2018 STUDENT PAPER & DISTINGUISHED CONTRIBUTIONS AWARD WINNERS
Annie Galizio (SPC Winner) & Mike Perone (DC Winner)

BRIEF REPORTS

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THE EXPERIMENTAL ANALYSIS OF HUMAN BEHAVIOR BULLETIN

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Student Paper Award Competition

About the award:

- Graduate students who have completed empirical or theoretical papers in the experimental analysis of human behavior are invited to submit their papers to the EAHB-SIG student paper competition. This competition specifically seeks to reward EAHB scholarship on human operant research topics. All papers submitted are sent to reviewers with expertise in the topic area of the student paper (many of the reviewers serve on the editorial boards of top behavioral journals). All student authors receive their reviews (regardless of award status). As such, this is an excellent opportunity for talented students to receive early peer-review experience.

2018 SPC Award Winner and Abstract

- **Annie Galizio, Utah State University**, “Resurgence of Reinforced Behavioral Variability in Humans” - (Academic Sponsor: Amy Odum)

- The present study examined resurgence of reinforced behavioral variability in humans. Resurgence is the reoccurrence of a previously reinforced response when reinforcement for an alternative response is suspended. In this study, college students completed a computer-based variability task, in which points were earned for drawing rectangles on the computer screen. The experiment was conducted in three phases. In Phase 1, Baseline, points were only delivered when a rectangle was produced that sufficiently differed from previous rectangles in terms of location. In Phase 2, Alternative, points were only delivered for rectangles that sufficiently differed from previous rectangles in terms of size. The order in which the dimensions, location and size, were presented was counterbalanced across participants. In Phase 3, Resurgence, no points were delivered for any response. In the first two phases, levels of behavioral variability were high for the reinforced dimension and low for the nonreinforced dimension. Levels of behavioral variability were high for both dimensions during the last phase. These results provide some evidence for resurgence of variability of a specific dimension of behavior. Cluster analyses identified several different patterns of responding, consistent with resurgence, rule-governed behavior, and extinction-induced response variability.

2018 EAHB Distinguished Contributions Award

About the award:

- Each year, SIG members vote on nominees for our Distinguished Contributions Award. This award is given to an individual who has made substantial, long-term contributions to the Experimental Analysis of Human Behavior and is presented each year at the ABAI annual convention.

- Past awardees include: Alan Baron, Murray Sidman, Joe Brady, Joe Spradlin, Charlie Catania, David Schmitt, Grayson Osborne, Travis Thompson, Jack Michael, Howie Rachlin, Nate Azrin, Harry Mackay, Deisy de Souza, Carol Pilgrim, and Phil Hineline

2018 Award Winner and Abstract

- **Michael Perone, West Virginia University**, “Circumvention of an Operant Analysis: How Do You Plead?”

- In Contingencies of Reinforcement, Skinner (1969) warned against the “circumvention of an operant analysis” of human behavior: the temptation to (a) tell subjects about contingencies instead of exposing them to the contingencies, and (b) ask subjects what they are likely to do instead of observing what they do. Verbal interactions between subject and investigator are inescapable in the experimental analysis of human behavior. Some investigators have taken pains to minimize the effect of these interactions and maximize direct control by contingencies. Others seem to have embraced the very practices that Skinner warned against. I will review the development of these two approaches to the analysis of human behavior and answer the charge: Are we guilty of circumventing an operant analysis?
Punishment procedures are sometimes clinically indicated to decrease problem behaviors (Fisher et al., 1993, Foxx & Azrin, 1972, Hagopian, Fisher, Sullivan, Acquisto, & LeBlanc, 1998). One factor that greatly influences the effectiveness of a punisher is the immediacy with which it follows a behavior (Azrin & Holz, 1966). Generally, the effectiveness of a punisher decreases as the delay between behavior and punisher increases. Although this observation might suggest punishers should only be delivered after short delays, there are some circumstances that either preclude or contraindicate the use of immediate punishers (Lerman & Vorndran, 2002; Meindl & Casey, 2012). For example, a behavior such as stealing may be detected only after a long period of time has elapsed. Alternatively, behavior may occur in a location where the delivery of a punisher is impossible (e.g., a mall when the punisher is time-out) or undesirable (e.g., in the presence of untrained staff members). In these situations, the delivery of a punisher will necessarily be delayed, and there is a risk of delivering a punisher that is less effective at suppressing the response upon which it is contingent.

Although there are no well-established methods for increasing the suppressive effect of delayed punishers (Lerman & Vorndran, 2002), there are several strategies that could prove potentially effective (Meindl & Casey, 2012). Of the methods which have been investigated, providing a verbal rule regarding the contingency between the response and the delayed punisher has produced encouraging results (Cheyne & Walters, 1969; Jackson, Salzberg, Pacholl, & Dorsey, 1981). Further, the explicitness of the rule has been shown to affect delayed punishment in that less explicit rules produce more suppression, and more explicit rules produce more suppression (Trenholme & Baron, 1975; Verna, 1977). For example, Verna (1997) demonstrated that the statement “Because you broke the game I will have to take away your token” (p. 622) was more effective at changing behavior than the statement “Because of what has happened, I will have to take away your token” (p. 622).

One potential problem with a delayed punisher is that it may suppress a response with which it occurs closely in time even if the punisher is not contingent on that response. Although no research could be found to explicitly support this claim, it is supported by general research on consequences. Behavior may be affected by immediate consequences even when no contingency exists between the behavior and consequence (Skinner, 1948). If, for example, aggressive behavior occurred at a mall and time-out was delivered later at home, the time-out may decrease the behavior occurring immediately before time-out and have no effect on aggressive behavior. This may pose a significant problem for clinicians as delayed punishers may be a) occasionally necessary or desirable, b) relatively ineffective at suppressing responses upon which they are contingent, and c) capable of “inadvertently” suppressing contiguous responses.

Although verbal rules have been shown to increase the suppressive effect of delayed punishers on contingent responses, the effect on contiguous (but not contingent) responses is unknown. If verbal rules allow a delayed punisher to affect contingent but not contiguous responses, this strategy may prove a viable tool for decreasing problem behavior that cannot be contacted by immediate punishment. If, however, delayed punishers suppress contiguous responses regardless of the inclusion of a verbal rule, the utility of this procedure would be highly questionable.

The primary purpose of this study was to examine the effect of a verbal rule on the suppressive effect
of a delayed punisher on responses with which the punisher was contiguous but not contingent. A secondary purpose was to further establish the effects of delayed punishers, with and without verbal rules, on contingent responses. To isolate the effects of a delayed punisher with a verbal rule, several aspects of responding needed to be controlled. First, to control for a potential confound of intermittent punishment it was necessary to ensure the participant could only respond once prior to experiencing the delayed punisher. Second, the length of the delay between the contingent response and the punisher needed to be held constant. Third, the punisher needed to occur immediately after the contiguous response. To control for these variables, a computer program was developed to precisely regulate opportunities to respond and deliver all programmed consequences and stimuli.

**METHOD**

**Participants and Setting**
Six graduate students enrolled in an Introduction to Applied Behavior Analysis course at a large mid-southern university participated in the study. The study took place in an on-campus computer lab equipped with PC computers. Upon entry to the computer lab, participants were assigned a seat, a computer, and were read instructions (see Appendix A). The instructions informed the participants how to use the computer program, to refrain from communication with anyone else during the study, to refrain from using other electronic devices, that the study would take approximately three hours, and that they could quit the research study at any time without penalty. Importantly, these instructions also informed the participants that they would be awarded 120 points at the beginning of the study, and that the choices they made throughout the study could result in the loss of points. Participants were informed that at the end of the study the number of points retained would be recorded and they would be entered into a raffle to win a 16GB Kindle Fire HD tablet – the more points retained, the more raffle tickets they would accrue. The loss of these points served as the punishment throughout the study. Across all subsequent conditions, selecting the most preferred letter (as identified by the paired stimulus preference assessment) resulted in the contingent presentation of punishment in the IP, DP, and DRP conditions, or simply the contingent presentation of a rule in the DR condition. Each condition was assigned unique letters such that...
no letters presented in one condition were ever presented in a different condition.

Immediate punishment. The IP condition consisted of two screens presented sequentially. To assist in discrimination, the two screens were different colors. Screen 1 presented two letters. The participant made a selection and was immediately presented with the second screen. Screen 2 presented the consequence based on the selection made on the first screen. If the letter associated with punishment (SDp) was selected, the participant lost points and this was indicated by a statement “You lost three points” on their screen. If the letter associated with no punishment (SΔ) was selected, the participant did not lose points and this was indicated by the statement “No points lost.” Once Screen 2 had been presented for 3 s, the participant was able to select “Continue,” which advanced the computer program. Each participant experienced 10 immediate punishment trials.

Delayed punishment. The DP condition consisted of four screens presented sequentially. Screen 1 presented two letters (similar to the IP condition) and the participant made a selection which moved the program to the second screen. Screen 2 presented text from Alice’s Adventures in Wonderland by Lewis Carroll. This text (pictures were omitted) was displayed for 5 min and served to provide a delay between the first and third screens. The participant could scroll through the text and the entire book was available. On each trial (across all delay conditions) the text resumed where the participant finished reading on the previous trial. After 5 min, Screen 3 was presented. This screen presented two letters (different from those on screen one) and the participant selected a letter. Neither letter was associated with any contingent consequence. The purpose of this screen was to determine whether a delayed punisher had any suppressive effect on a response with which it was contiguous but not contingent. To aid in discrimination, screen one and three were different colors. Selecting a letter on Screen 3 advanced the program to Screen 4. On Screen 4 a consequence was presented depending on which letter was chosen on Screen 1. If the SDp (associated with punishment) was selected, the participant lost points, and the statement “You lost three points” was displayed. If the SA (not associated with punishment) was selected, the participant did not lose points and the statement “No points lost” was displayed. Once Screen 4 had been presented for 3 s, the participant was able to select “Continue” which advanced the computer program. Each participant experienced 10 delayed punishment trials.

Delayed rule without punishment. The DR condition was similar to the DP condition described above. There were four screens total, and Screen 1 was a different color than Screen 3. Both screens were also different colors than the screens in the DP condition. The primary difference between the DR and the DP conditions was Screen 4. On this screen, if the SDp had been selected on Screen 1 the participant was presented with a written rule stating “You chose the incorrect shape on the [Screen 1 color] screen”; however, points were not mentioned and no points were lost. If the participant selected the SΔ on Screen 1, the participant was presented with a rule stating “You chose the correct shape on the [Screen 1 color] screen” and there was no change in points. Once Screen 4 had been presented for 3 s, the participant was able to select “Continue” which advanced the computer program. Each participant experienced 10 trials of the rule without punishment.

Delayed rule with punishment. The DRP condition was similar to the DP and DR conditions. There were four screens total, and Screen 1 was a different color than Screen 3. Further, both screens were different colors than the screens in the DP and DR conditions. The primary difference was Screen 4. On this screen, if the SDp had been selected on Screen 1 the participant was presented with a rule stating “You chose the incorrect shape on the [Screen 1 color] screen. You lost three points” and three points were deducted. If the participant selected the SΔ on Screen 1, the participant was presented with a rule stating “You chose the correct shape on the [Screen 1 color] screen. No points lost.” Once Screen 4 had been presented for 3 s, the participant was able to select “Continue” which advanced the computer program. Each participant experienced 10 trials of the rule with punishment.

Experimental Design

Conditions were introduced following a multielement design format wherein each condition was experienced as blocks of trials and the conditions alternated. This was done to limit sequence effects. Due to time constraints, only 10 trials were possible per condition (a total of 40 trials overall). These 10 trials were presented in three blocks of trials. The first block for each condition consisted of four trials and the second and third blocks consisted of three trials. For example, a participant might experience four trials of IP, followed by four trials of DRP, followed by four trials of DP, followed by four trials of DR, followed
by three trials of DRP, and continuing until the participant had experienced 10 trials (across three blocks) for each condition.

In an attempt to control for possible generalization of treatment effects (e.g., the participant generalized the rule from the DRP condition to the DP condition), participants were assigned to one of four different groups as they entered the computer room, and each group experienced a different initial condition sequence. The initial sequences for each group were as follows: Group 1 – IP, DP, DR, DRP; Group 2 – DP, IP, DRP, DR; Group 3 – DR, DP, IP, DRP; Group 4 – DRP, IP, DP, DR. Thus, each group started with a different condition.

Conditional Probability of Changes in Responding

The two primary objectives of this study were to determine whether the addition of a rule altered the suppressive effects of a delayed punisher on responses with which it was contingent but not contiguous (responses to Screen 1), as well as contiguous but not contingent (responses to Screen 3). To determine whether the consequence had an effect on either of these responses, it was necessary to calculate conditional probability (Catania, 1998), rather than simply counting responses. This was primarily necessary because, whereas the contingent responses consistently met with either punishment or non-punishment, the contiguous responses did not. Whether a response to Screen 3 met with punishment was determined by responses to Screen 1, and was therefore inconsistent.

In order to determine whether the delayed punisher had an effect, it was necessary to calculate the conditional probability of a change in responding from one trial to the next given specific consequences. Using procedures similar to Vollmer, Borrero, Wright, Van Camp, and Lalli (2001), conditional probability was calculated for changes in responding following punishment for both the contingent and contiguous responses, as well as following non-punishment for both responses (not displayed but available from the first author upon request). Calculating background probability, as was done by Vollmer et al. (2001), was not possible given that an initial preference assessment was conducted rather than conducting a baseline (which did not seem appropriate given the responses).

To calculate the conditional probability of changes in responding, the excel data file generated by the computer program was examined, and each trial that ended with punishment was marked, as was each trial that did not end with punishment. For each trial that ended with punishment, the letter that was selected was noted and compared to the letter selected on the next trial. To determine the conditional probability of response change after punishment, the number of times there was

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Figure 1. Conditional probability of response shift following punishment
a change in letter selection following punishment was tallied. This number was then divided by the total number of instances of punishment to generate a probability of changing responding following punishment. A score of 1.00 indicated a high probability of a change in responding whereas a score of 0.00 indicated a low probability. The same procedure was used to calculate the conditional probability of response change after non-punishment.

This conditional probability was calculated for both the contingent (i.e., Screen 1) responses and contiguous (i.e., Screen 3) responses. Further, this was calculated for IP, DP, DR, and DRP conditions – all trials within a condition were grouped and conditional probability of response change following punishment was calculated.

RESULTS

Figure 1 displays the average conditional probability of a shift in responding following punishment from one trial to the next across conditions for both the contingent set (i.e., those letters displayed on Screen 1) and the contiguous set (i.e., those letters displayed on Screen 3). Recall that the consequence (punishment or non-punishment) was entirely dependent on selections made on Screen 1. Responses on Screen 3 had no effect on whether punishment was produced or avoided.

Immediate Punishment. In the IP condition, selection of the SDp resulted in an immediate loss of points with no explanation as to the reason for the loss. A selection of the SΔ resulted in no loss of points. Across all participants, when participants selected the letter associated with punishment (SDp) and experienced the punishing consequence, the average probability of a shift in responding was 1.00. That is, on the next trial the participants did not select the same stimulus that previously produced punishment. This would indicate the consequence had a strong punishing effect.

Delayed Punishment. In the DP condition there was a delay of 5 min between a response to Screen 1 and the delivery of a consequence on Screen 4. Selecting the SDp resulted in a loss of points and selecting the SΔ resulted in no point loss. No reason for the consequence was provided. In this condition, there was an immediate decrease in the efficacy of the punisher compared to the IP condition. On average, the conditional probability that a participant would shift responding on the contingent set after experiencing punishment was .33. Further, it appears that the delayed punisher had a punishing effect on responding in the contiguous set. On average, the probability that a participant would shift responding in the contiguous set after experiencing punishment was .75. This would indicate that, compared to an immediate punisher, a punisher delayed by 5 min was less effective at shifting responding. Further, although responding on the contiguous set had no effect on whether punishment was produced, participants were still very likely to shift responding on this set following exposure to punishment.

Delayed Rule without Punishment. In the DR condition, there was a delay of 5 min between selection of the SDp and the displaying of a rule indicating that an incorrect letter had been selected. There was no mention of points and no points were lost. Selecting the SΔ produced an identical 5 min delay followed by a rule indicating the correct letter had been selected. Again, there was no mention of points and no points were lost. In this condition, the probability that participants shifted responding on the contingent set after experiencing the rule was .55 on average. A similar probability (.56) of shifting responding on the contiguous set after experiencing the rule was observed. This would indicate that, compared to delayed punishment alone, a rule increased the suppressive effect of delayed punishment on responding on the contiguous set. Further, the likelihood of a response shift on the contiguous set was somewhat decreased compared to the DP condition.

Delayed Rule with Punishment. In the DRP condition, there was a delay of 5 min between selection of the SDp and the displaying of a rule indicating that an incorrect letter had been selected and indicating that points had been lost. Selecting the SΔ produced an identical 5 min delay followed by a rule indicating the correct letter had been selected and that no points were lost. In this condition, the probability that participants shifted responding on the contingent set after experiencing the rule and punishment was .70 on average. The probability that participants shifted responding on the contiguous set was .32 on average. This would indicate that, compared to either a delayed punishment alone, or a delayed rule without a punishment, a delayed rule with a punishment produced the greatest suppression on responding on the contingent set, and the least suppression on responding on the contiguous set.

Individual Patterns of Responding. Figure 2 displays response allocations across each condition for individual participants. P1, P2, and P3 display patterns of responding most
consistent with the overall pattern of the group displayed in Figure 1. For these participants, the probability of a response shift on the contingent set following delayed punishment was highest in the DRP condition and the second highest in the DR condition. Furthermore, for P1 and P2, the likelihood of a response shift on the noncontingent set following delayed punishment was lower in the DRP condition than in the DP conditions. P3 did not contact punishment in the DP condition so this comparison is not possible. For P4, the probability of a response shift on the contingent set was equally high across all conditions (with the exception of the DP condition wherein no punishment was contacted), and the probability of a response shift on the noncontingent set was lowest in the DRP condition. For P5, the likelihood of a response shift on both the contingent and noncontingent sets was lowest in the DRP condition.

Response Change Following Non-Punishment.

The conditional probability of response change following non-punishment was also calculated (though not displayed). This was calculated to increase confidence when attributing response change following punishment to the actual consequence. If, for example, a participant shifted responding after every response, the conditional probability would be 1.00 following punishment and 1.00 following non-punishment. If the participant only shifted after punishment, the conditional probability would be 1.00 following punishment and 0.00 following non-punishment,
indicating it was likely the punishing consequence that caused the shift.

Across all conditions, for both contingent and noncontingent sets, the conditional probabilities of response changes were lower following non-punishment than punishment. This ranged from a high of .38 for the DR and DRP contingent sets to a low of .14 in the DR noncontingent set. These findings should increase confidence that the conditional probabilities of response change following punishment can be attributed to that consequence.

DISCUSSION

Overall, the addition of a verbal rule decreased the likelihood that the delayed punisher would suppress responses with which it was contiguous but not contingent. For contingent responses, it appears as though the suppressive effect of a delayed punisher on a contingent response is greatest when the punisher is presented with a rule explaining the contingency. These two effects of the rule are most noticeable when comparing the DRP condition to the DP condition, where the delayed punisher was least effective at suppressing responses upon which it was contingent, but most effective at suppressing responding with which it was contiguous.

These results highlight the importance of embedding rules describing relevant contingencies when employing delayed punishers. It is generally understood that a delayed punisher alone is minimally effective at suppressing behavior. What is less often considered is the effect a delayed punisher has on responding with which it is immediately contiguous. In this study, the effect was response suppression, which would likely be unintended by any practitioner using delayed punishment. Adding a rule appears to increases the selectivity of the punisher, in that it will primarily suppress those responses upon which it is contingent.

Limitations. Several limitations exist in this study. First, some participants never experienced all of the contingencies in each condition. Two participants did not experience punishment in the DP condition, and one participant did not experience punishment in the IP condition. If a participant did not experience the consequence, they were scored as NA for that condition and their data was not included in calculating conditional probability for that condition. Future research relying on a concurrent schedule arrangement might eliminate feedback following selection of the SΔ to promote initial shifting to increase the likelihood of contact with both contingencies.

A second limitation is that rules themselves may have had some punishing or reinforcing effect. Note that some response suppression was noted in the DR condition. Although there was no loss of points in this condition, the rule stated whether the letter they chose was “Correct” or “Incorrect.” The participants likely had experience with these words and this specific rule may have thus altered responding. Future research should generate rules that are relatively neutral. For example, a rule that simply stated which letter had been selected, but did not label the response as correct or incorrect, might limit the effect of the rule independent of the consequence.

Another limitation is that there may have been a sequence effect that influenced participant responding. Participants entered different conditions in different orders, but exposure to some conditions might have influenced responding in other conditions. For example, if a participant was first exposed to the DRP condition, they may have learned the contingency in the DP condition faster than a participant who was first exposed to the DP condition. The low sample size of this study prevents a statistical analysis of this possibility, but the possibility remains. Future research might look to increase the sample size to assess this possibility.

Another limitation is the inability to display the data in a traditional single subject arrangement. Although participants were exposed to conditions in a manner consistent with a multielement design (i.e., conditions were alternated frequently and in no consistent pattern), in order to determine the effects of punishment on contiguous (but not contingent) responding, calculating conditional probability was necessary. This was because punishment did not consistently follow specific responses to the contiguous set. In order to calculate conditional probability, responding across all trials needed to be combined. As a result, the graphical display is somewhat unusual given the arrangement of conditions, and may hinder the ability to demonstrate a functional relation.

Future Directions and Conclusion. A variety of questions remain unanswered regarding the effect of a rule on the suppressive effect of a delayed punisher. In this study, the rule was provided simultaneously with the punishment, after only a 5 min delay, was written rather than vocal, and the rule was complete (specified the antecedent, behavior, and consequence). In clinical settings,
however, the provision of a rule and consequence might be quite different than this arrangement. Rules may be provided at a variety of points in time relative to the delivery of punishment, punishers would likely be delayed much longer than 5 min, rules are likely vocal, and rules may be incomplete. Future research should investigate whether these variables influence the effectiveness of a rule by manipulating the temporal location of the rule, the length of the delay, the modality, and the completeness of a rule.

Immediate punishers are generally the most effective at suppressing behavior, and this is supported by the results of this study. In non-laboratory settings, however, there are a variety of situations wherein immediate punishment is either not possible or not desirable, and the delivery of the punisher is delayed. It is important, therefore, that strategies be developed to make delayed punishers maximally effective or practitioners risk delivering punishers that only suppress behavior occurring immediately prior. Although embedding rules represents a viable strategy and is commonly used, methods of making this strategy most effective are still in need of investigation.

References


Brief Report

On the Efficacy of Video Reinforcement in Human Operant Behavior

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Over the previous two decades, researchers have increasingly suggested pre-selected video may serve as an immediately-consumable reinforcer in the experimental analysis of human behavior (EAHB), analogous to food with non-human subjects (Andrade & Hackenberg, 2012; Charlton & Fantino, 2008; Forzano, Michels, Sorama, Etiope, & English 2014; Hackenberg & Pietras, 2000; Lagorio & Hackenberg, 2010; Macaskill & Hackenberg, 2013). Navarick described contingent video reinforcement as "an immediately consumable (intrinsic) positive reinforcer" (1996, pg. 540); wherein intrinsic reinforcers are stimuli that effectively reinforce behavior in the absence of a specified backup reinforcer. Forzano et al. (2014) reiterated this assessment, asserting that audio/visual entertainment does not require a backup reinforcer to be reinforcing, and therefore may function as intrinsic or primary consumable reinforcement. Locey, Pietras, and Hackenberg (2009) advised further research to isolate the variables contributing to the reinforcing efficacy of access to videos, thus potentially expanding the use of video access as a reinforcement procedure.

Previous findings demonstrate similarities between humans’ responding for access to video and non-humans’ responding for access to primary reinforcers (Hackenberg and Pietras, 2000; Navarick, 1996, 1998). Navarick (1996) reported adults reliably chose to hasten the delivery of video reinforcement under delay-discounting arrangements, preferentially selecting shorter, more immediate video segments over longer, more delayed video. Such findings contrast with results obtained when points or tokens were used as reinforcers with human participants. Hackenberg and Pietras (2000) reported similar findings, concluding: (a) greater durations of video are preferred over shorter durations when delay is held constant; (b) quicker access to video is preferred over delayed access with duration held constant; (c) under long delays, preference for longer duration reverses in favor of more immediate shorter duration; and, (d) with equal delay to video access, preference reverses back in favor of longer durations of video.

Other investigators concluded video access can function as an effective reinforcer in EAHB (Charlton & Fantino, 2008; Forzano et al., 2014; Lagorio & Hackenberg, 2010; Locey et al., 2009; Macaskill & Hackenberg, 2013); however, continued systematic investigation of variables affecting the efficacy of video access as a reinforcer is needed. Locey et al. (2009) suggested the reinforcing efficacy of video depends on an individual’s specific conditioning history; as well as procedural parameters, such as continuity (i.e., uninterrupted access over time), duration, and inter-clip interval. DeLeon et al. (2014) supported the importance of continuity, demonstrating that children with intellectual disabili-
ties oftentimes preferred accumulation procedures to those arranging for more immediate access, despite inherent increases in delay to onset of reinforcement.

The motivation of participants to volunteer for research must also be addressed when investigating within-session reinforcement procedures. One commonly reported procedure for recruiting volunteers involves offering course credit to undergraduates for their participation (Cassidy & Kangas, 2014; Critchfield, Schlund, & Ecott, C., 2000; Kangas & Hackenberg, 2009). However, the use of course credit itself may not effectively increase within-session responding once a participant is recruited. Additionally, extra-experimental incentives may have unforeseen effects on the efficacy of programmed within-session reinforcers.

In the case of access to video as reinforcement, course-credit adjusted across time (e.g., hourly rates) may increase the reinforcing efficacy of video as an artifact of increased overall credit (i.e., participants receive credit for watching video). Alternatively, arranging flat-rate credit may decrease the efficacy of video reinforcement as an artifact of decreasing compensation rate over time (i.e., less credits per unit of time watching video). It therefore remains critical that experimental evaluations of video reinforcement procedures continue to refine our methodological understanding of their effectiveness. A logical step towards developing our understanding of the efficacy of video as reinforcement includes evaluating the extent to which participants choose to watch, or forgo, the video they have earned.

The current study assessed the efficacy of access to video as reinforcement with undergraduates participating for pre-specified course credit. Investigators hypothesized: (a) when provided the option, participants will predominantly choose to save earned video clips and continue working (i.e., accumulate); and, (b) following completion of sessions, participants will forgo watching accumulated video in favor of leaving the research lab. Participants completed multiple choice arithmetic problems for access to video according to systematically increasing schedules of reinforcement, with a constant unit price for the duration of video (i.e., increasing duration). Two experimental conditions alternated across sessions, during which (a) earned video clips played immediately; or, (b) participants chose to either immediately play earned video clips or save earned video time and continue working.

**METHOD**

**Participants and Setting**

Investigators recruited 50 participants from undergraduate psychology courses at a private university in the Southeastern United States via the university’s School of Psychology online recruitment website offered. Investigators randomly assigned participants to one of two experimental groups, balancing the number of participants across groups such that each consisted of 25 participants (10 females; 15 males). Following participation, each student participant received two hours’ worth of research-participation credit via the recruitment website. All participants were at least 18 years of age prior to consenting to participate. No other demographic information was collected. Researchers excluded data from three additional participants due to incomplete sessions.

Participants completed all sessions in one of two laboratory spaces (2.7 m by 4.1 m) located in an on-campus building. Participants sat at a small table (1.2 m by 0.6 m) equipped with a desktop computer, keyboard, external mouse, and headphones. Portable partitions separated tables such that participants running simultaneously could not see each other or view adjacent computer screens.

**Apparatus and Data Collection**

A Microsoft Visual Basic® program sequentially presented all experimental conditions and recorded data on stimuli changes and participant responses in real time. Figure 1 displays screen shots of within-trial (a) and post-trial (b; Choice condition) response screens. All experimental stimuli and response options appeared within a single graphical frame (25 cm wide by
Figure 1. Within-trial response (top panel) and post-trial choice (lower panel) screen shots. Within each trial the top label displayed the current response requirement and video duration, as well as incrementally increasing correct responses. The center label displayed a randomly generated arithmetic problem, followed by three vertically aligned response options. During Choice condition, following completion of each response requirement a label presented the duration of video earned and response requirement completed, followed by a prompt to choose to watch or save the video.

13 cm high) centered on the computer monitor; participants responded by positioning the mouse cursor over a given option and clicking the left mouse button. Digital videos (i.e., previously selected television shows) displayed on the full computer monitor via Windows Media Player® software. All video clips played in sequence, such that each clip began where the previous clip stopped. If at any time an episode of the selected show concluded, the next episode in the sequence immediately began. The experimental program collected data on all stimulus presentations, choice responses, duration of video accumulated, and duration of video viewed. Following the conclusion of all data collection, data were analyzed using SPSS. The primary dependent variables of interest consisted of proportion of video segments skipped, final choice responses (view video or terminate session), and total duration of video remaining unconsumed. Of secondary interest was participant response rate in responses per minute.

Procedures

Researchers provided instructions during the informed-consent process indicating that full participation credit would be provided upon completion of all sessions, regardless of total duration of participation. These instructions were provided to minimize potential data artifacts in the form of inflated proportion of video selected by participants to increase total participation credit (i.e., participation time). During the informed consent process (i.e., prior to sessions), researchers provided participants with the following instructions:

The consent form states that you agree to participate for up to two hours. Participation should not actually take the full two hours, but you will still get full credit for completion of the entire program. During the program, you will be completing multiple series of basic arithmetic problems, with increasing numbers of problems and periodic opportunities to watch a video. The program will cycle through six full sessions, each followed by a brief break screen. Once all six sessions are complete, you will be prompted to inform a lab staff member, and your participation will be complete.

Following informed consent, the experimental program initially displayed an array of four television shows, from which participants chose one. Options included New Girl season 4, The Simpsons season 25, Friends season 10, and a Simpsons – Family Guy crossover special. Upon selection of a video, the program presented participants with the following on-screen instructions: “Use the computer mouse to select correct answers to problems and earn access to videos. You will need only the computer mouse for this portion of the experiment. When you are ready to begin, click the ‘Begin’ button below.” The session started when a participant clicked a “Begin” button centered 4.2 cm from the bottom of the instruction frame; after the “Begin” button was clicked, a 60-s pre-session segment of the selected video displayed, providing initial exposure to programmed reinforcement. Immediate-
ly following the pre-session video, session one began.

All sessions consisted of six trials; investigators presented two-by-two-digit multiple-choice addition problems to participants using a geometric progressive-ratio (2x step size) schedule of reinforcement. That is, Trial 1 required two correct responses, followed by four in Trial 2, eight in Trial 3, and so on, to sixty-four during Trial 6. Unit price for the duration of access to video remained constant across schedule requirements, starting at 5 s (i.e., 5 s, 10 s, 20 s, 40 s, 80 s, and 160 s). Investigators selected these schedule values based on pilot data suggesting all trials could be completed and video watched within the two-hour time limit.

Each math problem consisted of randomly generated two-digit numbers, ranging from 10 to 49; this range resulted in correct response options also consisting of two-digit numbers. The correct option and two randomly generated incorrect response options, ranging between +/- 75% of the correct option, were presented horizontally in random order, 5.5 cm from the bottom of the response frame. Response options measured 5.3 cm wide by 1.3 cm high, spaced 1.5 cm apart. Selection of an incorrect response resulted in immediate presentation of a new math problem, without increasing the “total correct” label.

Investigators utilized an alternating-conditions (A-B-A-B-A-B) research design across sessions. During Condition A (Immediate), completion of each schedule requirement immediately initiated access to the next video clip. During Condition B (Choice), following completion of each schedule requirement, a choice screen appeared stating: “You earned [X] seconds of video for completing [Y] problems correctly. Would you like to watch your video, or save it and continue to the next trial?” Two buttons labeled “Watch Video” and “Next Trial” appeared side-by-side on the center-lower half of the response frame. Clicking the “Watch Video” button immediately initiated the current video duration for that trial only; “Next Trial” resulted in the current video duration being added to any previously skipped video duration (i.e., accumulated), and immediate initiation of the next trial. Following completion of all trials and video access within a session, between sessions a break screen displayed containing a button for participants to initiate the next session.

To assess potential effects of delayed access to accumulated video, two experimental groups completed all sessions from Immediate and Choice conditions as previously described: final-session access (Group 1) or each-session access (Group 2). Within Group 1, accumulated video was only available following completion of the final session. Following completion of all sessions, if any video had previously been accumulated during any test sessions, a choice screen appeared stating: “Congratulations, you have completed participation in this experiment. You chose to skip [X] total seconds of video. Would you like to watch the video, or end the program now?” Two buttons labeled “Watch Video” and “End Program” appeared side-by-side immediately below.

Procedures within Group 2 were identical to those in Group 1, with additional choice options presented across sessions throughout participation. Following completion of each session (two through six), if any accumulated video remained unwatched, a choice screen appeared stating: “You have [X] seconds of video saved. Would you like to watch your video, or save it and continue to the next session?” Response options and procedures were identical to those described for Choice conditions. Clicking the “Watch Video” button initiated continuous playback of video until the total accumulated duration of video expired.

RESULTS

An independent samples t-test comparing mean of video skipped between the two groups revealed no significant difference in total videos skipped (Group 1, M = 12.68, SD = 4.52; Group 2, M = 14.16, SD = 4.40), or unconsumed video durations following conclusion of participation (Group 1, M = 597.22 s, SD = 260.32; Group 2, M = 622.33 s, SD = 320.96). A chi-squared test of independence examining the relation between
experimental group and non-consumption of video also revealed no significant difference between experimental groups, $X^2 (1, N = 50) = .802, p = .37$. Analyses of response rate similarly revealed no significant differences between groups (data available upon request). Therefore, all subsequent analyses were carried out on aggregate data across all participants.

Figure 2 depicts aggregate average proportion of video segments skipped across Choice trials for all participants. Visual analysis of the proportion of video segments skipped across trials revealed a slight decreasing trend as response requirement and video-segment duration increased within session.

A one sample t-test comparing total video segments skipped during Choice to Immediate (zero) across all participants revealed a significant difference ($M = 13.42, SD = 4.48$), $t(49) = 21.20, p < .001$. These results suggest participants are likely to skip earned video segments when provided the opportunity. Across all participants completing participation in the current study, 66% chose to terminate participation following the final session without consuming accumulated video.

A 2 (condition) X 2 (group) repeated measures ANOVA revealed a significant within-participant main effect of condition on average responses per minute: $F (1, 48) = 57.57, p < .001$. Average responses per minute for Immediate ($M = 22.00$) was lower than for Choice ($M = 24.05$) conditions. As previously noted, no significant between-group effect was observed for responses per minute. Interestingly, analyses did reveal a significant interaction effect between condition and group: $F (1, 4.38), p < .05$. The increase in responses per minute observed during Choice was more pronounced within Group 2, in which participants were provided additional opportunities to watch accumulated video.

**DISCUSSION**

This study aimed to assess reinforcing efficacy of video access for undergraduate students participating for course credit. Results support our two-fold hypothesis that (1) provided the option, participants will predominantly choose to accumulate earned video time; and, (2) following completion of sessions, a substantial number of participants will choose to forgo watching accumulated (i.e., saved) video in favor of leaving the research lab. During Choice conditions, participants chose to skip-and-save a significant number of earned video segments, preferentially electing to complete additional trials. Additional analyses revealed statistically significant increases in rate of responding when sessions included the option to accumulate video segments. Increases in response rate across conditions were greater for Group 2 (each-session access). However, it may be argued that the average increase from $M = 22.00$ to $M = 24.05$ responses per minute may not represent a practical significance.

These results are consistent with DeLeon et al. (2014) demonstrating preference for accumulated over distributed access to activity-based reinforcement in children with intellectual disabilities. The current study extends these findings to individuals in a basic human-operant setting, while concurrently analyzing reinforcing efficacy by providing participants an option to forgo watching accumulated earned video contingent upon completion of experimental sessions.

A large portion of participants (66%) chose to not watch saved video after completing all sessions, instead choosing to terminate participation and leave the experimental setting. Undergraduate students agreed to participate in the current study in exchange for two hours of research credit towards a given course. Comple-
tion of all six pre-arranged sessions, rather than a full two hours of participation, was required to earn full credit. Thus, skipping videos and quickly completing all schedule arrangements resulted in reduced total time spent in the research lab, therefore requiring less time to earn credits. These consequences may be interpreted as reduced delay to and/or temporal cost for credits. These findings suggest that experimental lab arrangements in which participants may be motivated to quickly complete participation and exit the experimental setting may result in maintenance of responding by extra-experimental reinforcement processes, rather than preprogrammed within-session video access.

It is possible that requiring a fixed duration of overall participation might increase the efficacy of video reinforcement by decreasing total work completed (i.e., a break from responding). Similarly, participants agreeing to participate in exchange for monetary compensation may respond differentially to time-based versus fixed allotments. Alternatively, experimental arrangements allowing participants to explicitly choose between working for video and working for reduced session time might allow for direct comparison of these variables. Future research is warranted to empirically evaluate these hypotheses.

Potential limitations to the current procedures are worth noting. In the interest of avoiding the necessity to train target responding, investigators selected completion of multiple-choice addition problems, presuming that undergraduate participants had previously mastered these tasks. Such a response presumably required some measure of attending on the part of participants and allowed for experimenter observation of discrete responding under ratio-based schedules of reinforcement. It is likely that differences in math fluency existed across participants and these differences may have affected choice responding to skip programmed reinforcement and continue completing problems, as well as affecting response rate across participants and sessions. The sample size of 50 participants does afford a high level of confidence in results of between-participant analyses of choice responding and within-participant analyses of rate of responding across conditions. However, further investigations of responding under alternative target-response and reinforcement-schedule arrangements are warranted to generalize findings across experimental procedures.

Investigators arranged for a progressive schedule of reinforcement within sessions across a fixed number of trials. This arrangement provided for a continuous unit price for video (i.e., response requirement-video duration ratio) while rapidly increasing response requirements. It may be the case that alternative progressive arrangements, or step sizes, as well as discontinuous unit-price changes, would yield differences in responding (Hursh & Silberberg, 2008). Additionally, although these progressive arrangements allowed for repeated exposure to schedules and conditions, alternative research designs incorporating baseline and reversal arrangements may be worthwhile toward further investigating reinforcing efficacy of video access.

Future studies might potentially increase the reinforcing efficacy of video in EAHB by arranging for pre-experimental identification and acquisition of preferred videos. However, this may be a time- and cost-intensive endeavor given large participant pools (i.e., undergraduate students) or samples, and limited individual participation time. It may also be of value to assess the current procedures given access to a larger array, or perhaps online streaming, of video.

The array of videos presented to participants in the current study was not extensive nor based on pre-trial preference assessments. Although the experimenters made an effort to include relatively recent and highly-rated viewing options, it is likely that some participants did not prefer any of the videos presented within the available array (i.e., preference for “none”). For these participants, the provided array may more closely resemble a forced-choice arrangement, rather than an indication of preference (see Tullis et al., 2011 for a review of choice and
preference in applied contexts). In these cases, subsequently choosing to skip earned video may be interpreted as a revealed preference for none of the available video options. Future research could assess this possibility directly by providing a “none of the above” or “break” (i.e., black-out period) option within the initial choice array.

Although the current study aimed to assess the efficacy of video reinforcement in a basic human-operant setting, potential limitations to generalizing the current findings to other settings and populations are also worth noting. It is unlikely that most applied settings incorporate an option to forgo earned reinforcers in favor of leaving early. Future research on the efficacy of such procedures in an academic or clinical setting may be of value to practitioners, particularly those who employ automated or computer-based educational programming. The current procedures could be readily adapted to assess reinforcement contingencies and stimuli in such programs. Practitioners may also find some utility in providing a choice between within-session reinforcers and extra session breaks or activities.

Additionally, it may be assumed that best-practice procedures in applied settings would include identifying and selecting client-specific reinforcers. If preferred videos have been previously identified for a given individual, it should be more likely those videos will serve as an effective reinforcer for the target behavior of that individual and would thus be consumed when available. The goal of the current study, however, was to specifically assess the efficacy of video as reinforcement in basic EAHB arrangements. It would seem based on the current results, under these conditions, response-dependent access to video in itself may not meet the conceptual definition of reinforcement for a large portion of participants. Future investigations should continue to directly evaluate variables related to programmed video reinforcement in EAHB, to strengthen the validity of conclusions drawn under these experimental arrangements.

REFERENCES


BRIEF REPORT

A PRELIMINARY ANALYSIS OF INDIVIDUAL DIFFERENCES IN PERSISTENCE DURING DISRUPTORS ACROSS TWO INDIVIDUALS WITH AUTISM SPECTRUM DISORDER

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The current study on behavioral momentum theory was conducted in a classroom-like setting with two adults with Autism Spectrum Disorder (ASD) and mild intellectual disability. The rate of response persistence on completing math problems in the presence of disruptors was evaluated according to a two-component multiple schedule with reversal experimental design. Completing math problems was reinforced according to either a rich or lean reinforcement schedule. During the disruptor test conditions in which participants were answering math problems, either an alternative stimulus or a highly preferred activity was presented simultaneously with math problems. Responding for one participant with relatively mild symptoms of ASD was disrupted only by an alternative stimulus, a different set of math problems. Consistent with predictions made by behavioral momentum theory, responding was more disrupted during the leaner context than in the richer context, suggesting that the reinforcement context affected response persistence. This finding may increase the generality of previous research on behavioral momentum theory (BMT) to functional academic skills in an adult with ASD and may aid clinicians and practitioners interested in decreasing or increasing response persistence depending on the environmental context. Response rates for the second participant with more severe symptoms of ASD were not disrupted regardless of the type of reinforcement schedule or disruptor.

Keywords: response persistence, alternative stimulus, concurrent distracting stimulus, behavioral momentum theory, adults with autism

Response persistence in academic environments where reinforcement for accurate responding is lean, or frequently disrupted, may contribute to academic success; therefore, determining the variables that contribute to or

Address correspondence to: Adam Brewer, Ph.D., BCBA-D. Western Connecticut State University, 181 White Street, Danbury, CT 06810. breera@wcsu.edu
detract from response persistence may have clinical and educational relevance. Behavioral momentum theory (BMT) is a useful metaphor for gaining a better understanding of the determinants of response persistence that parallels the concept of momentum in the field of physics (Nevin, 1984). Momentum of an object \( p \) is determined by the product of a body’s inertial mass \( m \) and velocity \( v \) when some external force or disruptor is applied to the object \( f \); \( f \) = \( m \) \( v \). Relating this physics metaphor to behavior, the rate of responding is analogous to velocity and is determined by the response-reinforcer relation (operant conditioning) whereas the total amount of obtained reinforcers in a situation, or the context-reinforcer relation, determines behavioral mass (respondent conditioning). Several studies have demonstrated that resistance to change (i.e., response persistence) is determined by the context-reinforcer relations (e.g., Mace et al., 1990; Mace et al., 2010; Nevin, 1984). Response persistence is operationally defined as the degree to which there is a change in rate of responding relative to baseline when behavior is exposed to a potential disruptor (i.e., response rates are expressed as a proportion of baseline levels of responding). An important finding is that increasing the total number of reinforcers delivered in a stimulus context increases the persistence of behavior when disruptions in the environment occur (e.g., Linello-Denolf, Dube, & McIlvane, 2010; Mace et al., 2010). That is, during disruption, responding tends to be more persistent in stimulus contexts associated with more overall reinforcers than less reinforcers, regardless of whether the reinforcers are delivered contingently or non-contingently. While an array of basic laboratory research studies with nonhuman animals (e.g., Nevin, 1984; Nevin, Tota, Torquato, & Shull, 1990; Podlesnik, Jimenez-Gomez, Ward, & Shahan, 2009) and humans with intellectual and developmental disabilities (e.g., Dube, Mazzitelli, Lombard & McIlvane, 2000; Dube, McIlvane, Mazzitelli, & McNamara, 2003; Linello-Denolf, Dube, & McIlvane, 2010) exist, only Parry-Cruwys et al. (2011) has used this basic BMT research paradigm in non-laboratory settings in clinically-relevant populations such as individuals with Autism Spectrum Disorders (ASD). Individuals with ASD often exhibit challenging behaviors that are evoked by changes in well-established and persistent routines (e.g., Reese, Richman, Zarcone, & Zarcone, 2003). Systematic replications in this area are important to strengthen connections between basic and applied research on response persistence and to increase the generality of these results (Wacker, 1996). A better understanding of the controlling variables of response persistence in individuals with ASD has applied implications for decreasing response persistence in inappropriate environmental contexts (e.g., devaluing reinforcement contexts for inappropriate behavior) and for increasing response persistence in appropriate situations (e.g., enriching reinforcement contexts for appropriate behavior).

Mace et al.’s (1990) study examined the determinants of response persistence. Mace et al. tested whether BMT predicted response persistence during a match-to-sample color-sorting task for two individuals with intellectual disabilities; no history of noncompliance was reported. Each color was correlated with a distinct rate of reinforcement for edible reinforcers (i.e., a multiple-schedule of reinforcement). For both components, earning a reinforcer was contingent upon a single sorting response that occurred immediately after a time interval had elapsed. For Phase 1 of the study, sorting red objects resulted in a reinforcer delivered after a 1-min mean interval—a variable interval (VI) 60-s schedule (the “rich” schedule component). In the “lean” component, sorting green objects resulted in reinforcers being delivered every 4 min, on average—a VI 240-s schedule. During the disruptor test, a preferred video was played while participants sorted. For both participants, the rate of sorting was disrupted in both schedule components; however, response rates in the rich schedule component were relatively more persistent (less disrupted) than in the lean component. In agreement with BMT, these results suggest response rates during disruption are
controlled by the rate of reinforcer presentation (i.e., frequency of reinforcement signaled by the task stimuli).

Phase 2 of the Mace et al. (1990) study examined whether response persistence was enhanced via the delivery of additional noncontingent reinforcers. Equal VI multiple schedule components were arranged (e.g., VI 60 s; VI 60 s) for sorting. However, in one component, noncontingent reinforcers were also delivered at a mean rate of one every 30 s (a variable-time 30-s schedule). During the disruptor test conditions, response rates were more persistent in the schedule component associated with additional “free” response-independent reinforcers than the component without the additional reinforcers. These results, consistent with BMT (Nevin, 1984), demonstrate that the total number of reinforcers associated within a stimulus context (the context-reinforcer relations) is a controlling variable for response persistence—indeed of the baseline response rates (the stimulus-reinforcer relations).

Extending these procedures to individuals with ASD (no history of noncompliance was reported) in a non-laboratory setting, Parry-Cruwys et al. (2011) systematically replicated Phase 1 of Mace et al.’s (1990) study using academic tasks in a special education classroom setting. While daily classroom activities were ongoing, six children with ASD and other neurodevelopmental disabilities (age 4 to 13 years) were exposed to a two-component, multiple VI 7-s VI 30-s schedule. Completing math worksheets or jigsaw puzzles resulted in access to either tokens or edibles. During the disruptor test, each individual’s highly preferred activity was presented (e.g., toys, books, or videos). Consistent with the predictions of BMT, response persistence was less disrupted in the context of the richer schedule component (i.e., the VI 7-s schedule). Parry-Cruwys et al. demonstrated the feasibility of using a BMT paradigm to assess response persistence in individuals with ASD and showed that the rate of reinforcement could increase response persistence in individuals with ASD. However, this study did not assess whether additional noncontingent reinforcers could increase response persistence in individuals with ASD in a non-laboratory setting.

The current study sought to further test the generality of non-laboratory replications of BMT by conducting a comprehensive evaluation of the determinants of response persistence in two individuals with ASD. The effects of differences in the rate of reinforcement (i.e., Phase 1: unequal VI schedules; Phase 2: equal VI schedules plus a superimposed VT schedule) for completing math problems during disrupted environmental conditions were assessed in two high-functioning adult participants with ASD in a classroom-like setting. Based on studies that have reported that some individuals’ behavior was insensitive to differences in rate but were sensitive to differences in reinforcer magnitude, we employed large and small reinforcer magnitudes in the rich and lean schedule components, respectively, in Phase 1 (Dube & McIlvane, 2002). In Phase 2, we held reinforcement magnitude constant across schedule components to more reasonably attribute potential rate increasing effects to additional noncontingent reinforcers. According to BMT, we predicted that response persistence would be greater in the stimulus contexts associated with richer rates of reinforcement (Phase 1) and that additional noncontingent reinforcers would enhance persistence (Phase 2).

METHOD

Participants, Setting, and Materials

Two young adults participated, and both were receiving services at a university-affiliated program for individuals with ASD transitioning from high school to employment. Andrew was a 23-year-old male diagnosed with Autistic Disorder and Reagan was a 21-year-old female diagnosed with Autistic Disorder; both participants were able to communicate vocally using complete sentences. Participants were initially selected based on informal observations from parents, teachers, and therapists, regarding ASD symptom severity and clinical observations of response persistence. For instance, informal
observations suggested that Ryan had “classic” autism symptoms such as repetitive (or persistent) motor and vocal behaviors (Kanner, 1943). He seemed almost disinterested in the social aspects of communicating with people. Reagan had much better social skills and exhibited infrequent repetitive motor and vocal behaviors. We then formally assessed ASD symptom severity by using the Childhood Autism Rating Scale – Second Edition High Functioning (CARS2-HF: Schopler, Reichler, De Vellis, & Daly, 1980). The CARS2-HF rating form is appropriate for individuals age 6 and older. The CARS2-HF is a rating form administered by professionals to adults familiar with the individual’s behavior across settings and it is interpreted as a measure of symptom preponderance and severity. The teacher rated participants on 15 items using a scale of 1 to 4, where 1 indicates behavior within normal limits, and 4 indicates markedly abnormal or severe behavior compared to peers. Scores were summed and compared to the Severity Group cut-scores. Andrew received a score of 33.5 (Mild-to-Moderate symptoms range = 28-33.5) and Reagan received a score of 19 (Minimal-to-No Symptoms; range 15-27.5). The CARS2-HF scores were used to identify Andrew as having relatively higher severity and Reagan as having lower severity of autism symptoms.

Participants were assessed on their adaptive functioning skills using the Scales of Independent Behavior - Revised (SIB-R: Bruininks, Woodcock, Weatherman, & Hill, 1996). The SIB-R is a structured interview form administered to a parent or caregiver which summarizes performance of motor skills, social interaction and communication skills, personal living skills, and community living skills to yield a Broad Independence standard score (M = 100, SD = 15). Both Andrew and Reagan received a standard score of 61 on the SIB-R, indicating comparable levels of independent adaptive functioning.

All sessions were conducted in a private room in the university furnished with a desk, two side-tables, and two chairs. Each participant sat at the desk. The researcher stood beside the participant while the data collectors sat behind the participant and out of view. Participants used dry erase markers to complete math problems that were tailored to each participant’s educational level. Math problems were arranged on laminated orange or blue paper the size of an index card. Each color of math problem, as well as matching placemats on the desk, was associated with a different reinforcement context.

Math skills assessment. The Calculation subtest of the Woodcock-Johnson III Tests of Achievement was used to identify types of calculations each participant could perform (i.e., single-digit addition, double-digit multiplication). Thirty unique problems of each type of calculation were printed on a sheet, and participants worked on each sheet for one minute. Rate correct (number of problems correct per minute) was calculated for each problem type, and a bank of 100 problems was built using calculations within each participant’s instructional level (20-39 digits correct for grades 4-12; Deno & Mirkin, 1977).

Preference and reinforcer assessment. Participants had an extensive history of exchanging tokens for backup reinforcers. To identify potential backup reinforcers for the experimental task, a Reinforcer Assessment for Individuals with Severe Disabilities (RAISD: Fisher, Piazza, Bowman, & Amari, 1996) was administered. The top six activities identified as preferred, plus two activities suspected to be non-preferred, were used in a paired choice preference assessment conducted according to procedures outlined by Fisher and colleagues (1992).

The three stimuli chosen most frequently during the preference assessment were evaluated using the concurrent operant reinforcer assessment described by DeLeon et al. (2001). For Andrew, playing a Super Mario® video game functioned as the most-preferred reinforcer and talking with another individual was a reinforcer for Reagan. Participants earned tokens during both phases, which could be exchanged for their choice of their top two reinforcing activities (30 s per token; playing Super? Mario® or watching a Super Smash Brothers™ video game on
YouTube for Andrew, and talking or playing dominoes for Reagan). The third most reinforcing activities (watching ESPN for Andrew and listening to Mandy Moore for Reagan) were selected as the continuously available stimulus for the concurrent distracting stimulus disruptor test condition. The rationale for selecting the third most reinforcing activity for the concurrent distracting stimulus was to maximize the potential for identifying an effective disruptor and to prevent stimulus confusion with the reinforcers associated with multiple-schedule components (top two preferred stimuli) and alternative stimulus disruptor. The third most reinforcing activities used in the current study also resembled features of concurrent distracting stimuli used in previous studies (e.g., excerpts of a music video; Mace et al., 1990).

Data Collection and Interobserver Agreement

Interobserver agreement (IOA) was assessed for condition code and total responses completed within each component for 30% of sessions (n = 25) distributed across participants and disruptor type. An independent observer received guided training on one video until he/she reached a 90% agreement criterion and then scored independently when he/she met or exceeded the 90% criterion on three successive videos. The independent observer coded the color associated with each multiple schedule component (orange or blue, signaling rich or lean contexts) and total number of responses completed (one response was scored when the participant wrote on a card from the problem pile, then placed it in the completed pile) and these results were compared to original data collected by the primary therapist. Inaccurate responding was an infrequent event between participants and did not occur differentially across conditions. Condition code exact agreement was calculated for all components scored by dividing agreements by total components observed and multiplying by 100. Percentage agreement for problems completed was calculated for each component by dividing the smaller number of problems completed by the larger number and multiplying by 100. Overall agreement for condition code was 98%. Mean agreement for problems completed was 98% (range = 85-100%).

Phase 1: Unequal VI and Reinforcer Magnitude Baseline. The aim of Phase 1 was to assess whether responding would be more persistent in richer reinforcement contexts compared to lean. Before each session, participants were given the following verbal instructions, “You can do some math problems, or you don’t have to do math problems at all. When the problems are blue you can only earn one token. When the problems are orange, you can earn three tokens. It doesn’t matter to us how many math problems you do. It is up to you! At the end of the session, you have to trade in any tokens you earned.” At the beginning of each session conducted thereafter, the participant was asked three questions (“How many tokens can you earn for doing blue?” “How many tokens can you earn for doing orange?” and “Does it matter to us how many math problems you do?”) with brief praise for correct answers and brief corrective feedback for incorrect answers. No other instructions were delivered and all participants started completing math problems as soon as the stack of problems was placed in front of them.

In Phase 1, unequal rates/magnitudes of reinforcement were correlated with two different multiple-schedule components. Orange materials were associated with a rich rate of reinforcement in which reinforcers were delivered contingent on a single response after a mean interval of 60 s elapsed (a VI 60-s schedule) and blue materials were associated with the lean schedule (VI 150 s). Correctly completing math problems during the rich schedule component produced three tokens and correctly completing problems in the lean component produced one token. Each session consisted of four 3-minute multiple-schedule components (two rich reinforcement contexts, two lean) randomly sequenced, and separated by a 40-s intertrial interval (ITI). Problems and placemats were removed and the research assistant did not provide attention during the ITI. Tokens delivered at the end of each
schedule component could not be accessed until the session was finished. Tokens could be exchanged for the backup reinforcers at the end of each session. A total of 20 tokens were earned during each baseline session (10 minutes of reinforcement activity). All problems correctly completed within each component were summed and divided by the total session duration to yield a rate of completion. Sessions were conducted daily. Baseline conditions were terminated upon visual inspection in which rate of correct responses were relatively stable.

Disruptor Tests. Next, participants were exposed to disruptor test conditions. Different types of disruptors were selected based on their effectiveness in previous studies (Lionello-DeNolf, Dube, & McIvane, 2010; Mace et al., 1990). The concurrent distracting stimulus test provided simultaneous access to a qualitatively different reinforcer (each participant’s third most-preferred activity) to disrupt completion of math problems. The concurrent distracting stimulus may serve as an analog to distracting events in the classroom (e.g., a random squirrel passing by the window during math class). The alternative stimulus test involved the opportunity to engage in a different response (a different set of math problems) for access to the same reinforcer as the target task. The alternative stimulus test may simulate disruption due to obtaining additional reinforcers for “off-task” behavior in the classroom. Across test sessions, the order of disruptor presentation type randomly alternated. The multiple schedule reinforcement context for completing math problems remained consistent with baseline. The disruptor tests were embedded within an ABAB design for Reagan and an ABA design for Andrew. For the concurrent distracting stimulus disruptor, the research assistant described to the participant that the stimulus would be available throughout the component and that they could choose to watch/listen to their preferred item at any point during the session. ESPN video clips for Andrew, and a Mandy Moore song for Reagan were played throughout each component and were turned off during the ITI.

For the alternative stimulus disruptor, the research assistant informed the participant that he/she could choose to do a different set of math problems during either schedule component. The alternative math task consisted of a stack of problems printed on white laminated paper that were placed next to the stimuli correlated with the rich or lean reinforcement contexts at the beginning of each component. The math problems for the alternative task came from the same bank of problems used for the rich or lean schedule components. Completion of the alternative stimulus resulted in the delivery of reinforcers according to a VI 72-s schedule. However, completed problems on the alternative stimulus did not count towards rate completed for the rich or lean schedule components. The alternative stimulus and the multiple-schedule components’ VI schedules were independent.

Because Andrew’s response rates were not disrupted for either the concurrent distracting stimulus or alternative task, he was the only participant exposed to a hybrid disruptor condition in Phase 1 and 2 (see Figure 1). This hybrid condition involved the simultaneous presentation of both the concurrent distracting stimulus and alternative math task to increase the probability that response rates would be disrupted. Both of these disruptors were presented through each schedule component and were removed during the ITI.

The first disruptor test condition was terminated after at least two sessions of exposure to each disruptor. Following a reversal to baseline, participants were exposed to a second set of disruptor test conditions. Second disruptor test conditions continued until there was no response differentiation between rich and lean schedule components.

Phase 2: Equal VI with Superimposed VT
The aim of Phase 2 was to assess the effects of noncontingent reinforcers on response persistence. All procedures in Phase 2 were the same as Phase 1 except that the orange materials were associated with the lean schedule (VI 60 s), and blue materials were associated with the rich schedule with added noncontingent reinforcers.
In addition, completing problems in both components produced one token, and one token was delivered noncontingently during the enriched component based on a mean of 30 s (VI 60 s + VT 30 s). As a result, a total of 24 tokens were earned during each session (12 minutes of reinforcement activity).

RESULTS

Phase 1: Unequal VI and Reinforcer Magnitude. Figure 1 shows response rates (resp/min) for both subjects under baseline and disruptor comparison conditions (alternative stimulus and concurrent distracting stimulus) during the Phase 1 of the experiment. The baseline multiple-schedule VI 60 s and 3 tokens; VI 150 s and 1 token procedure resulted in similar response rates across schedules and baseline; however, response rates differed between participants. One exception was the increased response rate between baseline conditions in both components for Andrew; the increase was more pronounced in the rich component.

The effects of different disruptors on response persistence during completion of a math task were evaluated within the context of rich and lean multiple-schedule components. For Andrew, no disruption in response rates occurred for either the alternative stimulus (AS) or the concurrent distracting stimulus (CDS). Furthermore, when both the alternative stimulus and the concurrent distracting stimulus were presented, disruption in response rates still did not occur. For Reagan, responding during both VI schedules decreased while the alternative stimulus was presented. No disruption occurred for the concurrent distracting stimulus. For the alternative stimulus in the first disruptor comparison condition, response rates during the component with the higher rate/magnitude of reinforcement (i.e., the VI 60-s schedule for 3 tokens) were initially higher than during the component with the lower reinforcer rate/magnitude (i.e., the VI 150-s schedule for 1 token); this differentiation did not occur in the subsequent session. Similar patterns of differentiation were reproduced in the second disruptor comparison condition. The disrupting effects of the alternative stimulus were more robust (i.e., lasting six sessions) relative to the first disruptor condition.

Figure 2 shows mean response rates collapsed across each condition during the disruptor tests expressed as a proportion of baseline responding during Phase 1. Mean response rates were collapsed across each session per condition. For Andrew, no decreases in response rates were observed for either type of disruptor. For Reagan, the alternative stimulus produced decreases in response rates during both alternative stimulus test conditions. Responding in the lean component was relatively more disrupted than in the rich component in both conditions; this disruption was more reliable in the second test condition. The concurrent distracting stimulus failed to produce disruptions in response rates for Reagan in either disruptor test condition.

Phase 2: Equal VI with Superimposed VT. Figure 3 shows response rates for both subjects under baseline and comparison conditions during the second phase of the experiment. The baseline multiple schedule VI 60 and VI 60 + VT 30 procedure resulted in similar response rates across
schedules and baseline; however, response rates differed between participants. Consistent with Phase 1, Andrew showed no disruption in the second phase of the study. During the disruptor test conditions, the ordinal relationship between response rates in the two; no disruption occurred in response to the concurrent distracting stimulus. Reagan showed higher response rates for the VI + VT schedule than with VI reinforcement alone in the first disruptor condition. However, during the second disruptor condition, this pattern of differentiation was smaller and less reliable in that it occurred four out of six sessions.

Figure 4 displays mean response rates (as a proportion of baseline responding) during the disruptor tests in Phase 2. For Andrew, no decreases in response rates were observed for any type of disruptor. For Reagan, relative to baseline, the alternative stimulus produced decreases in response rates during both test conditions. Visually, adding additional noncontingent reinforcers (VI 60 + VT 30 schedule) enhanced response rates in the first disruptor test condition but not in the second. Again, the concurrent distracting stimulus failed to produce disruptions in response rates for Reagan.
DISCUSSION

The current study provided a partial systematic replication of Mace et al.’s (1990) non-laboratory BMT procedures to assess the determinants of response persistence in two high-functioning adults with ASD engaging in academic tasks. In Phase 1 during the alternative stimulus disruptor test sessions, a robust finding for one participant was that response rates maintained by richer rates and magnitudes of reinforcement were more persistent compared to rates maintained by leaner reinforcement rates/magnitudes (i.e., 7 out of 9 disruptor test sessions)—consistent with predictions made by BMT. However, it is important to note that we did not separate the effects of reinforcement rate from reinforcer magnitudes on response persistence. Nevin and Grace (2000) have suggested that negative shifts in reinforcer magnitude can be a disruptor (see also, Galuska & Yadon, 2011). Nonetheless, our pattern of results replicated findings from the Mace et al. and the Parry-Cruwys et al. (2011) non-laboratory studies. This study also strengthens the connection between basic and applied research by increasing the generality of these findings to academic contexts in a high-functioning adult with ASD. That is, the current findings increase the generality of previous research on BMT and response persistence to functional academic skills (i.e., instructional level math problems).

In Phase 2, we sought to expand upon Parry-Cruwys et al.’s (2011) assessment of response persistence in individuals with ASD by investigating whether delivering additional noncontingent reinforcers would enhance persistence (cf. Phase 2: Mace et al., 1990). In treatment contexts, delivering response independent reinforcers is often a strategy used to decrease operant behavior (for a meta-analysis of NCR, see Richman et al., 2015). However, delivering noncontingent reinforcers can increase resistance to change (Nevin, 1984), which is an innovative treatment strategy for manipulating response persistence in individuals with ASD. In the current study, persistence was more likely (i.e., in 6 out of 9 sessions) in the component with noncontingent reinforcers during the alternative disruptor tests compared to the schedule without the response-independent reinforcers. These results are the first to more clearly elucidate the respondent conditioning effects on response persistence in a non-laboratory setting for individuals with ASD. Although response rates were higher in the VI+VT schedule component compared to the VI component across daily sessions, these results become obscured when response rates during the disruptor test conditions were expressed as proportion to baseline and collapsed across sessions. We hypothesize that this pattern of responding was due to day-to-day extra-experimental sources of variability that is a challenge commonly encountered in research with human subjects in natural settings. For instance, unrestricted access to reinforcers outside of experimental sessions may devalue conditioned reinforcers within-session. BMT researchers have acknowledged the issue of extra-experimental variability and have circumvented it by arranging both baseline and disruptor test conditions within session rather than between sessions (Dube, Ahearn, Linello-DeNolf, & McIlvane, 2009).

Across phases, the alternative stimulus disruptor was a relatively more effective disruptor than the concurrent distracting stimulus for the one participant that exhibited response disruption. This finding is consistent with the Linello-DeNolf et al. (2010) study. However, our results are contradictory to those results reported by Mace et al. (1990) that found a concurrent distracting stimulus was an effective disruptor, but neither disruptor was effective for the other participant (presented alone or when both disruptors were presented simultaneously). Each participant’s behavioral history may have interacted with the type of disruptor. In retrospect, a different type of disruptor than the concurrent distracting stimulus should have been chosen for experimental manipulation. That is, just because a stimulus functions as a reinforcer in one context (i.e., a reinforcer assessment) does not necessarily mean that it will function as a distractor in another context. Future BMT research-
ers may be interested in conducting probe sessions to assess if a given stimulus functions as a disruptor before conducting a more extensive assessment. For Andrew, who exhibited no response disruption to either disruptor, another tactic may have been to begin with extinction as a disruptor to demonstrate that responding could be disrupted and then explore the effects of other disruptors.

In Andrew’s case, the effects of rate of reinforcement, reinforcer magnitude, or noncontingent reinforcers also had no differential effects on response persistence. When compared with Reagan, who exhibited response disruption, these results may represent idiosyncratic differences in response persistence for individuals with ASD. These differences cannot be attributed to differences in adaptive functioning because both participants were scored equally on this feature; nor were differences due to procedural artifacts of directives during the study because participants were instructed that they could choose to engage in activities other than the target academic task, assuming that the participants discriminated the contingencies described in the rules. Although Andrew, who displayed more severe symptoms of ASD, did not show response patterns consistent with predictions made by BMT nor functional control, his results are, nonetheless, interesting because they may represent an extreme end of a continuum of response persistence when one considers the combined disruptor arrangements that were used. However, the current results provide preliminary evidence that BMT procedures can be useful in detecting individual differences in response persistence in individuals with ASD. Additional research is needed to determine if extreme response persistence that does not appear to be sensitive to BMT nor disrupted by concurrent distracting or alternative stimuli predicts ASD symptom severity or severity of perseverative behavior. Future researchers should pay special attention to controlling for and examining the effects of several environmental variables that may increase or decrease levels of response persistence such as participant reinforcement histories for specific response options, experience with extinction, formulation of verbal rules, and differences in expressive/receptive verbal behavior).

One dimension on which our participants substantially differed was in their ASD symptom severity scores from the CARS. Andrew, with his relatively higher rates of response persistence, also had a substantially higher ASD symptom severity score compared to Reagan. This raises the interesting notion of whether a possible positive correlation between response persistence and ASD symptom severity exists, at least for a subset of individuals with the very broad diagnostic category of ASD. To test this hypothesis would require more rigorous ASD diagnostic and symptom severity testing (e.g., ADI-R: LeCouteur, Lord, & Rutter, 2003; ADOS-2: Lord, Rutter, DiLavore, Risi, Gotham, & Bishop, 2012) and recruitment of a considerably larger sample size with a wide range of ASD symptoms. If a positive correlation exists between response persistence and ASD severity, this would inform an important aspect of direct behavioral measurement by supporting clinical interviews during the ASD diagnosis process. Another tactic may be to pursue other indirect measures of persistent behavior (rather than global ASD severity measures) to determine whether indirect and direct measures of response persistence assess the same construct. A possible option is to use the Repetitive Behavior Scale (Lam & Aman, 2007) that includes an “insistence on sameness” subscale, which contains questions regarding behaviors that are resistant to change (e.g., “Becomes upset if interrupted in what he/she doing; Resists changing activities; Difficulty with transitions”).

From an applied perspective, the current study demonstrated that, in some cases, response persistence in individuals with ASD can be affected by the rate/magnitude of reinforcement or more fundamentally by the total number of reinforcers associated within a stimulus context. These findings have important clinical implications for treating response persistence in individuals with ASD. Mace et al. (1990) first
described a hypothetical situation in which a therapist delivers reinforcers for an alternative response to the problem behavior. While this treatment strategy might produce immediate behavioral reductions in response persistence of problem behavior, there can also be unintended behavioral side effects, which are predicted by BMT (see Podelsnik & DeLeon, 2015, for a review). For instance, enriching the environment via the delivery of additional reinforcers for the alternative response can also serve to increase the persistence of problem behavior because of its association to the same stimulus context as the alternative response. The end result could be that the problem behavior becomes more resistant to change which can be observed during periods of extinction when the alternative response is reinforced with poor treatment fidelity or intermittently reinforced. This hypothetical scenario has been experimentally supported in a study conducted by Ahearn et al. (2003). Automatically-maintained vocal stereotypy for three boys with ASD was effectively treated with non-contingent access to preferred stimuli. However, during disruptor tests, stereotypy was relatively more persistent following periods of noncontingent access to preferred stimuli compared to periods without additional noncontingent reinforcers; a finding consistent with BMT. An innovative treatment inspired by BMT may be to conduct alternative response training in a separate context in which the problem behavior occurs (Mace et al., 2010).

Several important advances in BMT have been made in recent literature (e.g., Wathen & Podlesnik, 2018). For instance, BMT can account for post-extinction relapse of a target behavior (Nevin, Craig, Cunningham, Podlesnik, Shahan, & Sweeney, 2017; Podlesnik & Shahan, 2010) such as reinstatement (relapse due to the presentation of response-independent reinforcers) and renewal (relapse due to changes in environmental context). However, BMT does not readily account for relapse of a target behavior following the extinction of an alternative behavior (resurgence: see Craig & Shahan, 2016; Podlesnik & Kelley, 2015; Shahan & Craig, 2017, for reviews). Another important advance in BMT research highlights concerns regarding our understanding of the behavioral processes underlying response persistence. Nevin et al. described their use of a Pavlovian Instrumental Transfer test (Morse & Skinner, 1958) to examine respondent processes underlying response persistence. Their results suggest that response persistence may not be explained by a straightforward account invoking respondent processes that strengthen stimulus-reinforcer relations.

In closing, this non-laboratory study increased the generality of BMT literature by demonstrating both the operant and respondent determinants of response persistence in a high functioning adult with ASD with a socially significant dependent variable (i.e., instructional level math problems). This study is also noteworthy because it offers preliminary evidence that individual differences in response persistence exist within individuals with ASD and that the procedural framework offered by BMT can be sensitive to detecting these behavioral differences. Future researchers could use these procedures to fully evaluate if levels of response persistence are positively associated with ASD symptom severity or specific to levels of perseverative behavior. That is, we hypothesize that individuals with ASD with the most extreme forms of perseverative behavior could possibly be identified very early in life as the most likely to struggle with non-adaptive response persistence. These individuals could then be targeted for early intervention to decrease perseverative behavior and perhaps increase the probability of selective persistence when it is an adaptive response (e.g., learning new skills as opposed to persisting with nonfunctional perseverative behavior such as motor stereotypy).

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