min and a steadily ascending slope that continued for 13 min (RPM = 1.0). Her results were the most dramatic across all participants. Participant A emitted target sounds in the mand condition after 3.5 min with a stable slope for 6 min. The slope then increased for the next

Table 2
The number of target vocal sounds in pre-pairing, pairing, and post-pairing/direct reinforcement conditions

Level of Pre-exist reps	Participants	Target Snds	Preprng Cond.	Pairing Cond.	Postprng Cond.
High Verb, Low Voc Play	H	Crunchy Chip	0	2	0
High Verb, Low Voc Play	H	"Cold Juice"	0	0	0
High Verb, Low Voc Play	JI	"Hug"	0	0	0
High Verb, Low Voc Play	JI	"Up"	0	0	0
High Verb, Low Voc Play	MC	"Toy"	0	8	0
High Verb, Low Voc Play	MC	"Play"	0	12	0
High Verb, Low Voc Play	JA	"Boo"	0	2	7
High Verb, Low Voc Play	JA	"Hug"	0	6	0
High Verb, Low Voc Play	JO	"Ba"	0	0	6
High Verb, Low Voc Play	JO	"Ooo"	0	0	14
High Verb, Low Voc Play	A	"Tuh"	0	0	10
High Verb, Low Voc Play	A	"Uh-Poo"	0	0	11

Figure 2. Cumulative number of vocalizations emitted by Participants JO and A (high vocal play and low verbal responses). Open squares represent the target vocal responses in pre-pairing, pairing, and post-pairing conditions. Closed circles represent the target vocal responses in pre-pairing, pairing, and direct reinforcement conditions.

Figure 3. Cumulative number of vocalizations emitted by Participants MC and JA (mid level of vocal play and verbal responses). Open squares represent the target vocal responses in pre-pairing, pairing, and post-pairing conditions. Closed circles represent the target vocal responses in pre-pairing, pairing, and direct reinforcement conditions.

Figure 4. Cumulative number of vocalizations emitted by Participants JI and H (low vocal play and high verbal responses). Open squares represent the target vocal responses in pre-pairing, pairing, and post-pairing conditions. Closed circles represent the target vocal responses in pre-pairing, pairing, and direct reinforcement conditions.

5.5 min with a total of 11 target sounds (RPM = .65).

Figure 3 represents data from participants MC and JA. Both had zero target vocalizations in pre-pairing. MC emitted eight target sounds in the pairing condition (RPM = 2.7) and zero in post-pairing. JA emitted two target vocalizations in the pairing session with an RPM of .7. After 1 min in post-pairing he emitted four target vocalizations; target sounds were emitted again after 1.5 min, and again 30 s later, for an RPM of 1.4. There was no occurrence of target sounds after a total of 5 min. A much steeper slope for Participant JA than for any other participant was evident in this condition.

In the direct reinforcement condition MC and JA had zero target vocalizations in the pre-pairing sessions and direct reinforcement sessions. MC had 12 target sounds in pairing (RPM = 4.0), and JA had 6 (RPM = 2.0). MC's cumulative record shows an abrupt increase in rate after 1.5 min. Participant JA's results were not as dramatic but did show an increase over other conditions with an immediate increase in vocalizations.

Figure 4 represents data for participants H and JI. Both had zero target vocalizations in pre-pairing, post-pairing, and direct reinforcement conditions. Participant H did emit two target vocalizations in the pairing conditions (RPM = .7). One target sound occurred after 30 s and the other occurred after 2 min.

DISCUSSION

The shaping of behavior requires that behavior be variable, and reinforcement is then delivered differentially to those variants that are closer to some target response criterion. For that reason, it can be difficult to shape verbal responses in children with very limited or very stereotyped repertoires of vocal behavior. Previous studies have shown that in some cases a stimulus-stimulus pairing procedure can lead to increased rates of vocal behavior and perhaps even to the first appearance of certain forms of vocal behavior. The practical importance of these results is that once behavior is emitted, it can be strengthened and modified through shaping procedures. The present study attempted to evaluate this proposal by following stimulus-stimulus pairings with mand training. Thus there are two effects of interest: An increase in the rate of the target response fol-

lowing pairings and the strengthening of this response through mand training.

Of the six participants in the study, three did not emit any target responses in the direct reinforcement condition following stimulus-stimulus pairings (H, JI, and MC). Although there was an increase in target responses during the pairing condition for H and MC, there was no occurrences of target responses that could be strengthened or shaped during the direct reinforcement condition (mand training phase). Thus, for these three participants, neither effect of interest occurred.

Of the three participants who engaged in target behaviors following pairings, one did so only in the post-pairing condition (JA). The response targeted for direct reinforcement did not occur following pairing and therefore could not enter into a mand contingency. Thus, the experimenters replicated the reported effects of stimulus-stimulus pairing for one of two stimuli for participant JA, but for him, the direct mand contingency could not be used.

Only two participants' vocalizations increased during both the post-pairing condition and the direct reinforcement condition following the pairing procedure (JO, A). Prior to the study, JO had some vocal play and no functional verbal forms in his repertoire. Participant A had no functional vocal verbal forms in his repertoire, but had high rates of vocalizations that served no apparent function other than perhaps an automatic reinforcement function (Table 1). There were differences in vocalizations between post-pairing and direct reinforcement conditions for both participants. In the post-pairing sessions, target vocalizations eventually extinguished, a result that was also reported in previous studies (Miguel, et al., 2001/2002; Yoon & Bennett, 2000). However, during direct reinforcement conditions, the target vocalizations (mands) continued to occur almost until the end of the sessions without undergoing extinction. One can assume that providing a direct reinforcement contingency (e.g., a mand contingency, as in this study) immediately after the pairing sessions would continue to strengthen the target vocalization and could be manipulated to shape a particular verbal operant.

As mentioned above, the other four participants did not emit mands following the pairing sessions and three of them did not emit vocalizations during the post-pairing condition.

The reasons for this are uncertain, but a hypothesis can be offered: Participants H and JI had mand and tact repertoires prior to the study, indicating they had already been exposed to direct verbal contingencies. Additionally, they did not engage in vocal play, but their verbal skills were more developed. The target vocal responses may have been competing with stronger verbal operants already in the participants' repertoires (Miguel, et al., 2001/2002).

MC's vocalizations remained at zero during both post-pairing and direct reinforcement conditions, indicating that the pairing was not effective in increasing the rate of the target vocalizations. However it should be noted that MC emitted the target sound during the pairing sessions, a result which has typically not been observed in previous studies. Considering that MC's functional verbal skills were emerging, the vocalizations made during the pairing session may have been echoics, tacts, or even mands. It is plausible that his vocalizations were starting to come under the control of a direct reinforcement contingency rather than an automatic reinforcement contingency. JA, who had no verbal forms but a very high rate of vocal play, also emitted the target sound during the pairing sessions and during the post-pairing condition but did not produce any in the mand condition. Based on the emergence of vocalizations in the post-pairing condition and his high rate of vocal play at baseline, one could surmise that making the target sound was automatically reinforcing. The target sound eventually went into extinction during the post-pairing condition.

Participants H and JI, who demonstrated a high number of verbal forms and a low rate of vocal play, did not produce the target sounds with the exception of the two responses by Participant H during the pairing sessions. The pairing had no effect on inducing overt vocalizations in both post-pairing and mand contingencies, although it is possible that participants H and JI emitted the target responses covertly.

In summary, the current study demonstrated the effectiveness of a stimulus-stimulus pairing in inducing sounds in participants with limited vocal verbal repertoires and indicated the possibility of transfer of control from the pairing to the direct reinforcement (for mand) in two participants. However, participants who had a *high* level of verbal responses and were thus under the control of more direct reinforce-

ment contingencies were less sensitive to the pairing procedure at least in regard to overt vocalization. They didn't produce any mands during the direct reinforcement condition. We offer two possible reasons for this. First, it is possible that motivation for hearing oneself is much weaker for children with richer verbal repertoires, especially after the pairing sessions where they received reinforcers regardless of their vocalizations. Second, their vocalization may be covert; they have been in contact with more direct reinforcement contingencies and may even have a history of punishment for *self-talking* or *talking out loud*. With these children, mand training and manipulating establishing operations may be more effective than a pairing procedure. Data from the participants with mid to low levels of verbal responding and high vocal play who showed emerging verbal response repertoires also suggest that pairing may not be an effective procedure, as the subsequent mand contingency was not effective. However it is interesting to note that these participants vocalized the target sounds or words during the pairing sessions. Whether those sounds or words were echoics requires further investigation. Direct reinforcement contingencies, such as echoic training, may be more effective for such children. The repertoires of the participants who had a low level of verbal responding and high rates of vocal play were very sensitive to the pairing procedure in the present study. The target sounds occurred immediately after the pairing session for both participants in both post-pairing and mand conditions. Data from the post-pairing conditions were consistent with those of Yoon and Bennett (2000) and Miguel and his colleagues (2002) in that the target sounds eventually extinguished. When a direct reinforcement (mand) contingency was in place immediately after the pairing sessions, the target vocal sounds continued to occur and the slopes of the data paths were different from those in the post-pairing condition. These data suggest that the target sounds were coming under the control of the direct mand contingency.

Our results suggest that stimulus-stimulus pairings are less effective for children with verbal repertoires, at least with regard to their *overt* vocalization. Overall, participants who had more verbal responses (i.e., echoics, mands, tacts, intraverbals) in their repertoires engaged in less overt vocal play than partici-

pants who had fewer or no verbal responses in their repertoires. It should be noted that the vocalizations (vocal play) were not always nonsense sounds or utterances. Participants who had emerging verbal responses tended to engage in vocal play with sounds or words that had been taught as echoics, tacts, or mands. It was the participants with no verbal responses who produced nonsense sounds. It should also be noted that although children with a high number of verbal responses were not observed engaging in overt vocal play, they may have been engaging in covert vocalizations. Automatic reinforcement for overt vocalization seems to be evident in early stage of language acquisition as seen in infants and young children (Schlinger, 1995), but it can be suggested that eventually such children come into contact with direct verbal reinforcement in a particular verbal community, and automatic reinforcement continues to serve the behaviors that may be covert such as self-editing, thinking, and problem solving (Vaughan & Michael, 1982).

The results suggest several matters for further research. First, the current study defined the preexisting verbal repertoire based on the number of different verbal responses, and the rate of vocalizations (vocal play) made per minute. More extensive measures of the participants' preexisting verbal repertoires are needed in order to determine the nature of the relation between that repertoire and the effectiveness of a pairing procedure. Employing a larger number of participants at various levels of verbal repertoire and vocal play will also be necessary to determine the generality of the relations observed in this study.

Second, the current study failed to establish mand responses for participants with relatively high verbal repertoires. This failure doesn't force the conclusion that a pairing procedure is ineffective for these types of participants; the methodology of the present study may not be optimal for them. For children with verbal repertoires, studies on automatic reinforcement should be extended from inducing very basic vocal sounds to establishing higher verbal skills such as thinking and problem solving. Alternatively, the target responses could be restricted to novel ones, responses not in the repertoire of the subjects.

Third, the current study did not implement ongoing formal functional reinforcement as-

sessments. In a stimulus-stimulus pairing, as in direct reinforcement, it is important to pair preferred or reinforcing stimuli with the target sound. Since the sessions were conducted consecutively, it may be possible that the absence of vocal sounds during the direct reinforcement condition for some subjects was due to satiation or habituation of the reinforcer rather than to the ineffectiveness of the pairing procedure or to the receding of vocalization to the covert level.

Fourth, the number of pairings and the lengths of sessions should be investigated. In the present study, only 36 pairings (in 3-min sessions) were presented. If the occurrence of a target sound is consistent over time, then the possibility of that response being shaped will presumably be greater, since vocal play should provide a basis for such shaping (Bijou & Baer, 1965).

In conclusion, our results suggest that the effectiveness of a stimulus-stimulus pairing procedure in evoking subsequent target responses depends in part on the baseline repertoire of the participants and is most effective with subjects with very limited vocal repertoires—at least for the kinds of responses we investigated. However, subjects with limited repertoires are the very ones for whom such a procedure might be most helpful. The principal reason that the procedure is of interest in applied settings is that it may offer a way of increasing response frequency and variability so that standard shaping procedures can be implemented. A child with a substantial repertoire of vocal behavior would not profit much from pairing procedures.

Finally, the study illustrated that responses evoked by a pairing procedure can continue to be strengthened by a mand contingency. Although this is hardly surprising, the establishment of functional verbal behavior is the ultimate payoff for this line of research.

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