*EFFECTS OF PREFERENCE AND REINFORCER VARIATION ON
WITHIN-SESSION PATTERNS OF RESPONDING*

ALICE A. KEYL-AUSTIN, ANDREW L. SAMAHA, SARAH E. BLOOM, AND
MEGAN A. BOYLE

UTAH STATE UNIVERSITY

We examined correspondence between preference assessment outcome and within-session patterns of responding in one subject with autism. Responding maintained by a single highly preferred item resulted in a greater total number of responses, a slower decline in within-session response rates, and a greater proportion of short interresponse times compared to responding maintained by varied moderately preferred (MP) stimuli. Presenting varied MP stimuli within the same session produced greater levels and more sustained responding than presenting those same stimuli individually.

Key words: autism, preference assessment, behavioral economics, bridge study, marginal utility

Despite the existence of procedures to identify highly preferred and potent reinforcers, clinicians may struggle to maintain high rates of responding throughout extended work periods (e.g., North & Iwata, 2005). This can be especially problematic for individuals with a limited array of identified reinforcers. Reduced reinforcer effectiveness may result in response decrement, limiting the ability of clinicians to effect positive change in their clients. Within-session decreases may be attributed to behavioral processes such as satiation or habituation (see Murphy, McSweeney, Smith, & McComas, 2003) and also fit into a conceptualization from microeconomics called *diminishing marginal utility*, which states that the added utility or value of each successive good is less than that of the previous one (Böhm-Bawerk, 1891).

Few applied studies have attempted to characterize or mitigate within-session decreases in appropriate behavior. Studies by Egel (1980, 1981) are two exceptions in which subjects emitted more responses and sustained greater levels of on-task behavior across trials when varied (rather than constant) stimuli were

presented. However, Egel did not evaluate preference for the stimuli. Less consistent results were obtained by North and Iwata (2005), who evaluated the effects of several variables on food-maintained responding. The authors found greater levels of sustained responding in only two of six and one of five participants using varied reinforcers and highly preferred stimuli identified prior to each session, respectively. Koehler, Iwata, Roscoe, Rolider, and O'Steen (2005, Study 1) addressed a similar question by examining response allocation in a three-choice concurrent schedule. One option resulted in a single highly preferred stimulus, and the consequence for the second option was manipulated across conditions. The third option resulted in no consequence and served as a control. Varying the stimuli associated with the second option resulted in preference for that option under some conditions. These results suggest that varied stimuli may be more preferred (depending on their initial preference) than constant stimuli. Thus, although we know how preference is related to absolute and relative levels of responding (see Lee, Yu, Martin, & Martin, 2010; Roscoe, Iwata, & Kahng, 1999), it remains unclear how the outcomes of preference assessments might correspond to within-session patterns.

Address correspondence to Andrew L. Samaha, Department of Psychology, Utah State University, 2810 Old Main Hill, Logan, Utah 84322 (e-mail: andrew.samaha@usu.edu).

doi: 10.1901/jaba.2012.45-637

The purpose of this study was to examine within-session patterns of responding maintained by highly preferred (HP) and moderately preferred (MP) stimuli in 30-min sessions. We also evaluated the effects of varying MP stimuli on within-session patterns.

METHOD

Subject, Setting, and Materials

Arlo, a 4-year-old boy who had been diagnosed with autistic disorder, participated. He attended a university-based preschool for children with autism, could follow vocal instructions, and was able to complete simple tasks. All sessions were conducted in Arlo's cubicle (containing a small table and chairs) at the preschool. Materials consisted of edible items, a free-operant task (a small block and two small baskets), and a low-preference leisure item.

Preference Assessments

A 16-item paired-stimulus preference assessment (Fisher *et al.*, 1992) was conducted to identify one HP edible item (selected between 85% and 100% of available trials) and three MP edible items (selected between 30% and 60% of available trials). A Mini-Oreo (86%) was the HP item, and Cheez-It Gripz (60%), Fruit Loops (53%), and Chex (46%) were the MP items. To keep items the same approximate size, food items were delivered in their original package sizes with one exception: Mini-Oreos were divided into eighths by pulling the two halves apart and dividing each half evenly into four pieces. A seven-item multiple-stimulus without replacement preference assessment (MSWO; DeLeon & Iwata, 1996) was conducted to identify a low-preference leisure item. The lowest ranking item (small teddy bear) was selected as an alternative activity to be included across all sessions and all conditions, thus reducing the likelihood of the subject responding because there were no alternative activities available. A second independent observer collected data during the assessments, and

reliability was calculated by comparing scored selections for each trial and dividing the number of trials with agreements by the total number of trials and converting this ratio to a percentage. Reliability was 97% for the paired-stimulus assessment and 100% for the MSWO assessment.

Response Measurement and Reliability

A response was scored each time a toy block was moved from either of two baskets to the other. All data were collected via handheld devices, using Instant Data software that automatically creates and stores time codes for events as observers score them in real time.

A second observer simultaneously but independently scored responses during 23% of all sessions. Block-by-block reliability was calculated by dividing one observer's record by the other (smaller number of responses by the larger) in each 10-s interval, obtaining the average of those values across all the intervals, and converting this ratio to a percentage. Overall reliability was 94% (range, 89% to 100%).

Procedure

Three conditions (baseline, HP-MP single, and MP varied) were evaluated within an ABCBC design. All sessions were conducted in the morning between approximately 8:30 a.m. and 9:30 a.m. (before scheduled meal-times) and lasted 30 min unless the subject met the termination criteria of 2 consecutive minutes without responding. Prior to each session, the therapist said, "You can work, play, or do nothing," provided a prompt describing the contingency (described below), and presented the relevant consequence. Only one session was conducted per day.

Baseline. The purpose of this condition was to assess response rates in the absence of programmed contingencies. A prompt ("If you do this, you don't get anything") was provided before each session. Four baseline sessions were conducted.

HP-MP single. Each edible stimulus (HP, MP 1, MP 2, and MP 3) was assessed in a

Table 1
Condition Summaries

Stimulus condition	Total number of responses	Average session duration	Sessions terminated early
no stimulus	0	2 min	4 of 4
HP	1,467	29 min 53 s	1 of 8
MP1	674	19 min 47 s	6 of 8
MP2	699	21 min 38 s	7 of 8
MP3	511	20 min 16 s	6 of 8
MP varied	760	21 min 25 s	5 of 8

single constant format. That is, only one stimulus type was delivered throughout a session. Stimuli were delivered on a fixed-ratio (FR) 1 schedule. The prompt, "If you do this, you get [name of item]" was provided prior to sessions in this condition. Four sessions were conducted with each stimulus type, for a total of 16 sessions in this phase.

MP varied. The three MP stimuli were delivered in a predetermined pseudorandom order to ensure that exposure across the MP items was relatively equal and unpredictable. Stimuli were presented on an FR 1 schedule, and no single MP stimulus was delivered more than twice in a row. Preexposure consisted of three prompts to engage in the target response, following each of which a different stimulus was presented. The statement, "If you do this, you get X, Y, or Z," also was provided, where X, Y, and Z were the names of the MP items. Four sessions were conducted in this phase.

RESULTS AND DISCUSSION

Table 1 lists a summary of the results. No target responses were emitted during any baseline session; thus, all sessions were terminated after 2 min and omitted from subsequent analyses. Only one HP session terminated early compared to 23 of the 32 (72%) MP and MP varied sessions. The HP stimulus was associated with the greatest number of responses across all sessions (1,427) and the longest average session duration (29 min 53 s). However, the greatest number of responses observed (and reinforcers

delivered) in any one session (231) occurred in the second session of the first MP varied condition.

To evaluate within-session patterns, we divided each session into 3-min bins and averaged the number of responses in each bin across the four sessions for each stimulus type. Bins with no responding (in sessions terminated early) were included in this analysis. Data are plotted on the top panel of Figure 1. Conditions (separated by phase-change lines) are plotted in chronological order from left to right. Average within-session patterns reflect a decreasing trend across all stimulus types. Average patterns matched the individual session data, with the exception of the last two sessions of HP, which showed slight increasing trends. The HP stimulus resulted in greater levels of sustained activity within session than did the MP stimuli. Regression analyses of within-session patterns observed in each session further indicated that responding decreased more rapidly when MP stimuli were presented alone than when they were varied within session (data available from the second author).

Additional analyses were conducted to compare the distributions of interresponse times (IRTs) in the first and last 10 min of HP and MP sessions. A given IRT was categorized as falling into the first third or last third if both the preceding and following responses occurred within Minute 0 to 10 or 20 to 30, respectively, regardless of actual session duration. Data from all HP and MP sessions are shown in Figure 1 (bottom right panel). Data from two specific sessions that lasted 30 min and resembled the overall effect are shown in the bottom left panel. Both panels show the proportion of IRTs greater than t seconds, with t plotted on the x axis. Steeper data paths indicate segments of sessions that contain a greater proportion of short IRTs. Both panels show an upward shift in IRTs from the first to the last third of sessions for both HP and MP stimuli, indicating that Arlo generally responded more slowly towards the end of the session than at the

Figure 1. Average number of responses per 3-min bin (top). Log-survivor plot of IRT distributions in the first third (Minutes 0 to 10, indicated by filled symbols) and the last third (Minutes 20 to 30, indicated by open symbols) of two sessions in which the HP and MP2 stimuli were delivered (bottom left panel). Steeper data paths indicate a greater proportion of short IRTs. Log-survivor plot of IRT distributions in the first third and the last third of all HP and MP sessions (not including MP varied) (bottom right).

beginning. Both panels also show how changes in IRTs from the first third to the last third of sessions were more pronounced for MP than for HP stimuli. These patterns indicate that Arlo slowed down more in the last third of MP sessions than in HP sessions. Similar patterns were observed when a third of a session was defined according to number of responses. Only 5 of the 24 MP sessions included in this analysis lasted 30 min. Although data were not collected on interaction with the low-preference item, anecdotally it occurred almost exclusively

prior to the onset of session termination criteria. One potential limitation of the preceding analyses is that lower rates might have been obtained in MP conditions simply because those stimuli took longer to consume. A separate assessment of consumption time (the average time obtained when tracking from entry into mouth to swallowing) found that the HP stimulus actually took the most time to consume (33.4 s) compared to the MP 2 stimulus, which took the least (27.4 s).

Our results are similar to those of Egel (1980, 1981), who found responding for varied stimuli persisted longer than responding for any single stimulus. In this study, varied moderately preferred stimuli resulted in greater within-session maintenance than individual moderately preferred stimuli, but lower maintenance than a single highly preferred stimulus. Therefore, this study extends those findings by showing such effects may depend on the relative preference of the stimuli assessed.

Conceptually, this study also contacts work that has compared preference assessment outcomes with performance on progressive-ratio (PR) schedules through the notion of diminishing marginal utility. Both the current approach and PR schedules assess the point at which the cost or effort to obtain one more reinforcer becomes greater than the value of that additional reinforcer (i.e., its marginal utility). Progressive-ratio schedules do this by increasing cost, whereas the current approach relied on the diminishing value of each additional reinforcer. Analogous to the outcomes of this study, Glover, Roane, Kadey, and Grow (2008) found that HP stimuli were associated with higher breakpoints compared to other stimuli. Therefore, performance on PR schedules might also predict within-session patterns and may be more informative than preference assessments in cases in which the stimuli in question are ranked equally (e.g., Roane, Lerman, & Vorndran, 2001). Finally, future research may examine the generality of these effects using different session durations (e.g., examine responding throughout an entire school day) or schedules while directly measuring consumption time.

REFERENCES

- Böhm-Bawerk, E. V. (1891). *The positive theory of capital* (W. A. Smart, Trans.). Library of Economics and Liberty. Retrieved from <http://www.econlib.org/library/BohmBawerk/bbPTC16.html>
- 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., Hagopian, L. P., Owens, J. C., & Slevin, I. (1992). A comparison of two approaches for persons with severe and profound disabilities. *Journal of Applied Behavior Analysis*, 25, 491–498.
- Glover, A. C., Roane, H. S., Kadey, H. J., & Grow, L. L. (2008). Preference for reinforcers under progressive- and fixed-ratio schedules: A comparison of single and concurrent arrangements. *Journal of Applied Behavior Analysis*, 41, 163–176.
- Koehler, L. J., Iwata, B. A., Roscoe, E. M., Rolider, N. U., & O'Steen, L. E. (2005). Effects of stimulus variation on the reinforcing capability of nonpreferred stimuli. *Journal of Applied Behavior Analysis*, 38, 469–484.
- Lee, M. S. H., Yu, C. T., Martin, T. L., & Martin, G. L. (2010). On the relation between reinforcer efficacy and preference. *Journal of Applied Behavior Analysis*, 43, 95–100.
- Murphy, E. S., McSweeney, F. K., Smith, R. G., & McComas, J. J. (2003). Dynamic changes in reinforcer effectiveness: Theoretical, methodological, and practical implications for applied research. *Journal of Applied Behavior Analysis*, 36, 421–438.
- North, S. T., & Iwata, B. A. (2005). Motivational influences on behavior maintained by food reinforcement. *Journal of Applied Behavior Analysis*, 38, 317–333.
- Roane, H. S., Lerman, D. C., & Vorndran, C. M. (2001). Assessing reinforcers under progressive schedule requirements. *Journal of Applied Behavior Analysis*, 34, 145–166.
- 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.

Received July 25, 2011

Final acceptance January 16, 2012

Action Editor, Carole Van Camp