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Increased Variability in Tacting Under a Lag 3 Schedule of Reinforcement

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Research has shown that variability may be an operant dimension of behavior. One method of reinforcing response variability is to use a lag schedule of reinforcement (Page & Neuringer, 1985). Several studies have shown that a Lag 1 schedule is effective in increasing variable responding with human participants (e.g., Esch, Esch, & Love, 2009; Lee, McComas, & Jawor, 2002). In these arrangements, however, the return to baseline responding during reversal phases suggests that the resulting behavior change may not be maintained following intervention. The purpose of the present study was to investigate the effects of a Lag 3 schedule on increasing and maintaining variability of tacts in 2 children diagnosed with developmental disabilities. Results demonstrated increased variability in tacting for both participants and maintenance in variable responding after a 3-week follow-up.
Key words: Extinction, lag schedule, response variability

Variability in responding is socially and adaptively preferred in many situations because having a variety of responses in one's repertoire increases a person's ability to problem-solve (Miller & Neuringer, 2000). Such responding is also valued in social communities (Goetz & Baer, 1973). For example, if someone is accustomed to entering their home by turning the knob on the front door, but the door is jammed, continuing to respond in the same way may not yield entrance, whereas varying responses, such as wiggling the door, calling for help, or entering through an open window may succeed in getting into the house. Similarly, an individual who responds each time to the question, ''What did you do today?'' with the rote response, ''I went to school,'' may not continue to receive social reinforcement as others ''get bored'' and stop responding. Although variability in responding is important in the aforementioned ways, it differs across individuals, sometimes to significant degrees. Individuals diagnosed with autism and other developmental delays, in particular, often exhibit unvaried responses to stimuli, and this stereotypy is characteristic of the diagnosis (American Psychiatric Association, 2000).

A number of different procedures have been developed to increase response variability. For example, Goetz and Baer (1973) reinforced the first occurrence of a response within a given session. This procedure may be appropriate for some situations, such as an art class in which novel responses may be reinforced. Alternatively, Machado (1992) used a frequency dependence procedure with pigeons that based probability of food delivery on how frequently the response occurred, where the less frequent responses were more likely to produce food. In applied settings, there may be similar situations, such as describing a scenario during imaginative play, in which the social community is more likely to reinforce less frequently described scenarios.

However, not all situations call for completely novel responses in each interaction. Some situations may be appropriately approached simply with a sufficient variety of responses even if some are recycled from time to time. For example, continually exhibiting the rote response of, ''I'm fine,''

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when asked, ''How are you?'' may eventually be punished by the community, whereas cycling through, ''I'm fine,'' ''I'm doing well,'' and, ''Great, how about you?'' will sufficiently meet the expectations of the community. One method of reinforcing response variability in this way is a lag schedule of reinforcement, which is characterized by reinforcement being made contingent on a response differing in some defined way from a specified number of previous responses (Page & Neuringer, 1985).

A few studies have investigated the use of lag schedules in applied settings. For example, Lee, McComas, and Jawor (2002) demonstrated that use of a Lag 1 schedule resulted in increased variability in vocal responding to social questions for 2 of 3 participants with autism. Esch, Esch, and Love (2009) also showed increases in vocal variability with two nonverbal children with autism using a Lag 1 schedule.

However, some issues concerning the use of lag schedules in applied settings have yet to be explored. In the aforementioned studies, the return to baseline responding during reversal phases suggests that thinner lag schedules may be investigated to see if the behaviors they engender are maintained. For example, Manabe, Staddon, and Cleaveland (1997) found that song variety increased appreciably in budgerigars when the lag schedule was increased to 3. The results suggested that budgerigars could readily modify vocalizations through extinction of known responses paired with a schedule of food reinforcement for novel responses. In addition, results showed that the birds produced a ''round-robin'' pattern of calls during the first three conditions, but began to produce random behavior in the fourth condition. This study extended existing research showing that variability may be an operant dimension of behavior, and identified the frequency-dependent schedule needed to produce varied behavior in several budgerigars.

To date, the only study to use a Lag 3 schedule with a human participant was carried out by Susa and Schlinger (2012) who demonstrated that a Lag 3 schedule was effective at increasing variability with a child diagnosed with autism. However, no follow-up probes were presented to determine if variability was maintained after initial training. Thus, the present study investigated the effectiveness of a Lag 3 schedule of reinforcement on novel responses in two male children, one diagnosed with a mild intellectual disability and the other with autism and Fragile X syndrome, and presented follow-up probes following intervention to determine if the variability in responding continued to be maintained without exposure to the intervention.

METHOD

Participants

The 2 participants were Link, a 13-year-old boy diagnosed with autism and Fragile X syndrome, and Naota, a 4-year-old boy diagnosed with a mild intellectual disability. Prior to the study, both participants were evaluated for prerequisite skills, including meeting the goal for ''Labels pictures of common items'' as described in the Assessment of Basic Language and Learning Skills—Revised (ABLLS-R), which was demonstrated by correct responding on 80% or more trials over three consecutive sittings (Partington, 2008). Specifically, participants could tact each of the items in a larger picture subsequently used in training. In addition, each participant exhibited no fewer than one, but no more than two, appropriate response variations to the programmed stimuli.

Setting and Materials

Instructors conducted all sessions in the participants' homes. Instructors conducted the training sessions 2 to 4 times per week, and presented a follow-up probe in one session 3 weeks after the last training session.

During each training session, stimuli selected from a stimulus preference assessment were visible and controlled by the instructor. Before beginning the experiment, instructors conducted a multiple-stimulus-without-replacement preference assessment (DeLeon & Iwata, 1996) using stimuli that caregivers, instructors, or the participants had reported as preferred. The highest ranked stimuli were presented along with social praise following appropriate responding on the reinforcement schedule. Link showed a preference for watching DVDs, eating cheese-flavored chips, and interacting with

adults. Naota showed a preference for interacting with adults and playing with various toys. Other stimuli naturally found in the home environment, such as books, television, snacks, etc., were also present.

Definition and Measurement of Target Behaviors

The independent variable in this study was a lag 3 reinforcement schedule. The dependent variable was the frequency of novel tacts emitted within 10 trials. A trial was defined as the presentation of a piece of paper containing a visual array of 10–20 drawn images and the question, ''What do you see?'' followed by a 5-s period during which responding could occur. Responses were scored as novel on a trial-by-trial basis. A novel response was defined as vocally tacting an image located within the visual stimulus array that differed from all previous responses in the same session within 5 s of the question. Other responses (i.e., responses that were repeated during the same session, no response, or an incorrect response) were not scored.

An independent observer collected data on 42% of of sessions for Naota and 43% for Link (minimum 33% in each condition), either through direct observation in the home or remotely through viewing a video recording. An agreement was defined as both observers scoring a trial identically. Point-by-point agreement was calculated on each 10-trial block by dividing the number of code agreements by the sum of agreements and disagreements and converting this ratio to a percentage. Interobserver agreement was 100% for all sessions.

Procedure

A concurrent multiple-baseline-across-participants design with maintenance probes was used to evaluate the effects of the Lag 3 schedule. A trained observer assessed procedural integrity during the same sessions in which interobserver agreement data were collected (minimum 33% in each condition). Integrity was defined as presentation of the programmed stimuli (visual and auditory), providing the programmed consequence within 5 s, and reinforcement delivery on the Lag 3 schedule. Procedural integrity was 100% for each of the recorded or observed sessions.

During baseline, the instructor initiated each of the 10 trials per session by saying the child's name and then presenting the picture with the array of images and saying, ''What do you see?'' This picture, in terms of images displayed in the array, varied across sessions. If the child responded incorrectly or did not respond within 5 s, the instructor initiated the next trial. Any correct tact within 5 s of the question, ''What do you see?'' was followed with high-affect social praise presented along with a preferred stimulus.

The intervention condition was identical to baseline except instructors provided high-affect social praise and preferred stimuli on a Lag 3 schedule. In a Lag 3 schedule, reinforcement is provided for responses that differ from the previous three responses. Therefore, for the first three responses, instructors utilized a reinforcement of different forms procedure, such as the one described by Goetz and Baer (1973). By the fourth response, the instructor implemented the Lag 3 schedule regardless of the prior four responses (i.e., whether they were all novel, all rote, all irrelevant responses, or some combination of those). On this schedule, the instructor ignored incorrect responses, no response within 5 s, or responses that did not differ from the previous three responses, and proceeded to the next trial. In addition, a prompting contingency was present during the first intervention session for each participant. During this session, if two consecutive trials were scored as incorrect, the instructor provided a gestural prompt (finger pointing at an image within the visual array that differed from the three previous responses) after presenting the programmed visual and auditory stimuli, but before the participant responded. The instructor reinforced prompted responses. After each prompted trial, the next trial proceeded without prompting and prompting was reinitiated only if two consecutive trials were scored as incorrect.

During the follow-up condition, no training procedures were implemented. Similar to baseline, any appropriate vocal response within 5 s was followed with high-affect social praise paired with a stimulus selected from a preference assessment.

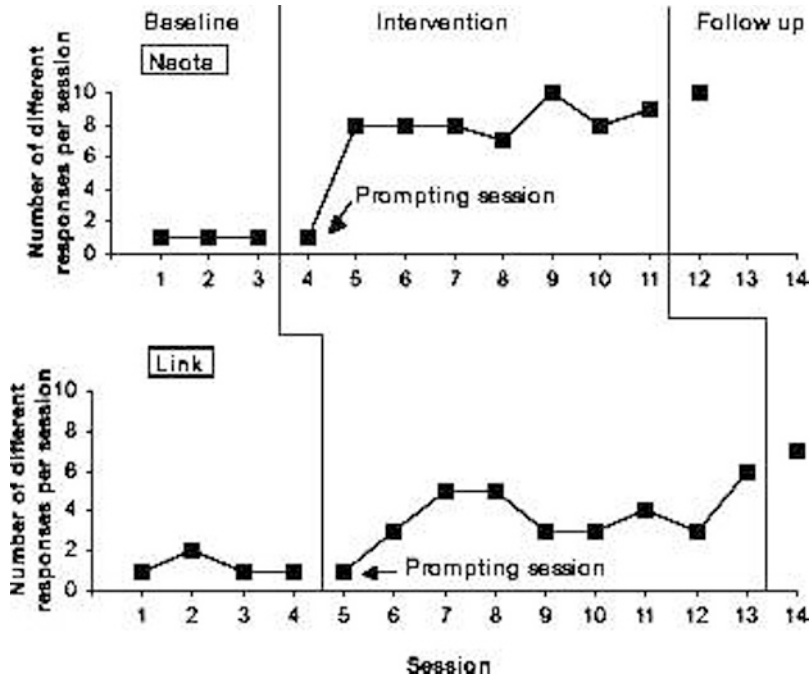

Figure 1. Number of different response topographies emitted during each session.

RESULTS AND DISCUSSION

The results of this study showed that the number of novel responses in 10 trials increased with the introduction of the Lag 3 schedule and were maintained following a 3-week period after the Lag 3 schedule was withdrawn. Figure 1 shows that during baseline, each participant emitted no more than two different responses. During the initial prompting session, only one independent novel response was emitted by each participant; however, several prompted responses were emitted and reinforced during this session. In subsequent sessions, there was an increase in independently produced variable responding for both Link and Naota, ranging from 3–6 different responses per 10-trial session for Link and from 7–10 different responses per 10-trial session for Naota.

In the follow-up session conducted 3 weeks after the Lag 3 schedule was withdrawn, Link and Naota maintained a similar level of responding, with Link emitting 7 different responses and Naota 10 different responses with only pre-intervention contingencies in place (i.e., all correct responses were reinforced, even if they were similar or rote, just as they were during baseline conditions).

These results add to the literature on lag schedules, further supporting the suggestion that they may be an effective method of increasing response variability. During both the intervention and follow-up conditions, Link and Naota's responding approximated random selection as opposed to a scripted pattern (data are available from the authors upon request), consistent with the results found under the Lag 3 condition in the study conducted by Manabe et al. (1997). Thus, the resulting behavior would not require additional training to approximate ''true'' variability. The fact that instructors varied the visual stimuli across sessions further supports the claim that the participants' responding approximated variable responding rather than higher order stereotypy.

Factors other than the Lag 3 schedule may have contributed to the participants' increase in responding during the Lag 3 condition. For example, although the review of past research suggested that variable behavior could

have been achieved without the use of prompting, prompts were utilized in the Lag 3 condition in order to avoid extinction-induced aggression, especially since Link had a history of aggressive behaviors. Although the prompts were relatively nonintrusive, were quickly faded, and were not required to sustain variable responding, it is not known whether combining prompting procedures with the Lag 3 schedule facilitated or hindered the acquisition of variable responding, or if it was a necessary component for teaching.

The results of the present study have important implications for teaching variability in applied settings, particularly to children with developmental delays. Rote responding is characteristic of the diagnosis of autism and is seen in other developmental delays; hence, systematic teaching methods are warranted to address this particular deficit. The teaching strategy utilized in the present study was shown to be effective at increasing variable responding as well as maintaining the effects following withdrawal of the teaching strategy. This strategy may have higher social significance in applied settings than strategies such as those described by Esch et al. (2009) and Lee et al. (2002), in which there was a return to baseline responding following withdrawal of the teaching strategies. This maintenance of effect may have occurred because the schedule of reinforcement used in the present study more closely mirrors the contingencies found in the natural environment than those used in the Lee et al. and Esch et al. studies. Therefore, the present study may be important in establishing a lag schedule as a method of teaching given the greater need for systematically teaching variability in these populations. The study also suggests that lag schedules can be effective with human participants and that its effects can be maintained following withdrawal of intervention for at least a brief period of time. Prior studies on Lag 1 schedules showed that there was a return to baseline levels of response variability following the withdrawal of the lag schedule (Esch et al., 2009; Lee et al., 2002). This was not the case in the present study in which effects were maintained 3 weeks after withdrawal of the intervention. The present study also improved on Susa and Schlinger's (2012) study, which did not incorporate follow up probes to determine if behavior was maintained following withdrawal of the intervention.

Furthermore, incorporating the teaching procedure used in the present study into discrete trial formats, which otherwise focus primarily on strengthening a specific response, may address a common criticism of discrete trial formats (i.e., that they teach children with developmental delays to respond ''robotically'' or in a scripted manner). Addressing the aforementioned criticism using methods such as the one described in the present study may not only strengthen the discrete trial teaching format in and of itself, but also make it more appealing to those outside the field of applied behavior analysis (e.g., families served, complementary service providers, funding sources, etc.). Given that discrete trial formats are commonly conflated with applied behavior analysis as a whole, improving the public appeal of discrete trial training may also extend the same public appeal to other behavior analytic techniques outside discrete trial formats and lead to a wider dissemination of other valuable techniques as well.

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