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AN EVALUATION OF THE NUMBER OF PRESENTATIONS OF TARGET SOUNDS DURING STIMULUS–STIMULUS PAIRING TRIALS

ADRIANE MILIOTIS, TINA M. SIDENER, AND KENNETH F. REEVE

CALDWELL COLLEGE

VINCENT CARBONE

THE CARBONE CLINIC

DAVID W. SIDENER

GARDEN ACADEMY

LISA RADER

CALDWELL COLLEGE

AND

LARA DELMOLINO

RUTGERS UNIVERSITY

We evaluated the differential effects of 2 variations of a stimulus–stimulus pairing procedure on the vocalizations of 2 children with autism. For both participants, presenting 1 sound per pairing trial resulted in a higher rate of vocalizations than 3 sounds per pairing trial.

Key words: autism, stimulus–stimulus pairing, vocalizations

Stimulus–stimulus pairing (SSP) of vocalizations pairs the speech of others with the delivery of highly preferred items. The goal of this procedure is to produce a temporary increase in vocalizations, thus creating a larger variety of sounds that can subsequently be brought under appropriate stimulus control (Esch, Carr, & Grow, 2009). To date, 12 studies have evaluated SSP of vocalizations. Nine studies demonstrated a temporary increase in at least one target vocalization with 19 of the 25 participants (Carroll & Klatt, 2008; Esch et al., 2009; Miguel, Carr, & Michael, 2002; Rader et al., in press; Smith, Michael, & Sundberg, 1996; Sundberg, Michael, Partington, & Sundberg, 1996; Ward, Osnes, & Partington, 2007; Yoon & Bennett, 2000; Yoon & Feliciano, 2007). Three studies failed to demonstrate an increase in any target vocalizations for any of the participants (Esch, Carr, & Michael, 2005; Normand & Knoll, 2006; Stock, Schulze, & Mirenda, 2008).

Although the reason for these discrepant findings is unknown, one procedural variation that may produce differential outcomes is the number of presentations of the target sound per pairing trial. For example, the instructor could present the target sound once (e.g., "buh") or multiple times (e.g., "buh, buh, buh") during each pairing trial. Of the nine studies that demonstrated an increase in vocalizations, four presented the target sound once per pairing trial (Smith et al., 1996; Sundberg et al., 1996; Yoon & Bennett, 2000; Yoon & Feliciano,

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Address correspondence to Tina M. Sidener, Department of Applied Behavior Analysis, Caldwell College, 120 Bloomfield Ave., Caldwell, New Jersey 07006 (e-mail: tsidener@caldwell.edu).

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2007). The remaining five studies presented the target sound either three (Esch et al., 2009; Rader et al., in press) or five (Carroll & Klatt, 2008; Miguel et al., 2002) times per pairing trial or did not report this information (Ward et al., 2007). The studies that did not demonstrate an increase in vocalizations presented the target sound three (Esch et al., 2005), five (Stock et al., 2008), or seven (Normand & Knoll, 2006) times per pairing trial. Stock et al. (2008) suggested that any pairing ratio of more than two presentations of the target sound per delivery of the highly preferred item would result in the target sound being paired more frequently with withholding of the highly preferred item than with its immediate presentation. The discrepant findings across studies that contained different pairing ratios warrant additional research to compare the effects of several pairing ratios on target vocalizations.

The purpose of the current study was to evaluate the differential effects of an SSP procedure that varied only in the number of presentations of the target sound per pairing trial on the rate of low-frequency vocalizations in children with autism.

METHOD

Participants and Setting

Participants were two children who had been diagnosed with autism: Mary (8 years 4 months) and Nik (6 years 6 months). Both children were selected to participate because their teachers reported that prior attempts to teach echoics and vocal mands had been unsuccessful. Results of the Behavioral Language Assessment (BLA; Sundberg & Partington, 1998) and Early Echoic Skills Assessment (EESA; Esch, 2008) for Mary indicated low-frequency vocal play and no echoic behavior (BLA Level 1–2; EESA Level 0). Assessment results for Nik indicated low-frequency vocal play (BLA Level 2), with six responses under some echoic control (EESA Level 2). During a 60-min free-play period with access to moderately preferred toys and no social interaction, the average rate of vocal play for Mary and Nik was 0.43 and 2.58 vocalizations per minute, respectively.

Sessions were conducted 3 to 5 days per week; they lasted approximately 5 to 15 min, but never more than 20 min. We conducted two sessions, one with each level of the independent variable, each day with sessions presented in a quasirandom order. A brief play period followed each session. The session room was familiar to each child and included moderately preferred toys. Closed opaque boxes contained highly preferred edible items and toys.

Response Measurement, Interobserver Agreement, and Procedural Integrity

Observers collected within-session data during each trial and during intertrial intervals on four vocalizations for each participant: two target paired (S+) vocalizations and two nontarget nonpaired (S–) vocalizations. We selected vocalizations if they occurred during 1% to 5% of 30-s intervals during the 60-min free-play period and assigned them to each condition quasirandomly (see Figure 1). Both target and nontarget vocalizations were defined as the participant's production of any vocalization that matched or was acoustically similar to the model (e.g., "uh" for "buh"). Observers scored any target or nontarget vocalization emitted by the participant that was separated by a 1-s interval without vocalizations as one response (Esch et al., 2009).

We calculated interobserver agreement on the frequency of target and nontarget vocalizations using the total frequency method (Esch et al., 2009). Mean interobserver agreement was 96% (range, 90% to 100%) for Mary and 99% (range, 97% to 100%) for Nik. Procedural integrity data were collected on the correct implementation of baseline and SSP procedures during at least 33% of sessions across conditions. We scored an instance of procedural integrity if the experimenter implemented all aspects of the procedures as indicated in the

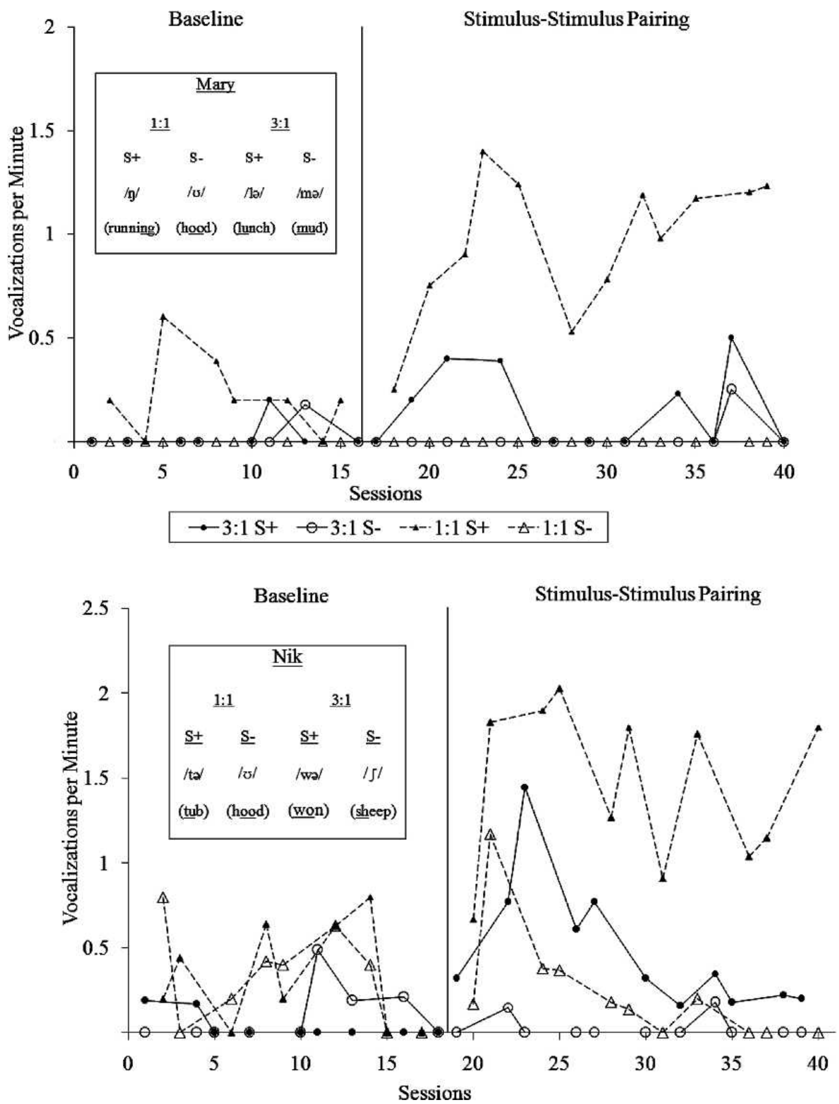

Figure 1. Within-session data on the rate of target and nontarget vocalizations for Mary and Nik. The inset box shows the specific sounds for each participant for each condition presented in the International Phonetic Alphabet with sample words exemplifying the sounds. S+ = target vocalizations; S– = nontarget vocalizations.

protocol. Mean procedural integrity was 97% (range, 91% to 100%) for Mary and 98% (range, 95% to 100%) for Nik.

Design and Procedure

We compared the effects of four conditions using an adapted alternating treatments design (Sindelar, Rosenberg, & Wilson, 1985). The four conditions included one presentation of the target sound per trial (1:1 S+), one presentation of the nontarget sound per trial (1:1 S–), three presentations of the target sound per trial (3:1 S+), and three presentations of the nontarget sound per trial (3:1 S–). We based our SSP procedures on the enhanced SSP procedure described by Esch et al. (2009).

Baseline. Before the first session each day, the experimenter presented six items to the participant (three toys, three foods) identified via a stimulus preference assessment (Carr, Nicolson,

& Higbee, 2000). The experimenter rotated among the first three items that the participant touched during the day's sessions. Each baseline session consisted of 20 trials, 10 each of S+ and S–, quasirandomly arranged. Each trial began with a prompt to attend (e.g., "look"). The experimenter then presented the auditory model with exaggerated prosodic patterns (i.e., motherese) without pairing it with a preferred item. The trial concluded at the end of an intertrial interval of either 5 s, 10 s, 15 s, or 20 s, included to reduce temporal predictability as a confounding effect to the SSP effects (Esch et al., 2009). We conducted a separate baseline for each condition. In the 1:1 condition, the experimenter presented the auditory model for approximately 1 s (e.g., S+ "ba"; S– "dee"). In the 3:1 condition, the experimenter presented the auditory model at the rate of one sound per second for 3 s (e.g., S+ "ba, ba, ba").

Stimulus–stimulus pairing. Pairing sessions were identical to those in baseline, with two exceptions. Presentation of S+ trials included immediate delivery of a highly preferred item just before and overlapping with the model (i.e., delay pairing). The other difference was the inclusion of a 20-s correction delay if the participant emitted the target response between the experimenter's model and delivery of the reinforcer during S+ trials. The purpose of this correction procedure was to control for adventitious reinforcement of the target response (Esch et al., 2009).

RESULTS AND DISCUSSION

As seen in Figure 1, substantial and consistent increases in vocalizations occurred only in the 1:1 S+ condition for both participants. For Mary, mean increases from baseline to SSP were 0.75 (1:1 S+), 0 (1:1 S–), 0.11 (3:1 S+), and 0 (3:1 S–), and Nik's mean increases were 1.48 (1:1 S+), 0.08 (1:1 S–), 0.47 (3:1 S+), and 0.07 (3:1 S–). Although vocalizations in the 1:1 S+ condition were slightly higher and more variable than the other targets in baseline for Mary, none of the vocalizations increased during baseline in the absence of treatment. Interestingly, Nik's vocalizations increased initially and subsequently decreased in both the 1:1 S– and 3:1 S+ conditions during treatment.

This investigation is the first to compare the effects of the number of presentations of target sounds per trial during SSP. Although this study did not attempt to isolate specific variables that may be responsible for this effect, several possibilities exist. In addition to the suggestion made by Stock et al. (2008) regarding the ratio of pairing to reinforcement, the conditioned reinforcement literature also notes that the strength of a conditioned reinforcer (i.e., the rate of the sound associated with the paired targets) may depend on the frequency of the primary reinforcers correlated with it (Kelleher & Gollub, 1962). Highly preferred items were correlated less frequently with the target vocalization during the 3:1 condition than during the 1:1 condition, in which sounds were presented only once before item delivery. In addition, Esch et al. (2009) noted that a practical disadvantage of presenting a sound three times was that participants often emitted a triadic response pattern (e.g., "beh, beh, beh"). Presenting a sound only once should decrease the likelihood of triadic response patterns, eliminating the need to alter the response topography during subsequent verbal behavior training.

Several limitations are worth noting. We had difficulty identifying four targets of equivalent difficulty for each participant. Although several methods were identified initially, none were able to isolate four sounds at similar speech sound acquisition stages. Thus, we selected responses that occurred at similar frequencies during a free-play period. In addition, both participants produced the 1:1 S+ target at a slightly higher rate during baseline than the other paired and nonpaired targets, despite random assignment of targets to each condition. Finally, as in Esch et al. (2009), we used the total frequency method to calculate interobserver agreement. Because this method may overestimate agreement, future studies should use a more conservative method (e.g., exact agreement within intervals).

The results of the current study provide preliminary support for use of the 1:1 pairing procedure with children who have failed to respond to other attempts to increase vocalizations. Future research should seek to refine the SSP procedure to produce optimal results, such as the method of pairing (e.g., delay, trace, simultaneous), use of motherese modeling of the vocalizations, more frequent preference sampling to verify the value of stimuli used during pairing (Esch et al., 2009), and the use of social reinforcers (a review of SSP studies revealed that social reinforcers were associated more often with a pairing effect than tangible reinforcers; Stock et al., 2008). In addition, future research should evaluate social validity, demonstrate functional language (e.g., manding) following SSP, and assess differential effects of SSP on novel versus low-frequency targets. Finally, future SSP evaluations should seek to determine the learner profile for which this technology is most relevant.

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