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Effects of a Stimulus–Stimulus Pairing Procedure on Conditioning Vocal Sounds as Reinforcers

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Two experiments were conducted to investigate the effects of stimulus–stimulus pairing on conditioning vocal sounds as reinforcers. Four preschoolers with severe language and communication delays participated. In Experiment 1, an attempt was made to condition vocal sounds as a reinforcer by pairing a specific vocal sound with a reinforcing event (e.g., physical interaction). Results indicated that presentation of a stimulus–stimulus pairing was effective in conditioning the target vocal sounds as reinforcers, which increased the occurrence of vocalizations of those sounds by the participants. Experiment 2 compared the effects of the pairing procedure with those of echoic training. The pairing procedure was identical to that in Experiment 1. In the echoic training condition, the experimenter produced the target vocal sound and gave the participant an opportunity to echo. The same reinforcing stimulus (e.g., physical interaction) was provided contingent upon the occurrence of the target vocal sound emitted by the participant. Results showed that the pairing procedure was more effective than the echoic training. Findings from this study suggest that for these participants, who had no vocal imitation skills, the stimulus–stimulus pairing was an effective procedure for conditioning vocal sounds as reinforcers and increased the probability of occurrence of the vocalization without a direct reinforcement contingency.

Frequent repetition and rapid expansion of vocal sounds by infants and young children have been observed even in the apparent absence of direct relevant parental reinforcement and corrections (Kravitz & Boehm, 1971; Mowrer, 1954; Nakazima, 1962; Thelen, 1979, 1981). Rapid changes in topography and range of vocalizations are conspicuous during these early years, raising further doubts that such responses are explicitly shaped, one by one, by the verbal community (Holland, 1992). Brown and Hanlon (1970) analyzed transcripts of parent–child interactions and found little evidence of either explicit reinforcement for grammatically correct verbal behavior or correction of grammatically incorrect verbal behavior. In contrast, they found that parents were vigilant about the truth of their children's utterances. Such observations have contributed to a widely held position among psycholinguists that the principles of behavior are inadequate to explain language acquisition. A common corollary is that the development of a fluent verbal repertoire must be governed, at least in part, by special cognitive processing mechanisms or an innate language acquisition device (e.g., Chomsky, 1965).

Moerk (1983, 1990) reanalyzed Brown and Hanlon's data and showed that although explicit verbal praise for correct construction was indeed rare, adult–child interactions were in fact very rich with relevant contingencies. Parents commonly recast nonconforming utterances into more acceptable forms; they respond appropriately to the child's tacts and mands; they model appropriate constructions; they repeat utterances; they modulate the content of their verbal behavior appropriately;

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and they provide considerable generalized reinforcement. The crude notion that language is learned through the explicit shaping of every verbal response by teachers and parents is clearly wrong, but such instruction comprises only a small proportion of the relevant reinforcement contingencies in a child's history. It is premature to conclude that behavioral principles are inadequate to explain language acquisition.

An important challenge for behaviorists, then, is to offer a more complete account of the role of indirect reinforcement contingencies. How exactly does the generalized reinforcement of a parent–child interaction lead to the strengthening of verbal operants? In particular, how do repetitions and recast utterances by adults exert control over the topography of the child's behavior? A plausible interpretation of these phenomena would greatly strengthen a behavioral alternative to the prevailing mentalistic models of language acquisition.

All behavior has stimulus properties, proprioceptive or exteroceptive, but responses that generate sounds are distinctive in that they are heard by the subject much as they are heard by observers. Under some conditions such responses seem to be able to undergo a process of automatic shaping. People can learn to hum a familiar tune or play it on the piano, increasing fidelity with each repetition. A response might serve a reinforcing function if the stimulus properties of that response are familiar, that is, if they already exert discriminative control over the individual's behavior. In this way, a child's verbal behavior might be automatically reinforced if it conforms to the prevailing practices of the verbal community.

A verbal stimulus might also acquire a reinforcement function when adult vocalizations of that stimulus are followed by a reinforcing event (Bijou & Baer, 1965; Skinner, 1957). If a vocal sound becomes a conditioned reinforcer, it would presumably strengthen the response which produced that sound when it is produced by the child. The process in which a response product reinforces the producing behavior itself has been described as automatic reinforcement (Skinner, 1957; Smith, Michael, & Sundberg, 1996; Sundberg, Michael, Partington, & Sundberg, 1996; Vaughan & Michael, 1982).

There is a clear distinction between direct reinforcement and automatic reinforcement (Vaughan & Michael, 1982). In direct reinforcement, the consequence for the behavior is reinforcement delivered by another organism. Automatic reinforcement does not require this mediation of consequences by another organism. An important concept here is that producing a reinforcing stimulus is automatically reinforced by the presence of the reinforcing stimulus.

In *Verbal Behavior* (1957), Skinner provided an example to describe the process in which vocal sounds could become automatic reinforcers:

> The young child alone in the nursery may automatically reinforce his own exploratory vocal behavior when he produces sounds which he has heard in the speech of others. The self-reinforcing property may be merely an intonation or some other idiosyncrasy of a given speaker or of speakers in general. Specific verbal forms arise from the same process. The small child often acquires verbal behavior in the form of commendation used by others to reinforce him. The process is important in the automatic shaping up of standard forms of response. (p. 58)

The implications of automatic reinforcement for an interpretation of language acquisition are dramatic, particularly for the claim that reinforcement contingencies are inadequate to explain the rapidity with which complex verbal constructions are acquired. Every verbal response offers an occasion in which a reinforcing effect might be observed. However, at present it is difficult to predict whether automatic reinforcement will in fact occur on a given occasion. As noted above, a neutral stimulus can acquire a reinforcing function as a result of being paired

with an established reinforcer (Bijou & Baer, 1965; Smith et al., 1996; Sundberg et al., 1996; Vaughan & Michael, 1982). This conditioning process and consequent automatic reinforcement have been recognized as important issues, but there have been relatively few empirical investigations of theses processes.

Recently, Sundberg et al. (1996) demonstrated that vocal sounds, words, or phrases could be conditioned as reinforcing stimuli by being paired with an established reinforcer. Using 4 participants with severe to moderate language delays between the ages of 2 and 4 years who demonstrated a range of 100 to 300 mand and tact repertoires and 1 typically developing participant, their data showed that the response products (utterances, words, or phrases) gained stronger control over the producing of the stimulus (vocalization responses). Direct reinforcement was unnecessary for the establishment of new vocal sounds. A study by Smith et al. (1996) paired a neutral stimulus with three different stimuli: reinforcing stimuli, punishing stimuli, and neutral stimuli. Using 2 typically developing participants between the ages of 11 and 14 months, their findings demonstrated that a pairing procedure could condition stimuli as punishers as well as reinforcers. Results from a study by Yoon (1998) indicated that a similar pairing procedure was effective in evoking new vocal sounds and in the subsequent acquisition of the mand function for 5 preschoolers with severe language delays who did not demonstrate any vocal mand or tact repertoires. In this study, new vocal sounds were paired with reinforcers and were shaped as mands immediately following the pairing sessions. Moreover, the participants maintained their newly acquired vocal mands in a 2-week follow-up.

Considering the importance of early language acquisition as a subject matter, much has been left to theoretical speculation. There have been relatively few experimental studies that have investigated pairing procedures and automatic reinforcement as controlling variables (e.g., Smith et al., 1996; Sundberg et al., 1996). This is due, in part, to the methodological difficulties in separating and measuring a behavior from its product and manipulating the variables (Vaughan & Michael, 1982). Nevertheless, an analysis of the pairing procedure and automatic reinforcement is still needed and requires further empirical support.

The first experiment in the current study addressed this topic by systematically replicating the study by Sundberg et al. (1996) to confirm and extend their findings. The method and procedure used in this study were similar to those of Sundberg et al., except for a difference in participants' vocal repertoire, the number of pairings presented, and the duration of total sessions. Participants in the first experiment of the current study had shown limited imitation skills and few vocalizations in both structured trials and free-operant settings. Thus, this experiment investigated whether the procedures would be effective in establishing a new vocal response with a baseline rate of zero. The second experiment in the current study attempted to compare the effect of the pairing procedure with that of echoic training and to investigate the difference between automatic reinforcement and direct reinforcement on vocalizations.

EXPERIMENT 1

METHOD

Participants

Three preschoolers between the ages of 3 and 4 years participated in this study. All 3 participants (Participants A, R, and W) had severe developmental delays, no speaker behavior, and limited listener skills. Participant A could imitate large gross motor movements without any physical prompts, and Participants R and W could do so with physical prompts. All participants had no oral motor or vocal verbal imitation skills. With regard to vocal play,

which might show vocalizations that had already been conditioned as reinforcers, Participant W had been observed to vocalize two sounds in a free-operant setting. The sounds included repetition of "duh-gha" or "sh" sounds, which mainly occurred while he was engaging in stereotypic behaviors (e.g., hand flapping). Participants R and A did not engage in vocal play to the extent that Participant W did.

Setting and Materials

This study took place in a private, not-for-profit preschool located in a suburb of New York. During the study, sessions were conducted in a room (2 m by 1.5 m) containing a small preschool-size table, two chairs, simple toys, and books. Only the experimenters and a participant were present in the room during the sessions.

The materials used in this study included a tape player and a tape recorder. The tape player presented the experimenter's voice indicating when to present pairing trials. That is, the tape started by saying, for example, "Start with one," and indicated each interval by saying, "One . . . two . . . one . . . two . . ." This tape player was used only during the pairing condition. The tape recorder was used to record participants' vocal sounds during all sessions.

Selection of Reinforcing Events

The stimulus chosen as the reinforcing event was physical interaction, which consisted of tickling, light poking in the stomach, or hand swinging for all 3 participants. The selection was made based on a general functional reinforcer assessment. Because these physical interactions had been shown to serve a reinforcing function in these assessments, they are called "reinforcers" below even when they were not serving a reinforcing function. During the stimulus–stimulus pairing procedure, for example, it was convenient to refer to the tickling and poking as primary reinforcers even though they did not explicitly function as reinforcers in that phase of the experiment.

Response Definition and Recording System

All target sounds were one-syllable utterances or, because of participants' limited articulation, a sound approximating the target form. Each utterance was recorded as one vocal sound. A target vocal sound was identified during the prepairing sessions and was chosen only if it had not been observed to occur either during the prepairing sessions or in a 20-min observation period in a classroom setting. The target sounds were "ah" for Participant A, "eee" for Participant W, and "uhm" for Participant R.

Vocal sounds emitted by each participant were recorded on a tape recorder during all sessions, and were replayed for data collection after the sessions were completed. Different durations of time bins were assigned to each participant based on his or her rate of other vocalizations observed prior to this study. The number of target vocal sounds was recorded in time bins of 10 s for Participant A, 30 s for Participant R, and 1 min for Participant W.

Experimental Design

The study employed a single-subject design with prepairing, pairing, and postpairing conditions presented consecutively, and multiple baselines across participants. The dependent variable was the total number of target vocalizations emitted by each participant. The independent variable was the presentation of stimulus–stimulus pairings in which the experimenter produced the target vocal sound and simultaneously provided physical interaction with the participant.

Procedure

Prepairing (baseline). No reinforcers were manipulated during this condition. Toys and books were available

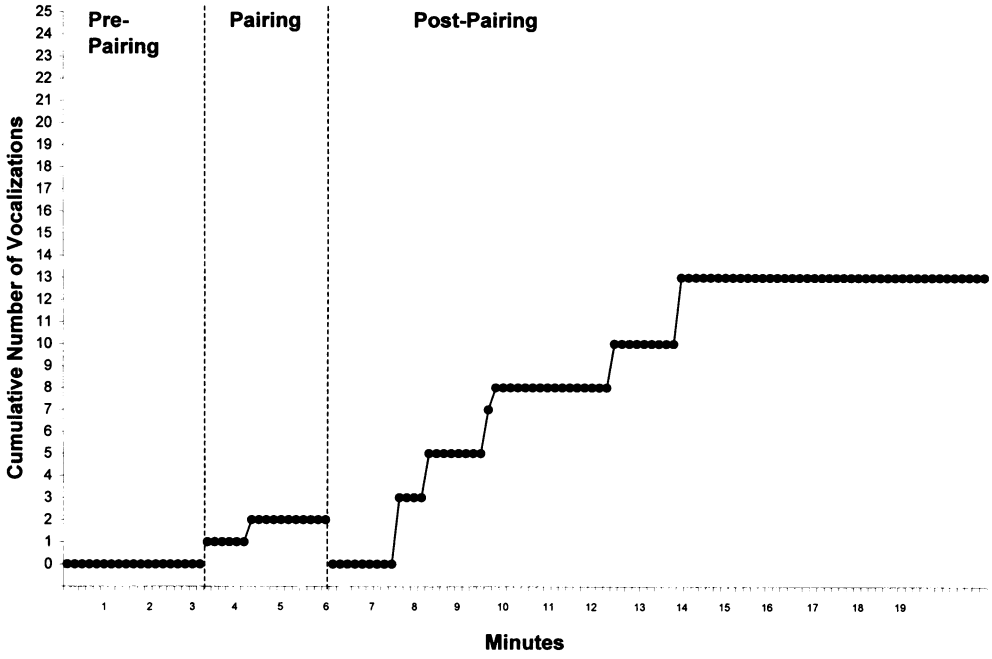

Fig. 1. Cumulative number of target vocalizations emitted by Participant A. Each datum represents the cumulative number of the target vocalizations at each consecutive 10-s time bin.

on the floor for the participant to manipulate. The experimenter did not interact with the participant vocally or physically. When interaction was unavoidable (e.g., the participant reached to the experimenter for attention), the experimenter discontinued the session, and an attempt to repeat the session was made 20 to 30 min later.

Pairing. Sessions in the pairing condition started immediately after the prepairing condition. The experimenter emitted the target vocal sound and simultaneously paired it with physical interaction. 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 physical interaction, there were no vocal or physical interactions between the experimenter and the participant during the session.

Postpairing. Postpairing sessions immediately followed the pairing sessions. The data-collection procedure was identical to that in the prepairing sessions.

Interobserver Agreement

For all participants across all sessions, 100% interobserver agreement was achieved. After the sessions were completed for each student, the experimenter and one observer simultaneously listened to the tape that recorded each participant's vocal sounds during all sessions and recorded the occurrences of target vocal sounds per time bin on a separate form without making any contact with each other.

RESULTS

Participant A

Figure 1 represents the cumulative number of vocalizations by Participant A. There were no occurrences of the target sound during the prepairing condition. In the 3-min pairing condition, the target sound occurred twice, with a rate of 0.7 per minute. After approximately 1 min in the postpairing condition, Participant A's target vocalization occurred three times. For about the next 7 min, vocalizations occurred in

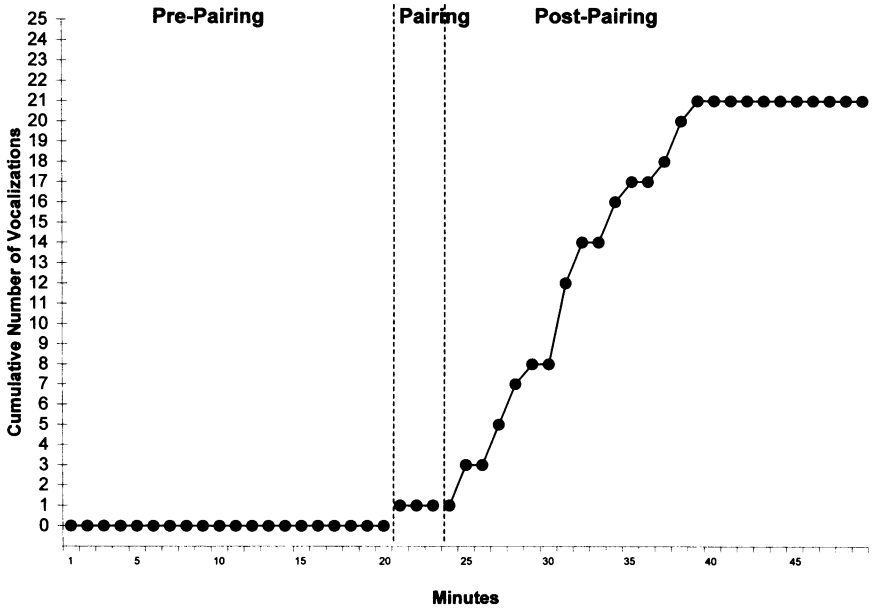

Fig. 2. Cumulative number of target vocalizations emitted by Participant W. Each datum represents the cumulative number of target vocalizations at each consecutive 1-min time bin.

bursts of three for an overall rate of 1.6 target vocalizations per minute during this portion of the session. No target responses were observed after the 8th minute of the postpairing condition.

Participant W

Figure 2 represents the cumulative number of vocalizations by Participant W. No target vocalizations occurred during the prepairing condition. During the pairing condition, one occurrence of the target vocalization was observed (0.3 per minute). In the postpairing condition, a steep slope was observed. The target vocalizations increased immediately and continued for 16 min at a fairly steady rate of 1.25 per minute. No responses were observed during the last 11 min of the session.

Participant R

Figure 3 represents the cumulative number of vocalizations by Participant R. The prepairing condition lasted for 10 min with no target vocalizations emitted. No target vocalizations were emitted during the pairing condition. During the postpairing sessions, Participant R's target vocalizations showed a rapid increase, with two occurrences in the 1st minute. Another increase in target vocalizations was observed in the 2nd and 3rd minutes, with an overall rate during the first 3 min of 2.7. No further responses occurred after the 3rd minute.

Discussion

The data from Experiment 1 support findings from three previous studies (Smith et al., 1996; Sundberg et al., 1996; Yoon, 1998). First, the pairing procedure was effective in increasing the rate of target behaviors. All target vocalizations started from a baseline rate of zero and increased immediately after the pairing sessions, with a mean rate of 1.85 per minute across participants (range, 1.25 to 2.7). A plausible interpretation of these results was that the target vocal sounds had, in fact, been conditioned as reinforcers and functioned to strengthen and briefly maintain vocalizations when produced by the participants themselves. The

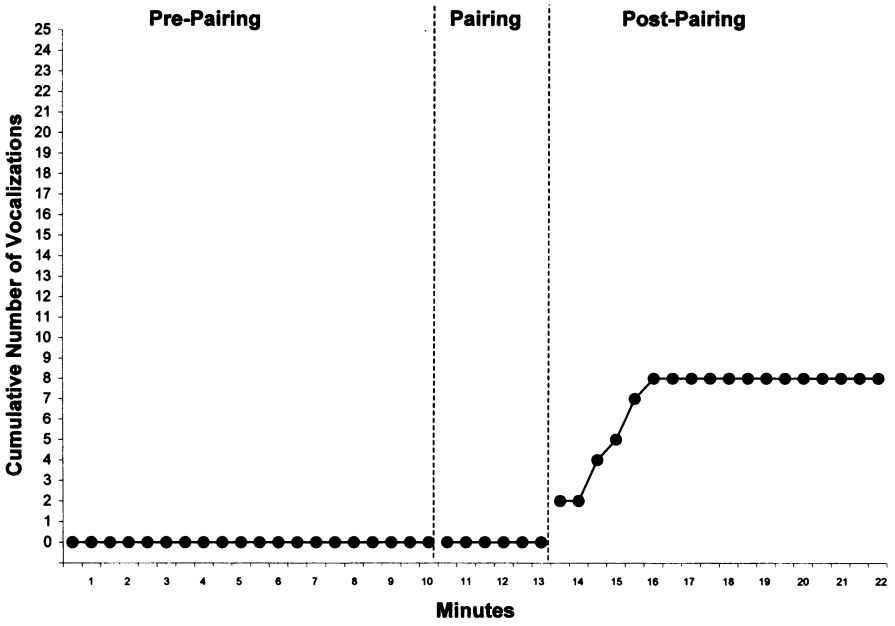

Fig. 3. Cumulative number of target vocalizations emitted by Participant R. Each datum represents the cumulative number of target vocalizations at each consecutive 30-s time bin.

pairing phase provided conditions under which one would expect a neutral stimulus to acquire a conditioned reinforcing function, and the final phase showed an apparent reinforcing effect. The results were not simply a motivational or arousal effect, because the observed behavior in each case was specific to the sound paired with the primary reinforcer. That is, only the target vocalization increased in frequency. This finding was consistent with the study by Yoon (1998), which showed a dramatic increase in frequency for the target vocalizations and a decrease or no change in other vocalizations during the postpairing condition. If the increase in behavior were the result of a general increase in activity, the effect would not have been specific to the target response.

It is noteworthy that the occurrence of Participant W's target vocal sounds was more dramatic than that of the other 2 participants. Participant W was the only subject who showed some vocal play skills prior to the current experiment. It may be that this participant's reinforcement history through pairing or vocal play prior to the onset of these procedures might bear on the size of the effect.

The effects of pairing were temporary, as in previous studies. The target vocalizations stopped after a mean of 9 min across participants, with a range of 3 to 16 min. This may have been the result of the extinction of the conditioned reinforcing function, because each target response in the postpairing phase was an extinction trial for that function.

What remained unexplained in this interpretation was the origin of the first target response by the participant. Reinforcement could explain the strengthening of a response but not its origin. For all participants, the target response began immediately upon the termination of pairings, and 2 participants emitted their target vocal sound during the pairing condition. Perhaps the response was in the participants' repertoire and was simply brought to strength by the pairing procedure. Or perhaps the participants had the basic phonemes in their repertoire and the sound used, being very simple, was

easy enough to reproduce. In either explanation, it is likely that the first response of each subject was under echoic control. Otherwise it is difficult to explain why the target response was emitted. Target responses in all participants occurred immediately after the beginning of the postpairing condition and not before, suggesting that the termination of periodic presentations of the primary reinforcers served as an establishing operation, much as extinction typically briefly increased response force, rate, and variability and evoked emotional behavior.

Participants A and W emitted the target sound during the pairing condition and experienced adventitious contingencies. Although the occurrence during the pairing sessions was infrequent (once for Participant W and twice for Participant A) when compared to occurrences during postpairing, it is possible that the target vocalization was briefly under control of direct reinforcement which strengthened the echoic function of the vocalizations. The function of target vocalizations during postpairing for these 2 participants may have been partly echoic (self-echoic), and the postpairing responses would reflect the extinction of the effect of the direct, but adventitious, contingencies. However, this alternative interpretation could not apply to Participant R, who did not emit a target response in the pairing phase of the experiment.

EXPERIMENT 2

Experiment 2 was designed to evaluate the possibility that the results of Experiment 1 may have been partly due to direct reinforcement contingencies for 2 participants. In this experiment, vocalizations were compared in two reinforcement procedures: pairing and echoic. The pairing process was, once again, used to establish automatic reinforcement contingencies. The echoic condition was used to establish direct reinforcement contingencies.

METHOD

The general procedures for setting, materials, selection of reinforcing events, and response definitions were identical to those in Experiment 1. Participants W and R from Experiment 1 and 1 new participant were involved in this study. The new Participant N had also shown limited skills in oral motor movements and vocal verbal sounds. He did not show vocal play skills in a free-operant setting.

Response Definition

A target vocal sound was identified during the prepairing sessions. The target sound was chosen because it did not occur during the prepairing sessions. Also, the experimenter and the second observer agreed that the vocal sounds did not occur in other settings (e.g., in the classroom). The target sound was "ah" for Participants N, W, and R.

Experimental Design

The study employed a single-subject design with preechoic, echoic, postechoic, pairing, and postpairing conditions and multiple baselines across participants. Conditions were consecutively presented in that order. We did not counterbalance the echoic and pairing conditions across participants because if the target vocalizations occurred during echoic or postechoic training prior to the pairing or postpairing conditions, then it would confirm that the target response was under echoic control. The dependent variable in this study was the total number of target vocalizations emitted by each participant. The independent variables were (a) the presentation of a stimulus–stimulus pairing procedure identical to the pairing procedure in Experiment 1 and (b) the presentation of an echoic condition in which the experimenter produced the target vocal sound as an antecedent and provided reinforcers contingent upon a correct echoic response.

Procedure

Preechoic. Toys and books were available on the floor for the participant to manipulate. The experimenter did not interact vocally or physically with the participant. When interaction was unavoidable (e.g., the participant reached to the experimenter for attention), the experimenter discontinued the session. An attempt to repeat the session was made 20 to 30 min later.

Echoic. Echoic sessions started immediately following the preechoic sessions. The experimenter emitted the target vocal sound as an antecedent. If the participant correctly echoed the target vocal sound within 1 s, the experimenter delivered the reinforcer (physical interaction) immediately. There was no correction for incorrect emission or nonoccurrence of the target vocalizations. Approximately 36 echoic trials were presented for 3 min. Of course, if the participant did not emit an echoic response, this condition reduced to 36 spaced presentations of the target stimulus with no presentations of the reinforcing stimulus.

Postechoic. Postechoic sessions immediately followed the echoic sessions. Data-collection procedures were identical to those in the preechoic sessions.

Pairing. Pairing sessions started immediately after the postechoic sessions. The experimenter emitted the target vocal sounds and immediately paired it with physical interaction. Approximately 36 pairings were presented per 3-min pairing session. Except for the experimenter's target vocal sound paired with physical interaction, there were no vocal or physical interactions between the experimenter and the participant.

Postpairing. Postpairing sessions immediately followed the pairing sessions. Data-collection procedures were identical to those in the postechoic sessions.

Interobserver Agreement

By using the same procedure in Experiment 1, 100% interobserver agreement was achieved for all participants across all sessions.

RESULTS

Participant N

The cumulative number of target vocalizations by Participant N is shown in Figure 4. There were no target vocalizations in the preechoic and echoic conditions. There was one occurrence of the target vocalization during postechoic sessions. Vocalizations remained at zero during pairing sessions. Participant N's target vocalizations immediately occurred in the first time bin of postpairing sessions. Target vocalizations continued to occur during postpairing sessions, with an average rate of 0.4 per minute. The postpairing sessions continued for about 20 min with no extinction of the target sound. Thus, the pairing procedure increased target vocalizations, and the echoic procedure had no effect. These results do not permit one to evaluate the effect of direct contingencies, because none occurred, but they offer another example in which the obtained effect cannot be attributed to that variable.

Participant W

The cumulative number of target vocalizations by Participant W is shown in Figure 5. The participant emitted no target vocalizations during the preechoic condition, which lasted for 13 min. There were also no target vocalizations during the echoic, postechoic, and pairing conditions. Once again, the occurrence of target vocalizations was observed immediately in the postpairing condition. The participant produced the target vocal sounds with a rate of 2.8 per minute for the first 8 min of the condition, but no further responses occurred after that. Results from this participant indicate that the pairing procedure was the controlling variable for the increase in the target vocalization, and that merely presenting the target stimulus alone (the echo-

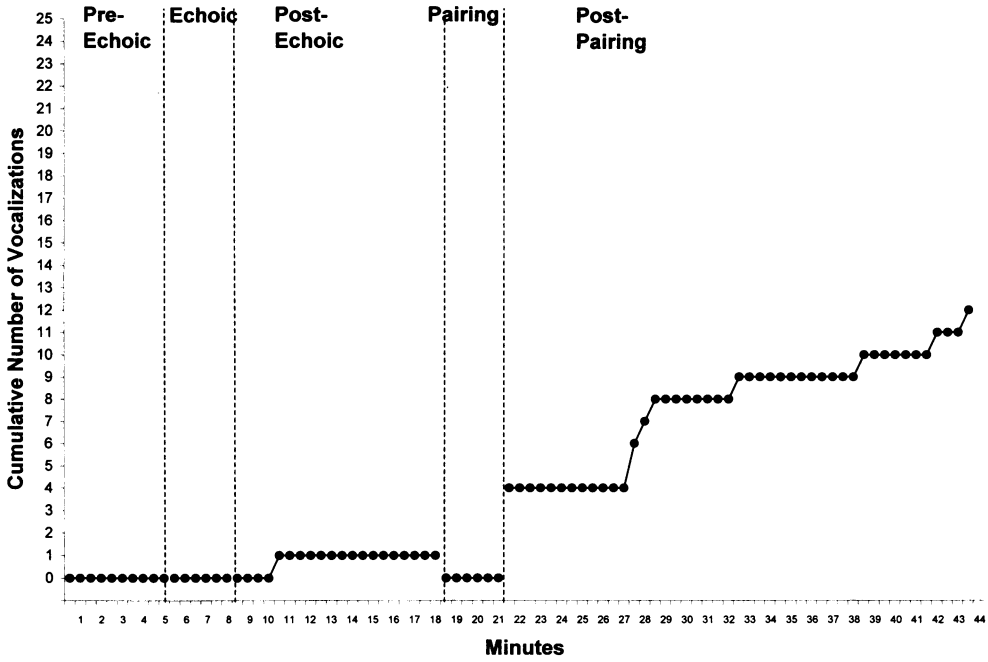

Fig. 4. Cumulative number of target vocalizations emitted by Participant N. Each datum represents the cumulative number of target vocalizations at each consecutive 30-s time bin.

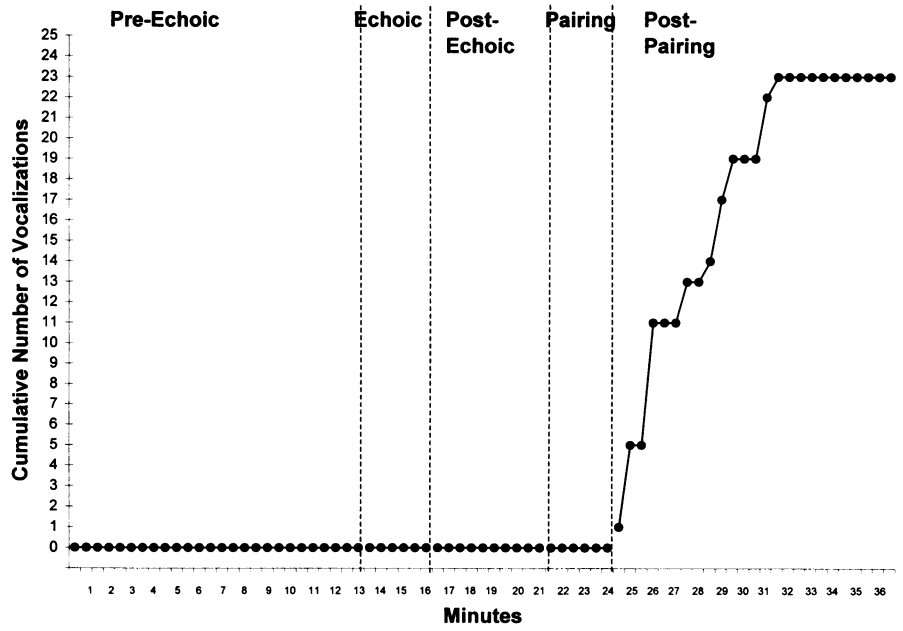

Fig. 5. Cumulative number of target vocalizations emitted by Participant W. Each datum represents the cumulative number of target vocalizations at each consecutive 30-s time bin.

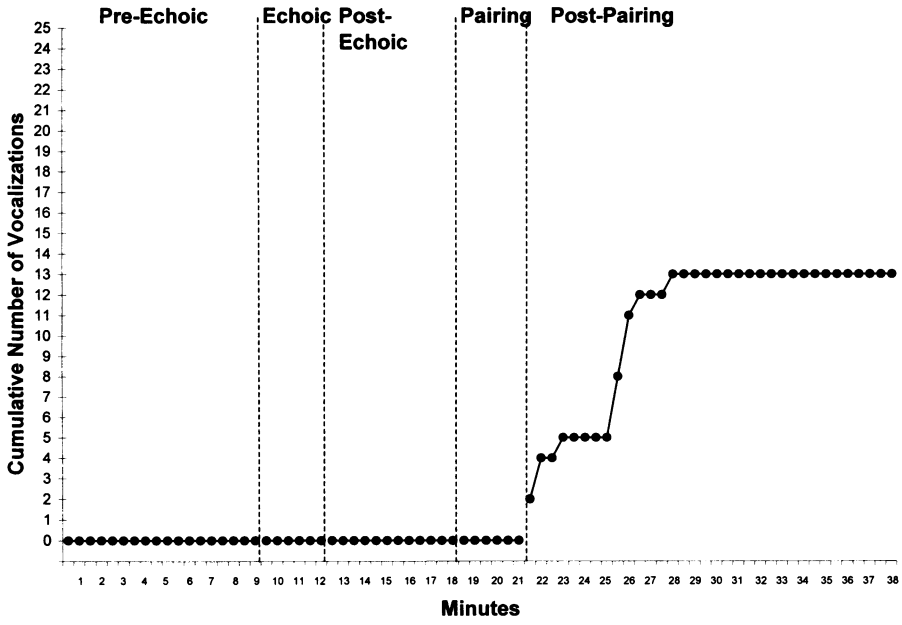

Fig. 6. Cumulative number of target vocalizations emitted by Participant R. Each datum represents the cumulative number of target vocalizations at each consecutive 30-s time bin.

ic condition) had no effect on evoking the target response.

Participant R

The cumulative number of target vocalizations by Participant R is shown in Figure 6. As was the case with Participant W, there were no target vocalizations in the preechoic, echoic, postechoic, and pairing conditions. Vocalizations remained at zero until postpairing sessions began. Participant R's target vocalizations immediately occurred consistently through the 8th minute, with a rate of 1.4 per minute. Target vocalizations were no longer observed after that. Participant R was observed for 10.5 min, at which point it was determined that the vocalizations had been extinguished. As with Participant W, the echoic procedure had no effect on conditioning vocal sounds as a reinforcer. Results from all participants indicate that the pairing procedure had an effect, although temporary, on increasing target vocalizations, whereas presenting the target stimulus alone had no effect.

Discussion

Results from Experiment 2 show that the stimulus–stimulus pairings were effective in evoking target behaviors, presumably through the conditioning of the sounds as reinforcers. Data from the pairing and postpairing conditions in Experiment 2 show results similar to those of Experiment 1. The vocalizations of Participants W and R occurred for about 8 min immediately after the pairing sessions, and were extinguished after that. Participant N's data were interesting in that the immediate rate of his target vocalizations during the postpairing sessions was not as high as the rates of the other 2 participants. However, unlike the other 2 participants, Participant N continued to emit the target vocal sound throughout the session. Relevant variables accounting for this difference and in need for further investigation include establishing operations, differences in value of the reinforcers that are paired with vocal sounds, and differential satiation.

Data from echoic and postechoic

conditions for all 3 participants indicate that, as implemented, the echoic procedure had no immediate effect on the occurrence of the target vocalizations. Perhaps a target response might have occurred and been reinforced as an echoic if the direct contingency had been in effect for a longer period of time. Or perhaps echoic training became aversive for these children and nonresponding resulted in less aversive activities. In any case, the present data could not be attributed to direct contingencies, and this seemed to exclude the interpretation that the target responses were self-echoics. Findings from Experiment 2 support the suggestion that automatic reinforcement and direct reinforcement contingencies are alternative ways in which a response might be strengthened. Moreover, it appears that automatic reinforcement contingencies can be established by a pairing procedure like that of the present study. What remains to be investigated is whether the automatic reinforcement procedure would lead to echoic or manding behavior faster than direct echoic training. Although findings from the current study clearly show the effects of the pairing procedure on inducing novel vocalizations, refinement of the procedure to shape those vocalizations to be functional verbal behavior is in need of further investigation.

GENERAL DISCUSSION

The purpose of the current study was to investigate the effects of a stimulus–stimulus pairing procedure as a controlling variable for conditioning vocal sounds as a reinforcer and to support the suggestion that automatic reinforcement plays an important role in language acquisition. The results of this study indicate that vocal sounds can acquire a reinforcement function through the pairing procedure and thus increase the rate of vocalization. Furthermore, these findings indicate that vocalizations of participants with communication delays can come under the control of stimulus-stimulus pairing procedures. The results are consistent with previous findings by Sundberg et al. (1996) and Smith et al. (1996), and suggest that adult-generated vocal sounds, combined with social interaction, are major factors in how infants and young children engage in and develop vocal repertoires (Bijou & Baer, 1965; Hart & Risley, 1995). In addition, the results of the two experiments indicate that adult vocalization, when paired with a reinforcing event, is one controlling variable that may explain the rapid induction and development of vocal sounds by young children with a limited vocal repertoire.

The results of Experiment 2 provide an analysis of vocalizations in two different procedures: verbal stimuli alone, and stimuli paired with a reinforcer. An immediate increase and temporary maintenance of the target vocalization were observed only with the pairing procedure. Thus, the results support the premise that conditioned reinforcement is established by the pairing procedure, and support the interpretation that there is a distinction between automatic and direct reinforcement contingencies.

Children with severe language delays often demonstrate low occurrence of vocalizations. Even though they may vocalize, the vocalizations are limited to a few sounds (Lovaas, Varni, Koegel, & Lorsch, 1977). Introducing echoic training to this population has not always been successful. The current study confirms previous findings (e.g., Yoon, 1998) indicating that a pairing procedure might be necessary for children who emit limited vocal sounds prior to echoic training, and the pairing procedure provides potential alternative explanations for strategies for teaching children with severe language delays to expand vocal repertoires (e.g., vocal play).

In some respects, the current study differed from previous studies (e.g., Smith et al., 1996; Sundberg et al., 1996). First, the present study used participants who had no form of vocal mand or echoic in their repertoires. Even so, pairing produced a sudden

emergence and increase in vocalizations. That is, the target sounds that had never been observed before (both during preechoic and observation in free-operant settings) occurred immediately after the pairing sessions. This dramatic and sudden increase did not always occur in the study by Smith et al. Possible variables include competing establishing operations, participants' current emotional status (Smith et al.), number of pairings, and pairing history (Sundberg et al.). Data from Participant W, who demonstrated vocal play skills, showed a much more dramatic increase in the rate of target vocalizations when compared to the other 4 participants who did not show vocal play. These results suggest that each child's history of reinforcement through a pairing procedure is a variable. In addition, participants' basic response systems (e.g., oral motor mechanism) and difficulty level of responding may be important factors. For all participants in the current study, target sounds were selected based on ease of articulation. Pairing sentences for the current participants would not have produced the same degree of increase.

Second, although the current study does not present any new information regarding variables that control extinction of the target sounds, it should be noted that blends of the target sound with others or alteration of the target sound was observed while the target sounds started to extinguish. Blends of the target sound with other sounds or alteration of the target sounds (e.g., "euh" or "ahm" for the target "ah") were not recorded as an occurrence of the target sound. Interestingly, these results are somewhat similar to those of Sundberg et al. (1996). They observed the occurrence of old phrases when a new phrase was introduced to pairings. We agree that the pairing history or emergence of a general response class may be important variables and further speculate that those variables control how children's vocal play gets strengthened and expanded.

Third, the current study did not examine whether the target vocal sounds could acquire any other functions (e.g., mand) other than automatic reinforcement. Providing a mand contingency subsequent to the increased frequency of target sounds after the pairing session might provide an explanation as to why children rapidly acquire vocal repertoires (e.g., vocal play) and almost simultaneously learn to mand or tact.

The results of this study add to the body of research conducted on the use of the pairing procedure for establishing an automatic reinforcement contingency. In particular, the current findings add to the growing body of literature on early language acquisition. Continued research should be conducted in this area to refine the role of pairing history, variables controlling expansion of vocal sounds, and subsequent acquisition of verbal behavior.

A question requiring further research, for example, is where the first response in the postpairing condition comes from. As noted above, the fact that a response may serve an automatic reinforcing function can only explain the increase in strength of a behavior; the first response in a sequence, before reinforcement, necessarily has other origins. This raises the question whether these other sources of control might not also contribute to the burst of behavior in the postpairing condition. Future experiments might present a second vocal stimulus during training that is explicitly unpaired with the reinforcer. Any subsequent differences in rate between the paired and unpaired vocalizations might reflect the effects of automatic reinforcement more precisely.

Whatever the ultimate theoretical interpretation of the data is, the present study, together with previous studies, provides a powerful tool for applied behavior analysts who work with children with very limited vocal responses. Pairing new vocal stimuli with known reinforcers can increase the variability of a child's vocal responses, and the effect appears to be significant. By in-

creasing variability, there is an increase in the pool of responses from which shaping procedures can be drawn to extend children's functional verbal behavior.

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