Effects of Reinforcer Magnitude and Quality on Preference for Response-Reinforcer Arrangements in Young Children with Autism

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Abstract The present study evaluated the effects of reinforcer magnitude and quality on preference for continuous and discontinuous arrangements. Two preschool children with autism spectrum disorder (ASD) participated in the study. Both participants initially preferred a discontinuous arrangement when choice options included the same quality and magnitude reinforcers; however, magnitude and quality manipulations resulted in a change in preference for continuous arrangements.

Keywords Continuous · Discontinuous · Preference · Response-reinforcer arrangements · Reinforcer magnitude · Reinforcer quality

Several studies have shown that, under certain conditions, participants prefer to complete a larger set of responses followed by longer duration of access to a reinforcer instead of completing several smaller sets of responses followed by brief reinforcer access that result in the same overall amount of work and reinforcement (Bukala, Hu, Lee, Ward-Horner, & Fienup, 2015; DeLeon et al., 2014; Fienup, Ahlers, & Pace, 2011; Ward-Horner, Pittenger, Pace, & Fienup, 2014). For

instance, Fienup et al. (2011) provided a participant a choice to complete either 120 math problems consecutively followed by 18 min of reinforcer access (continuous arrangement) or six sets of 20 math problems with each set followed by 3 min of reinforcer access (discontinuous arrangement). The participant preferred the former arrangement despite a larger delay to reinforcer access and greater response effort.

There have been several replications of Fienup et al. (2011) that have largely focused on variables influencing preference and performance for response-reinforcer arrangements with older participants who generally preferred a continuous arrangement (e.g., DeLeon et al., 2014; Kocher, Howard, & Fienup, 2015; Ward-Horner et al., 2014). For instance, DeLeon et al. (2014) investigated the effects of the type of reinforcer on preference by providing access to edible and activity reinforcers. The researchers found that three out of four participants preferred the continuous arrangement regardless of type of reinforcer, and one participant preferred the continuous arrangement when the reinforcer was an activity but did not demonstrate a preference when the reinforcer was an edible. Ward-Horner et al. (2014) investigated the effects of reinforcer magnitude by reducing the duration of reinforcer access during the continuous arrangement. The researchers found that the participant preferred the continuous arrangement when it resulted in 20% less reinforcement than the discontinuous arrangement but not when it resulted in 60 and 80% less reinforcement.

Thus, far researchers have investigated the effects of response-reinforcer parameters (e.g., type and magnitude of reinforcer, and type of task) with a homogeneous group of participants (adolescents between the ages of 13 and 20 years old) that has generally preferred a continuous arrangement (Ward-Horner, Cengher, Ross, & Fienup, 2017). Researchers have not yet investigated preference and performance in younger participants. Younger participants may be more impulsive

Examine the relation between reinforcer characteristics and preference
Demonstrate the utility of concurrent chain procedures for evaluating preference for response-reinforcer arrangements in applied settings
Provide a model for examining impulsivity and self-control
Demonstrate the utility of response-reinforcer arrangements for teaching participants to tolerate longer delays to reinforcer access

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and prefer the discontinuous arrangement that results in shorter delays to reinforcer access (e.g., Dixon & Hayes, 1998). Therefore, the purpose of the present study was to examine preference and performance for response-reinforcer arrangements with younger participants and to examine the effects of reinforcer characteristics on preference and performance.

Method

Participants, Settings, and Materials

Two children with a diagnosis of autism participated in this study. Ted and James were 5 and 4 years old, respectively, and both participants followed two-step directions, read consonant-vowel-consonant words, and communicated vocally using three to five word sentences. In addition, both participants occasionally displayed non-compliance (verbal refusal) to complete tasks. Ted attended a half day public school preschool 12.5 h per week and received home-based ABA services for 15 h per week. James attended a half day preschool for 12.5 h per week and an after-school program. Ted's sessions occurred at the kitchen table at his house. James' sessions occurred at his daycare in a small room adjacent to the main play area at a child-sized table. During the second unequal magnitude experimental phase (described below), James played outside on play structures or in the sandbox.

A concurrent chains procedure was used to assess participants' preference and color cards served as initial link stimuli. Each color card included a textual schedule (e.g., work/play/work/play) that described the contingencies of each terminal link condition (i.e., response-reinforcer arrangement). The colors black, brown, and white were associated with the continuous arrangement, discontinuous arrangement, and control condition, respectively. The same color cards were used across experimental phases, but the schedule written on the cards changed to reflect the changes associated with the terminal link conditions. The preferred activities included play houses and figures, playdoh, small squishy toys, windup toys, and trains.

Procedure

Prior to each choice session, the experimenter presented five preferred leisure activities (outdoor activities for Ted were described vocally), which were identified based on parent and therapist report, and instructed the participant to pick the activity he would like to earn for completing work. Once an activity was selected, the experimenter presented the three color cards associated with each response-reinforcer arrangement. The color cards were arranged horizontally on the table in front of the participant, and the experimenter reviewed the arrangements by reading the schedule of work and

reinforcement listed on the cards (e.g., "If you pick the white card, we will do work, work, work, work, and then play ____ for 5 minutes"). The experimenter instructed the participant to select a card by saying "choose." After the participant selected a card, the experimenter removed the cards that were not selected and began presenting instructional trials. Each instructional trial consisted of the experimenter presenting a vocal instruction (e.g., Wh questions) that was previously mastered, which required an intraverbal response from the participant. The experimenter provided praise for independent correct responses. If the participant did not respond within 5 s or responded incorrectly, the experimenter followed a least-to-most prompting hierarchy that consisted of repeating the instruction and providing a partial vocal model. If the participant did not emit the correct response following a partial vocal model, the experimenter repeated the question and provided a full vocal model. The experimenter provided access to the leisure item based on the selected arrangement (described below).

The arrangement of task work and access to the preferred leisure activity depended upon the color card selected by the participant. The *continuous arrangement* consisted of 10 instructional trials followed by 10 min of continuous access to the leisure activity. The *discontinuous arrangement* consisted of five instructional trials followed by either 1 or 5 min (depending on experimental phase) of access to the leisure activity, which occurred twice. The control condition consisted of the completion of 10 instructional trials without access to the preferred item.

Prior to the first experimental phase, the experimenter exposed the participant to the color cards and associated conditions one time each. The exposure sessions were identical to the participant choice sessions, except that the experimenter chose the arrangement of work and reinforcement. Following the first experimental phase, the experimenter vocally described the schedule depicted on each color card and the associated contingencies. The location of the color cards was rotated across choice sessions. Each session lasted approximately 15 min, and 1 to 10 choice sessions were conducted per day.

Equal Magnitude and Equal Quality The duration of access to and quality of the preferred activity were equivalent for the continuous and discontinuous arrangement. The continuous arrangement required the completion of 10 instructional trials followed by 10 min of continuous access to the preferred activity, and the discontinuous arrangement consisted of the completion of two cycles of five instructional trials followed by 5 min of access to the preferred activity. The experimenter interacted with the participant while the participant engaged with the preferred activity during the continuous and discontinuous arrangements.

Unequal Magnitude The overall duration of access to the preferred activity for the discontinuous arrangement was reduced from 10 to 2 min. Thus, the discontinuous arrangement consisted of 1 min of access to the preferred activity following each set of five instructional trials, while the continuous arrangement was unchanged (i.e., 10 trials followed by 10 min of access to the preferred activity). The experimenter interacted with the participant while the participant engaged with the preferred activity during the continuous and discontinuous arrangements.

Unequal Quality During the first unequal quality phase, the continuous arrangement consisted of the experimenter interacting with the participant during the preferred activity, whereas the discontinuous arrangement consisted of the experimenter refraining from interacting with the participant. During the second unequal quality phase (James only), the continuous arrangement consisted of the participant engaging in the preferred activity outside and with peers, whereas the discontinuous arrangement consisted of the participant engaging in a preferred activity indoors and without social interactions (unequal quality outside).

Dependent Measure and Inter-observer Agreement The primary dependent variable was the cumulative number of choices for the continuous and discontinuous arrangements and the control condition. A participant's choice of an arrangement was defined as the participant touching or pointing to the color card. Data were also collected on the percentage of independent correct responses (defined above) and the percentage of trials the participants were non-compliant (i.e., vocally refusing to comply with the instruction). The percentage of independent correct responses was calculated by adding the total number of independent correct responses and dividing by the total number of trials within the session. Inter-observer agreement (IOA) data were collected for 100% of sessions for both participants by having a second observer independently collect data for each session. IOA for selection of arrangement (continuous, discontinuous, and control) was measured for each choice session. An agreement was scored for the choice of arrangement if both observers recorded the selection of the same color card, and IOA was calculated by dividing the number of agreements by the total number of choice sessions, multiplied by 100. IOA for the percentage of independent correct responses and percentage of trials during which non-compliance occurred was calculated on a trial-by-trial basis. An agreement for correct responses and challenging behavior was scored when both observers recorded identical responses for a trial, and IOA for a session was calculated by dividing the total number of agreements by the number of trials, multiplied by 100. IOA was 100% for choice of arrangement, and IOA averaged 98.5% (range, 90 to 100%) and 99% (range, 90 to 100%) for the percentage of correct

independent responses and the percentage of trials with non-compliance, respectively.

Design

An ABACA and an ABACDADA reversal design was used for Ted and James, respectively. The equal magnitude and equal quality phase was the first experimental phase for both participants, as it served as a baseline to determine the participants' initial preference. The unequal magnitude phase (phase B) followed the initial assessment of preference, and the unequal quality phase (phases C and D) followed the analysis of reinforcer magnitude.

Results and Discussion

Figure 1 displays the cumulative number of choices for the continuous and discontinuous arrangements and the control condition for both participants. During the equal magnitude and quality phases, Ted chose the discontinuous arrangement for all but two choice sessions. When the overall magnitude of reinforcement was reduced during the discontinuous arrangement (unequal magnitude phase) and when reinforcement did not involve social interactions during the discontinuous arrangement (unequal quality phase), Ted exclusively chose the color card corresponding to the continuous arrangement.

James' exclusively chose the discontinuous arrangement during the first equal magnitude and equal quality phase. During the unequal magnitude phase, the overall magnitude of reinforcement was reduced from 10 to 2 min in the discontinuous arrangement, and James chose the continuous arrangement during three out of four choice sessions. During the second equal magnitude and quality phase, James initially displayed indifference between the continuous and discontinuous arrangement but chose the discontinuous arrangement four times out of the last five sessions. James continued to choose the discontinuous arrangement when social interactions were withheld during the discontinuous arrangement (unequal quality). However, James exclusively chose the continuous arrangement when the activity was completed outside with social interactions (unequal quality outside). During the last equal magnitude and equal quality phase, James did not demonstrate a clear preference for the continuous or discontinuous arrangement.

Table 1 displays the percentage of correct independent responses for both participants. For Ted, the percentage of correct responses during the continuous arrangement decreased slightly during the unequal magnitude and unequal quality phases. For James, the percentage of correct responses during the continuous arrangement was relatively high and stable across experimental phases. In addition to the percentage of correct responses, data were collected on the percentage of

Fig. 1 Cumulative number of choices for the continuous, discontinuous, and control arrangements across experimental phases

trials with non-compliance, which remained near zero levels across experimental phases for both participants (Ted and James engaged in non-compliance on two and three trials, respectively).

The present study extended the literature by examining preference for response-reinforcer arrangements in younger participants with ASD and by examining the effects of reinforcer characteristics on preference. Unlike previous studies (e.g., Bukala et al., 2015; DeLeon et al., 2014; Ward-Horner

et al., 2014), the present study demonstrated that both participants initially preferred the discontinuous arrangement, which resulted in shorter delays and more frequent reinforcer access. It is possible that participant characteristics contributed to the participants' initial preference, as younger participants may respond more impulsively than older participants (Logue, Forzano, & Ackerman, 1996). Nevertheless, the effects of participant characteristics should be interpreted cautiously because we did not directly compare preference for response-

Table 1 Displays the percentage of correct independent response for the continuous and discontinuous arrangements across experimental phases. A (-) indicates a phase in which the participant did not select an arrangement and “Na” indicates that the participant was not exposed to the experimental phase

	Arrangements	Equal magnitude/equal quality	Unequal magnitude	Unequal quality	Unequal quality outside
Ted	Continuous	95	87	77	Na
	Discontinuous	88	-	-	Na
James	Continuous	95	83	100	90
	Discontinuous	93	100	92	-

reinforcer arrangements in younger and older participants. Therefore, more research is needed with younger students to determine the generality of our findings.

An important finding of this study was that both participants preferred the continuous arrangement when reinforcer magnitude and quality were manipulated. When reinforcer magnitude was diminished in the discontinuous arrangement (i.e., the initially preferred arrangement), both participants shifted preference to the continuous arrangement. This finding is similar to the outcome of Ward-Horner et al. (2014) who found that a 40 and 80% decrease in the reinforcer magnitude associated with the continuous arrangement (i.e., the initially preferred arrangement) resulted in the participant selecting the discontinuous arrangement. Furthermore, when the quality of the reinforcer was altered by withholding social interactions in the discontinuous arrangement, Ted preferred the continuous arrangement whereas James continued to prefer the discontinuous arrangement. However, James chose the continuous arrangement when it involved completing the activity outdoors with peers. The outcome of the magnitude and quality manipulations is important because both participants chose delayed reinforcer access, and delayed access did not affect non-compliance for either participant and had a marginal effect on James' percentage of correct responding. The applied significance of this finding is that clinicians may consider using response-reinforcer arrangements to teach self-control (i.e., choosing the larger, delayed reinforcer over the smaller immediate reinforcer). Previous studies used concurrent operant with progressive delays to reinforcement to teach self-control (e.g., Dixon & Hayes, 1998), whereas the present study used a concurrent chains arrangement and manipulations of reinforcer magnitude and quality that resulted in responses that can be described as self-control.

A limitation of this study is that the discontinuous arrangement consisted of longer duration of reinforcer access and fewer response-reinforcer cycles than previous studies. That is, the discontinuous arrangement in the present study consisted of two units of five responses with each unit followed by 5 min of reinforcer access, whereas the discontinuous arrangement in previous studies consisted of at least five response-reinforcer units with 30 s to 3 min of reinforcer access per unit. Furthermore, for three out of the five previous studies (Bukala et al., 2015; DeLeon et al., 2014; Kocher et al., 2015), the duration of continuous reinforcer access in the continuous

arrangement was 5 min, which was the same duration of the discontinuous arrangement in the present study. Therefore, it is possible that the participants' initial preference was, in part, a function of fewer response-reinforcer units with longer duration reinforcer access in the discontinuous arrangement. It is also possible that participants may have initially preferred the continuous arrangement if there were several smaller response-reinforcer arrangements with shorter duration of reinforcer access per unit. Future research should examine the effects of different response-reinforcer ratios and varying durations of reinforcer access on preference and performance during response-reinforcer arrangements.

Compliance with Ethical Standards

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Conflict of Interest The authors declare that they have no conflict of interest.

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