JOURNAL OF APPLIED BEHAVIOR ANALYSIS 1997, **30,** 451–458 NUMBER 3 (FALL 1997)

ASSESSMENT OF PREFERENCE FOR VARIED VERSUS CONSTANT REINFORCERS

LYNN G. BOWMAN, CATHLEEN C. PIAZZA, WAYNE W. FISHER, LOUIS P. HAGOPIAN, AND JEFFREY S. KOGAN

KENNEDY KRIEGER INSTITUTE AND
JOHNS HOPKINS UNIVERSITY SCHOOL OF MEDICINE

One method that has been demonstrated to improve the effectiveness of reinforcement is stimulus (reinforcer) variation (Egel, 1980). Egel found that bar pressing increased and responding occurred more rapidly during varied reinforcement than during constant reinforcement when identical stimuli were used across phases for 10 individuals with autism. The purpose of the current investigation was to assess the preferences of 7 individuals for varied presentation of slightly lower quality stimuli relative to constant access to the highest quality stimulus. Varied presentation was preferred over constant reinforcer presentation with 4 participants, and the opposite was true for 2 participants. One participant did not demonstrate a preference. These results suggest that stimulus variation may allow less preferred reinforcers to compete effectively with a more highly preferred reinforcer for some individuals.

DESCRIPTORS: reinforcer assessment, paired choice, stimulus variation, concurrent operants

Identification of effective reinforcers continues to be an important component of successful behavioral interventions for persons with developmental disabilities (e.g., Amari, Grace, & Fisher, 1995; Vollmer, Marcus, & LeBlanc, 1994). One approach to identifying reinforcers is to present a variety of stimuli in pairs and have the individual choose one stimulus over the other during each pair presentation or trial in a forced- or paired-choice assessment (e.g., DeLeon & Iwata, 1996; Fisher et al., 1992). Other investigations have focused on methods for increasing the effective use of reinforcers, such as modifying establishing operations (Vollmer & Iwata, 1991), conducting presession reinforcer assessments (Mason, McGee, Farmer-Dougan, & Risley, 1989), and offering individuals a choice from among several options (Fisher, Thompson, Piazza, Crosland, & Gotjen, 1997). Another method that has been demonstrated to improve the effectiveness of reinforcement is stimulus (reinforcer) variation. Egel (1980) evaluated the effects of varied versus constant reinforcement on interresponse time and total number of bar presses of 10 individuals with autism. Individuals had access to one of three stimuli that were randomly selected across trials within a session in the varied condition. One of the three stimuli from the varied condition was presented following each successful trial throughout a given session in the constant condition. The number of bar presses increased and responding was more rapid when individuals had access to varied reinforcement following bar pressing than when constant reinforcement was available. In a follow-up study, Egel (1981) applied these findings to a more natural situation: correct responding on academic tasks and on-task behavior. He replicated the findings from his

This investigation was supported in part by Grant MCJ249149-02 from the Maternal and Child Health Service of the U.S. Department of Health and Human Services. The authors thank Jamie Owen-DeSchryver and Gregory Hanley for their assistance with this project.

Requests for reprints should be sent to Lynn G. Bowman, Neurobehavioral Unit, The Kennedy Krieger Institute, 707 N. Broadway, Baltimore, Maryland 21205.

earlier study, in that correct responding and on-task behavior were higher when participants had access to varied reinforcement.

Egel used edible items as reinforcement in both investigations. The method for selection of these items was not specified, but Egel noted that these items had been previously demonstrated to be reinforcers. Without the benefit of a stimulus choice assessment, it is not clear that the reinforcers selected for the children in Egel's studies were the most highly preferred stimuli or the most effective reinforcers available.

The purpose of the current investigation was to assess preference for varied, slightly lower quality stimuli relative to preference for constant access to an individual's highest quality stimulus using a concurrent-operants arrangement. That is, would several lower quality reinforcers compete with one high-quality reinforcer if the lower quality reinforcers were presented in a varied format?

METHOD

Participants and Setting

Participants were 7 children who had been diagnosed with moderate to profound mental retardation who had been admitted to an inpatient unit for assessment and treatment of destructive behavior. Jeff was a 12-year-old boy who had been diagnosed with mild to moderate mental retardation, pervasive developmental disorder, and a seizure disorder. Julius was a 14-year-old boy who had been diagnosed with severe mental retardation, autism, epilepsy, and intermittent explosive disorder. Jason was an 8-year-old boy who had been diagnosed with severe mental retardation and autism. Meris was a 10-year-old girl who had been diagnosed with severe mental retardation and a seizure disorder. Kelsey was a 14-year-old boy with severe to profound mental retardation. Cher was a 10-year-old girl who had been diagnosed with profound mental retardation, Rett syndrome, and a seizure disorder. Radford was a 16-year-old boy who had been diagnosed with severe mental retardation and borderline microcephaly. Sessions were conducted either in a treatment room (3 m by 3 m) equipped with a one-way mirror or in a classroom.

Procedure

Caregiver interview. The person assuming primary care for a participant throughout the day prior to the hospital admission was asked to generate a list of potential reinforcers during a structured interview called the Reinforcer Assessment for Individuals with Severe Disabilities (RAISD; Fisher, Piazza, Bowman, & Amari, 1996). The RAISD provides prompts to caregivers regarding child-preferred stimuli within a variety of categories to facilitate the identification of as many potential reinforcers as possible and to identify the conditions under which those stimuli are preferred (e.g., eating potato chips with french onion dip). For each participant, 16 stimuli (except for Jason and Cher, for whom only eight items were used) then were compared in a paired-choice assessment.

Paired-choice assessment. During each trial (Fisher et al., 1992), two stimuli were placed in front of the participant or, for social stimuli, were presented by having the therapist act out the activity (e.g., the therapist claps). Each stimulus was paired once with every other stimulus. Approach responses resulted in 5 s of access to the approached stimulus and removal of the other stimulus. Simultaneous approach to both stimuli was blocked. If no approach response occurred, the therapist prompted the participant to sample the stimuli, and the stimuli were re-presented. If the participant again failed to respond within 5 s, both stimuli were removed and the next trial was initiated. Stimuli from the choice assessments were then ranked based on how frequently the participant selected each stimulus. If more than

Table 1
Percentage of Trials in Which Each Stimulus Was Approached for Each Client During the Stimulus Choice Assessment

	Stimulus ranking			
Client	1	2	3	4
Kelsey	80	80	80	73
Meris	86	73	66	66
Jason	85.7	71.4	57.1	42.9
Radford	100	86.7	86.7	73.3
Julius	86.7	86.7	86.7	66.7
Jeff	93.3	80	80	73.3
Cher	85.7	85.7	71.4	71.4

one stimulus was approached an equal percentage of times, the stimulus selected more frequently when those particular stimuli were compared was ranked higher. The four stimuli ranked as most preferred and the percentage of trials on which the stimuli were selected during the choice assessment for each participant are presented in Table 1 and were used in the subsequent analysis.

Training trials. Prior to beginning the reinforcer assessment, each participant was taught a simple response to obtain reinforcement (sitting in a chair for Jeff, Julius, Jason, and Meris; standing in a square for Kelsey; pressing a microswitch for Cher; and stuffing an envelope for Radford). During training trials, a concurrent-operants paradigm (Catania, 1963; Herrnstein, 1970) was used in which three identical responses were available concurrently during each session: sitting in Chair A, B, or C for Jeff, Julius, Jason, and Meris; standing or sitting in Square A, B, or C for Kelsey; pressing Switch A, B, or C for Cher; and folding and placing one of three different colored papers into an envelope for Radford. A training session consisted of 10 trials. The therapist randomly selected two of the top four stimuli from the stimulus choice assessment for each session. One response was assigned randomly as a control (e.g., sitting in Chair A produced no differential consequence), and the remaining two responses (e.g., sitting in Chair B or C) were each randomly assigned one of the two stimuli.

A training trial consisted of placing each stimulus being evaluated on a chair (Jeff, Julius, Jason, and Meris), in a square (for Kelsey), or directly behind a microswitch (for Cher). Radford was given a verbal instruction on which item corresponded with each color. Participants were allowed 5 s to independently engage in the response (i.e., sit in a chair). If no response was emitted, the therapist used sequential verbal, gestural, and physical prompts to occasion the target behavior. Access to the stimulus was provided immediately for 10 s when the child engaged in the target behavior. The trial ended for Jeff, Julius, Jason, Meris, and Kelsey when the child left the chair or square. If the child remained in the chair or square for 10 s, the therapist removed the stimulus while physically guiding the child to leave the chair or square. Cher's trial ended following each microswitch press, and Radford's trial ended following the placement of a colored piece of paper into an envelope. Training ended when the child independently engaged in the target behavior (e.g., sat in a chair) that produced reinforcement during at least 80% of the trials across three consecutive sessions.

Reinforcer assessment. All sessions lasted 20 min. A concurrent-operants arrangement was used to evaluate the effects of constant presentation of the highest quality stimulus (ranked first on the choice assessment, constant HQ) relative to (a) varied presentation of three stimuli (ranked second, third, and fourth on the choice assessment, varied SLQ) that were of slightly lower quality and (b) a control condition (no stimulus). The room and conditions were arranged in a manner similar to those of the training trials. However, the participants were not prompted to emit target responses. In addition, the constant HQ

stimulus was placed in or near one response option (e.g., in a chair for Jeff), the three varied SLQ stimuli were placed in or near another response option, and the remaining response option served as a control. Each time a participant met criterion for reinforcement (e.g., sat in Chair B, pressed Switch A), he or she received the stimulus or stimuli associated with that response option. The response–stimulus pairings were randomly arranged prior to each session, and the SLQ stimuli were presented to the participants in a random order. The schedule of reinforcement for both the constant HQ and varied SLQ conditions was a fixed-ratio (FR) 1 when either switch pressing (Cher) or envelope stuffing (Radford) were the dependent variables. If the stimulus was a food item, the therapist presented one bite approximately every 10 s for 30 s. Nonfood items were presented for 30 s.

In-seat and in-square behaviors were measured in terms of duration rather than total number of responses; therefore, a different method of stimulus presentation was employed. The constant HQ stimulus was placed in its corresponding chair or square at the beginning of the session. If the participant sat in the corresponding chair or entered the square, the constant HQ stimulus was presented. If the participant left the chair or square, the reinforcement interval ended, and the stimulus was withdrawn. The therapist presented one bite of food approximately every 10 s until the participant left the chair or square. Nonfood items were presented at the beginning and withdrawn at the end of the reinforcement interval. The method of stimulus presentation and withdrawal was the same in the varied SLQ condition except that every 30 s while the participant was in the chair or square, a different stimulus was presented according to a random schedule.

Data Collection and Interrater Agreement

Observers were positioned either inside the classroom or behind the one-way mirror. During the stimulus choice assessments, observers recorded each time the participant approached one of the presented stimuli during each trial. An approach response was defined as movement toward the stimulus with any part of the body within 5 s of stimulus presentation (Pace, Ivancic, Edwards, Iwata, & Page, 1985). A second independent observer recorded approach responses during an average of 95.6% of trials across participants. Reliability coefficients for each choice assessment were calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. Mean agreement coefficients for approach responses across participants were (a) occurrence, 95.5% (range, 89.3% to 98.9%); (b) nonoccurrence, 94.9% (range, 89.7% to 100%); and (c) total, 95.7% (range, 89.3% to 98.9%).

During the reinforcer assessment, in-square behavior was defined as the participant having any portion of his or her body within a square (0.7 m by 0.7 m) drawn on the floor with tape. In-chair behavior was defined as the participant's buttocks contacting the chair. Microswitch presses were recorded each time Cher's hand depressed the microswitch. Envelopes stuffed were counted each time Radford folded a piece of paper and placed it into an envelope. Observers used laptop computers to record the total duration of in-square or in-chair behavior as well as the frequency of microswitch presses and envelopes stuffed. A second independent observer collected data during reinforcer assessment sessions during an average of 81.2% of sessions across participants. Exact interval-by-interval agreement coefficients were calculated for duration of in-square or in-chair

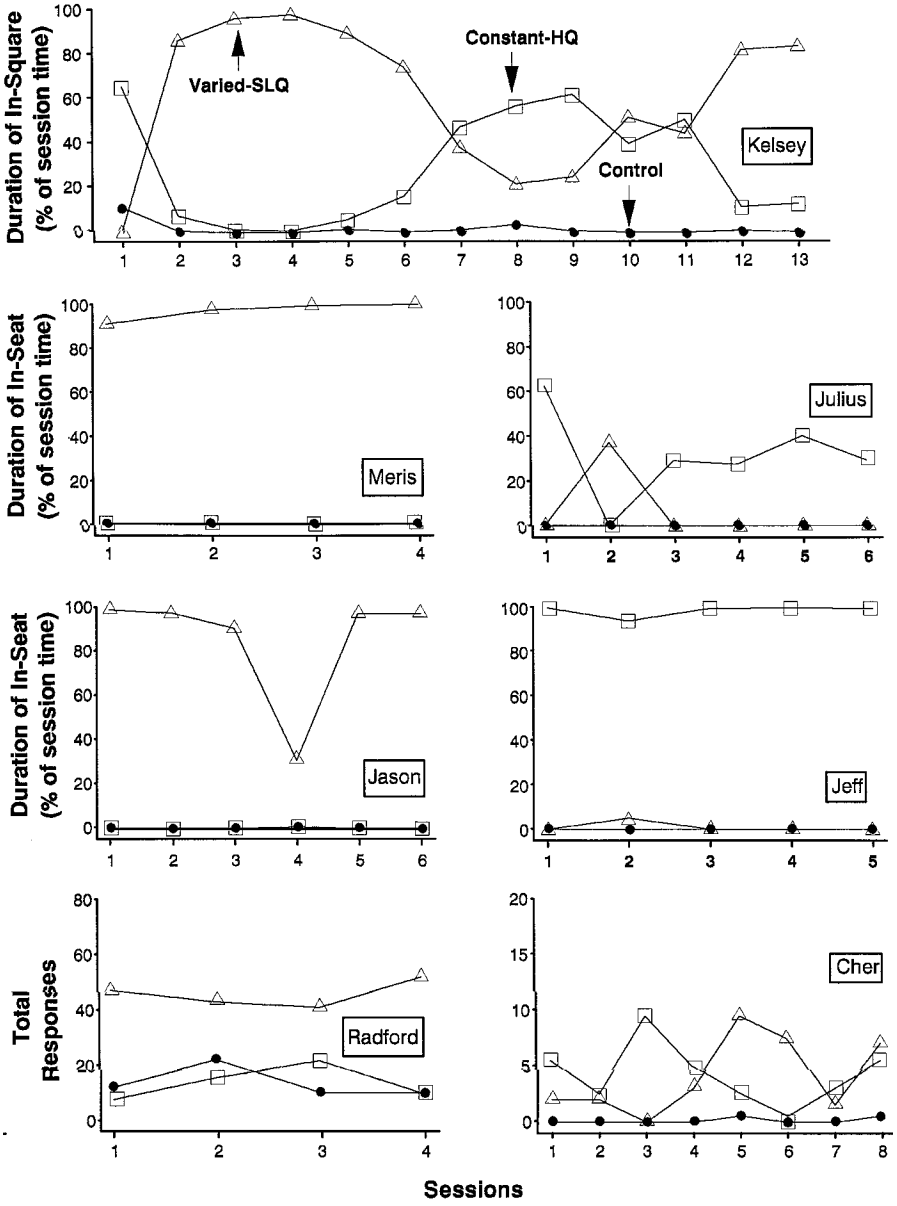

Figure 1. Target responses across constant HQ (highest quality) reinforcement, varied SLQ (slightly lower quality) reinforcement, and control conditions for all participants.

behavior or for frequency of microswitch presses and envelopes stuffed by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100%. An agreement was defined as a 10-s interval during which both observers recorded the same duration (in seconds) or frequency of the target behavior. The mean exact agreement coefficient across participants was 95.7% (range, 83.3% to 99.7%).

RESULTS

The results from the reinforcer assessments are depicted in Figure 1. Higher

rates or longer durations of responding were associated with the varied SLQ reinforcement condition for 4 participants (Kelsey, Meris, Jason, and Radford) and with the constant HQ condition for 2 participants (Julius and Jeff). Cher's preferences alternated between the two conditions both within and across sessions, thus showing an effect for varied reinforcement. Responding rarely occurred in the control condition for all participants. Kelsey's duration of in-square behavior was quite variable during both the constant and the varied phases; however, the mean percentage of session time spent in the square associated with the varied SLQ condition was twice that of the constant HQ condition. In addition, variability in Kelsey's responding did not begin until he experienced almost twice as many sessions as most of the other subjects.

DISCUSSION

The current results differ from those reported by Egel (1980, 1981), who found that varied reinforcement consistently maintained higher levels of responding than did constant reinforcement for all participants. Similar results occurred for some but not for all of the participants in the current investigation (i.e., for 4 of 7 participants). This difference is probably due to the fact that the constant reinforcement condition was associated with the stimulus that had been determined to be most highly preferred by each participant in the current investigation but not in Egel's studies. Our results suggest that relative stimulus preference may be important in determining the effectiveness of reinforcer variation. However, the extent to which stimuli that are identified as less preferred during a concurrent-operants arrangement would have functioned as reinforcers in a single-operant arrangement is unclear.

Results of the current investigation illustrate that it is not only important to systematically identify preferred stimuli but it may also be helpful to determine the best method of presenting those items on an individualized basis. That is, it may be important to systematically determine when and how often to vary reinforcement for an individual. This issue may be of clinical relevance when attempting to determine whether to provide an individual with one potent reinforcer or to arrange conditions to accommodate less potent reinforcers. The current results also suggest that it may be possible to assess whether an individual prefers constant rather than varied reinforcement in a relatively short period of time. The comparison of constant and varied reinforcement in this investigation was completed in an average of 6.5 20-min sessions, but in most cases, the participant's preference was clear in the very first session.

Another method for varying reinforcement in accordance with preference may be to allow individuals to choose from a set of available reinforcers each time reinforcement is delivered (Fisher et al., 1997). That is, an individual's relative preferences from among a set of reinforcers may change over time due to satiation, deprivation, or other establishing operations (Michael, 1993; Vollmer & Iwata, 1991). Allowing individuals to choose from arrays of preferred stimuli provides them with a mechanism for adjusting reinforcer delivery in accordance with momentary fluctuations in preference or motivation (see Catania, 1980, for a discussion). Future research might examine the mechanisms that are responsible for the effects of stimulus variation.

REFERENCES

Amari, A., Grace, N. C., & Fisher, W. W. (1995). Achieving and maintaining compliance with the ketogenic diet. *Journal of Applied Behavior Analysis, 28,* 341–342.

Catania, A. C. (1963). Concurrent performances: A

baseline for the study of reinforcement magnitude. *Journal of the Experimental Analysis of Behavior, 6,* 299–300.
Catania, A. C. (1980). Freedom of choice: A behavioral analysis. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 14, pp. 97–145). New York: Academic Press.
DeLeon, I. G., & Iwata, B. A. (1996). Evaluation of a multiple-stimulus presentation format for assessing reinforcer preferences. *Journal of Applied Behavior Analysis, 29,* 519–532.
Egel, A. L. (1980). The effects of constant vs. varied reinforcer presentation on responding by autistic children. *Journal of Experimental Child Psychology, 30,* 455–463.
Egel, A. L. (1981). Reinforcer variation: Implications for motivating developmentally disabled children. *Journal of Applied Behavior Analysis, 14,* 345–350.
Fisher, W. W., Piazza, C. C., Bowman, L. G., & Amari, A. (1996). Integrating caregiver report with a systematic choice assessment to enhance reinforcer identification. *American Journal on Mental Retardation, 101,* 15–25.
Fisher, W. W., Piazza, C. C., Bowman, L. G., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992). A comparison of two approaches for identifying reinforcers for persons with severe to profound disabilities. *Journal of Applied Behavior Analysis, 25,* 491–498.
Fisher, W. W., Thompson, R. H., Piazza, C. C., Crosland, K. A., & Gotjen, D. (1997). On the relative reinforcing effects of choice and differential consequences. *Journal of Applied Behavior Analysis, 30,* 423–438.
Herrnstein, R. J. (1970). On the law of effect. *Journal of the Experimental Analysis of Behavior, 4,* 267–272.
Mason, S. A., McGee, G. G., Farmer-Dougan, V., & Risley, T. R. (1989). A practical strategy for ongoing reinforcer assessment. *Journal of Applied Behavior Analysis, 22,* 171–179.
Michael, J. (1993). Establishing operations. *The Behavior Analyst, 16,* 191–206.
Pace, G. M., Ivancic, M. T., Edwards, G. L., Iwata, B. A., & Page, T. J. (1985). Assessment of stimulus preference and reinforcer value with profoundly retarded individuals. *Journal of Applied Behavior Analysis, 18,* 249–255.
Vollmer, T. R., & Iwata, B. A. (1991). Establishing operations and reinforcement effects. *Journal of Applied Behavior Analysis, 24,* 279–291.
Vollmer, T. R., Marcus, B. A., & LeBlanc, L. (1994). Treatment of self-injury and hand mouthing following inconclusive functional analyses. *Journal of Applied Behavior Analysis, 27,* 331–344.

Received March 4, 1997
Initial editorial decision March 28, 1997
Final acceptance April 30, 1997
Action Editor, Brian A. Iwata

STUDY QUESTIONS

1. What were Egel's (1980, 1981) findings with respect to reinforcer variation, and how did the present experiment extend those findings?

2. Briefly describe the procedures used by the authors to identify the high-quality (HQ) and slightly lower quality (SLQ) reinforcers.

3. How were the HQ and SLQ reinforcers compared?

4. Given that responding under the two experimental conditions (constant HQ and varied SLQ) produced reinforcement according to identical schedules, what method of data presentation would have equated the different response measures (frequency and duration) that were used for different participants?

5. What features of the relative stimulus rankings, presented in Table 1, suggest that shifts in preference might be observed when an individual is offered a choice between the highest ranked item and the lower ranked items?

6. Data for 3 of the participants (Kelsey, Radford, and Cher) showed evidence of within-session switching between the two reinforcement options (data for the other 4 showed exclusive preference for one of the options during any given session). How might satiation have influenced within-session switching, and what type of data presentation might have revealed such effects? Also, how might procedural differences related to response effort have further facilitated within-session switching by Radford and Cher?

7. What did the results indicate about the participants' overall preference for format of reinforcer presentation, and how did the authors resolve the difference between their results and those reported by Egel (1980, 1981)?

8. The authors suggested that establishing operations may influence preference on a momentary basis. What method of reinforcer delivery was suggested to accommodate such rapid fluctuations in preference?

Questions prepared by Iser DeLeon and Han-Leong Goh, The University of Florida