AN EVALUATION OF THE VALUE OF CHOICE-MAKING OPPORTUNITIES IN SINGLE-OPERANT ARRANGEMENTS: SIMPLE FIXED- AND PROGRESSIVE-RATIO SCHEDULES

JEFFREY H. TIGER, KAREN A. TOUSSAINT, AND CHRISTOPHER T. ROATH

LOUISIANA STATE UNIVERSITY

The current study compared the effects of choice and no-choice reinforcement conditions on the task responding of 3 children with autism across 2 single-operant paradigm reinforcer assessments. The first assessment employed simple fixed-ratio (FR) schedules; the second used progressive-ratio (PR) schedules. The latter assessment identified the differential strength of choice-making conditions in promoting task responding relative to no-choice conditions for 2 participants; no differential findings were obtained during the FR assessment.

Key words: choice, fixed-ratio schedule, progressive-ratio schedule, reinforcer assessment

———————————————

Given a choice (i.e., a concurrent-operants format), children tend to prefer conditions associated with the opportunity to make choices between reinforcing events relative to conditions in which reinforcers are delivered independent of their choices (Brigham & Sherman, 1973; Fisher, Thompson, Piazza, Crosland, & Gotjen, 1997). This finding holds true even when the items delivered under choice and no-choice conditions are identical (e.g., receiving one red jelly bean in a no-choice condition or choosing one red jelly bean among five in a choice condition; Thompson, Fisher, & Contrucci, 1998; Tiger, Hanley, & Hernandez, 2006). Although children prefer these conditions, it is unclear that delivery of choices of reinforcers sustains behavior beyond that of delivering a reinforcer without the choice-making opportunity. For instance, Lerman et al. (1997) and Smith, Iwata, and Shore (1995) compared task-completion rates of individuals with developmental disabilities across choice and no-choice sessions (i.e., in a single-operant format) and found no differences. These

divergent results may be partially explained by the differing assessment formats. That is, concurrent-operants assessments are differentially sensitive to reinforcer strength in part due to the absence of ceiling effects that may occur in single-operant assessments (Geckeler, Libby, Graff, & Ahearn, 2000; Roscoe, Iwata, & Kahng, 1999).

The current study was designed to evaluate the sensitivity of an alternative single-operant reinforcer assessment (progressive-ratio [PR] schedules; Hodos, 1961; Roane, Lerman, & Vorndran, 2001) relative to the simple fixed-ratio (FR) formats of previous studies (i.e., Lerman et al., 1997; Smith et al., 1995) in assessing the effectiveness of choice-making conditions at sustaining engagement relative to no-choice conditions. We initially replicated the single-operant assessment described by Lerman et al. and then assessed these same conditions with PR schedules, similar to those described by Roane et al.

METHOD

Participants and Setting

Three children who had been diagnosed with autism participated. Caleb and Archer were 7-year-old twin brothers. Both had been referred to an on-campus clinic for children with autism for educational programming assistance; their

sessions were conducted in an otherwise unoccupied therapy room in the clinic. Dennis was 3 years 6 months old and was recruited from an on-campus child-care center that served children both with and without developmental disabilities; his sessions were conducted in a small alcove just outside his classroom. We did not conduct any formal assessments of the children's skill levels; however, each was at least partially integrated into a classroom of same-aged peers and could answer questions accurately and follow multistep instructions. Each child had goals related to the development of fine motor skills; thus, we selected placing clothes pins on a string for Archer, drawing a straight line between two points for Caleb, and sorting colored beads into bowls for Dennis as operant tasks.

Response Measurement and Interobserver Agreement

Each response (clips placed on a rope for Archer, lines drawn for Caleb, and beads sorted for Dennis) was recorded by one or two independent observers using handheld computers. To determine interobserver agreement, each session was divided into 10-s intervals, and observers' records were compared on an interval-by-interval basis using the proportional agreement method. A second observer was present during a minimum of 33% of sessions, and mean agreement was above 90% across each individual and assessment.

Procedure

We conducted a paired-item preference assessment (Fisher et al., 1992) to identify three high-preference edible items that were delivered as reinforcers through the remainder of the study. We conducted an additional brief assessment prior to each session pair to determine which items would be included for that session pair (i.e., edible items delivered across each pair of choice and no-choice sessions were identical).

We compared two experimental conditions in each assessment. We presented a plate of five identical edible items from which the participant could select one item following completion of the schedule requirement during choice sessions and presented a plate with a single edible item (identical to those presented during choice sessions) following schedule completion during no-choice sessions. We assessed differences in responding during these two conditions using simple FR schedules and then with PR schedules.

Simple FR assessment. We based this assessment on the procedures described by Lerman et al. (1997). All sessions during this assessment were 5 min in duration. We conducted a baseline with each participant to determine the initial level of task responding. We presented all materials needed to complete the task, but no instructions or prompting were provided, nor were any edible items delivered for engaging in the task. Following baseline, we conducted training similar to that described in Lerman et al., in which the therapist prompted the target response using a graduated, three-step sequence if no response occurred for 30 s. The therapist delivered reinforcement following both prompted and independent responses; the therapist discontinued prompts following two consecutive sessions in which the participant received five or fewer prompts. Reinforcement conditions were introduced according to a multiple baseline design across participants. Choice and no-choice conditions were alternated in a random and counterbalanced order in accordance with a multi-element design within participants.

PR assessment. The duration of PR schedule sessions varied based on participants' performances. Sessions were terminated following (a) a 3-min period without a target response, (b) a withdrawal of assent from the participant (i.e., a request to stop), or (c) following 30 min of session time. The number of responses required to obtain reinforcement increased throughout

each session according to a geometric progression with a multiplier of two responses, with the exception that each value was repeated twice. That is, each schedule value was in place for two reinforcer deliveries and then was multiplied by two to determine the response requirement to produce the next reinforcer (i.e., schedule values were 1, 1, 2, 2, 4, 4, 8, 8, 16, 16, etc., until one of the stop criteria was reached).

Concurrent-operant assessment (Caleb only). Three colored pieces of paper with dots to mark end points were spaced equally on a tabletop during these 10-min sessions. Drawing a line on one paper resulted in the delivery of a plate of five preferred edible items from which Caleb could select one (choice), drawing a line on the second paper resulted in the delivery of a plate with one edible item identical to those delivered in the choice condition (no choice), and drawing a line on the third paper resulted in the presentation of an empty plate (i.e., no tangible reinforcers were delivered; control). The supply of papers was replaced continuously, as were edible items.

RESULTS AND DISCUSSION

Results from the simple FR assessment are shown in Figure 1 (top left). During baseline, Archer engaged in low rates of rope clipping ($M = 0.1$ responses per minute). Rope clipping increased when prompting and reinforcement were introduced; there were no systematic differences observed between the choice ($M = 4.2$) and no-choice ($M = 4.1$) conditions. Dennis did not engage in any bead sorting during baseline. His sorting increased when prompting and reinforcement were implemented. Response rates were similar across choice ($M = 1.9$) and no-choice sessions ($M = 1.6$). Caleb engaged in low levels of line drawing during baseline ($M = 0.5$), which increased following the implementation of prompting and reinforcement. Again, no differences were observed during choice ($M = 5.4$) and no-choice ($M = 5.5$) sessions.

Results from the PR schedule assessment are shown in Figure 1 (top right) and are reported as the total number of responses emitted per session prior to meeting stop criteria. For Archer, large differences in response persistence were observed during choice ($M = 19.3$) and no-choice ($M = 5.0$) sessions. A similar difference was observed for Dennis, who engaged in more responding during choice ($M = 55.0$) than in no-choice ($M = 13.3$) sessions. No consistent differences were observed between choice ($M = 47.8$) and no-choice ($M = 64.2$) sessions for Caleb. Break points (i.e., the last schedule completed) from each session are provided in parentheses by the corresponding session data point.

We also conducted a concurrent-operants assessment with Caleb, which allowed us to determine whether (a) he was not sensitive to choice as a reinforcer or (b) both the simple FR and the PR schedules were insensitive to choice as a reinforcer. The results from his concurrent-operants assessment are shown in Figure 1 (bottom). Although differences had not been observed previously using both single-operant assessment formats, Caleb drew more lines on the choice papers (1.9 responses per minute) than on the no-choice (0.3) or control (0.1) papers.

In summary, the task-completion rates of three children with autism were shown initially to be similar across choice and no-choice conditions when compared in a single-operant FR schedule format (similar to Lerman et al., 1997, and Smith et al., 1995). Two of these children engaged in higher rates of task completion during choice conditions when compared in a PR schedule format. The third participant's responding was not affected differentially by choice and no-choice conditions until they were compared in a concurrent-operants format. These results provide additional support that choice making may enhance the efficacy of reinforcement-based interventions (e.g., Brigham & Sherman, 1973; Fisher
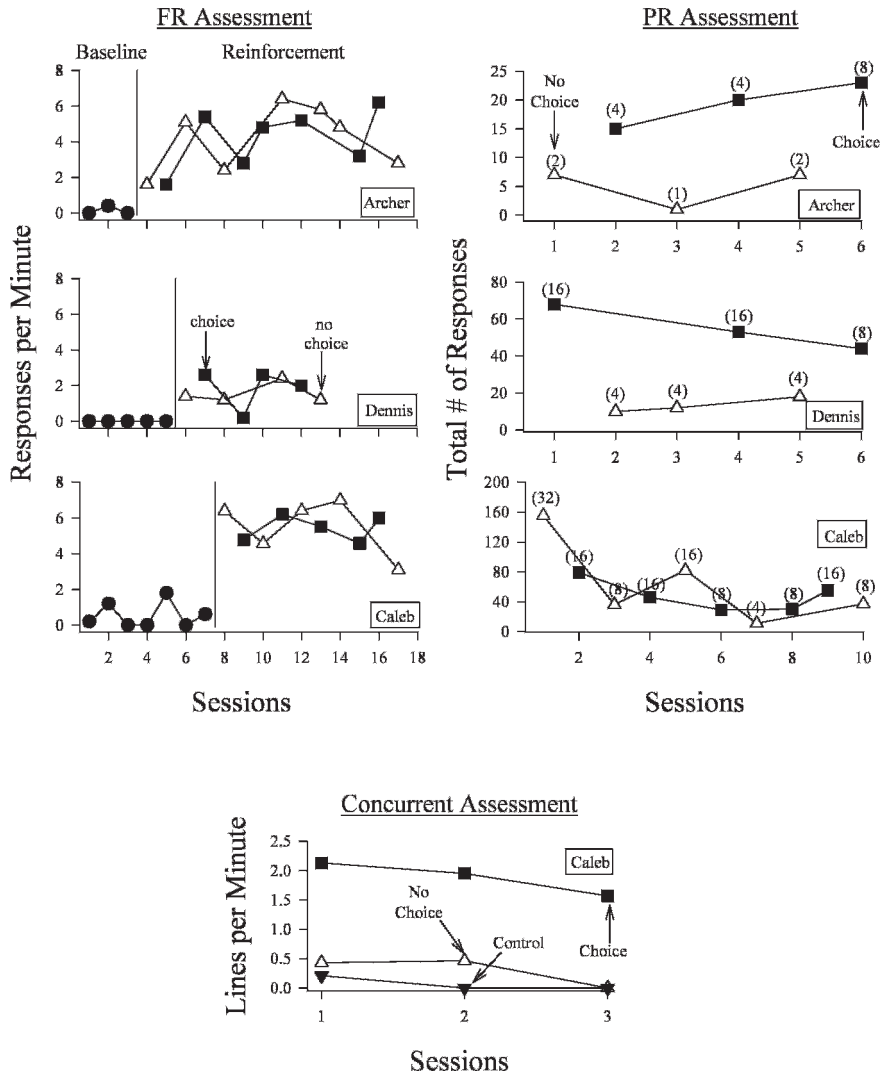
Figure 1.   The number of responses per minute during baseline, choice, and no-choice sessions of the fixed-ratio (FR) assessment for Archer, Dennis, and Caleb are presented at top left. The total number of responses during choice and no-choice conditions of the progressive-ratio (PR) assessment for Archer, Dennis, and Caleb are presented at top right, with the breaking point (last schedule value completed) in parentheses above the data point for each session. Line-drawing rates across choice, no-choice, and control options during the concurrent assessment (Caleb only) are shown at bottom.

et al., 1997; Tiger et al., 2006) and are also similar to those of Geckeler et al. (2000), who demonstrated that single-operant arrangements using FR schedules were insensitive to the added value of choice. The combined results of Geckeler et al. and the current study support the assertion that Lerman et al. (1997) and Smith et al. (1995) may have failed to identify differential reinforcement effects associated with choice conditions due to the ceiling effects imposed by single-operant arrangements.

There are a number of variables associated with the PR schedule that may enhance or hinder the sensitivity of these assessments.

Specifically, PR schedules may vary by (a) the algorithm by which response requirements increase, which is typically either a linear (i.e., a constant is summed to the completed requirement to arrive at the next schedule value) or a geometric (i.e., a constant is multiplied to the completed requirement to arrive at the next schedule value) progression, (b) the size of the constant used to calculate the increase (called the step size), (c) the number of times each step is repeated, (d) the session cessation criteria, and (e) the complexity of required responses (Roane, 2008). Although the parameters selected in the current investigation were suitably sensitive to assess choice preference for Archer and Dennis, the same progression was insensitive to Caleb's choice preference. Future research should conduct a parametric manipulation of the features of the PR schedules to identify optimally sensitive and efficient parameters for these reinforcer assessments and to identify the stability of preferences across time and procedural manipulations (i.e., the assessment of the current study was relatively brief).

Given the evidence available in both the current and previous research, it is safe to conclude that, at least for some individuals, choice may be a particularly valuable event that can be included in reinforcement-based interventions. Based on this conclusion, there are a number of important questions for future researchers, notably in determining (a) the prevalence of sensitivity to choice making as a reinforcer, (b) the learning histories that may result in choice making serving as a reinforcer, and (c) the variables that influence the effectiveness of choice making as a reinforcer.

For teachers, therapists, and other practitioners, choice making appears to be a relatively robust augmentation to reinforcement delivery techniques that comes at little additional cost in terms of time or resources, can easily be embedded into educational or habilitative programming, and allows individuals with limited communicative abilities to express their preferences (Parsons & Reid, 1990; Reid, Green, & Parsons, 2003). For these reasons, the provision of choice-making opportunities among similar or disparate items is recommended to enhance the efficacy of reinforcement-based interventions.

REFERENCES

Brigham, T. A., & Sherman, J. A. (1973). Effects of choice and immediacy of reinforcement on single response and switching behavior of children. *Journal of the Experimental Analysis of Behavior, 19*, 425–435.

Fisher, 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 and profound disabilities. *Journal of Applied Behavior Analysis, 25*, 491–498.

Fisher, W. W., Thompson, R. H., Piazza, C. C., Crosland, K., & Gotjen, D. (1997). On the relative reinforcing effects of choice and differential consequences. *Journal of Applied Behavior Analysis, 30*, 423–438.

Geckeler, A. S., Libby, M. E., Graff, R. B., & Ahearn, W. H. (2000). Effects of reinforcer choice measured in single-operant and concurrent-schedule procedures. *Journal of Applied Behavior Analysis, 33*, 347–351.

Hodos, W. (1961). Progressive ratio as a measure of reward strength. *Science, 134*, 943–944.

Lerman, D. C., Iwata, B. A., Rainville, B., Adelinis, J. D., Crosland, K., & Kogan, J. (1997). Effects of reinforcement choice on task responding in individuals with developmental disabilities. *Journal of Applied Behavior Analysis, 30*, 411–422.

Parsons, M. B., & Reid, D. H. (1990). Assessing food preferences among persons with profound mental retardation: Providing opportunities to make choices. *Journal of Applied Behavior Analysis, 23*, 183–195.

Reid, D. H., Green, C. W., & Parsons, M. B. (2003). An outcome management program for extending advances in choice research into choice opportunities for supported workers with severe multiple disabilities. *Journal of Applied Behavior Analysis, 36*, 575–578.

Roane, H. S. (2008). On the applied use of progressive-ratio schedules of reinforcement. *Journal of Applied Behavior Analysis, 41*, 155–161.

Roane, H. S., Lerman, D. C., & Vorndran, C. M. (2001). Assessing reinforcers under progressive schedule requirements. *Journal of Applied Behavior Analysis, 34*, 145–167.

Roscoe, E. M., Iwata, B. A., & Kahng, S. (1999). Relative versus absolute reinforcement effects: Implications for preference assessments. *Journal of Applied Behavior Analysis, 32*, 479–493.

Smith, R. G., Iwata, B. A., & Shore, B. A. (1995). Effects of subject- versus experimenter-selected reinforcers on the behavior of individuals with profound developmental disabilities. *Journal of Applied Behavior Analysis, 28*, 61–71.

Thompson, R. H., Fisher, W. W., & Contrucci, S. A. (1998). Evaluating the reinforcing effects of choice in comparison to reinforcement rate. *Research in Developmental Disabilities, 19*, 181–187.

Tiger, J. H., Hanley, G. P., & Hernandez, E. (2006). An evaluation of the value of choosing with preschool children. *Journal of Applied Behavior Analysis, 39*, 1–16.