*FURTHER ANALYSIS OF VARIABLES THAT AFFECT SELF-CONTROL
WITH AVERSIVE EVENTS*

CHRISTOPHER J. PERRIN AND NANCY A. NEEF

THE OHIO STATE UNIVERSITY

The purpose of this study was to examine variables that affect self-control in the context of academic task completion by elementary school children with autism. In the baseline assessment of Study 1, mathematics problem completion was shown to be an aversive event, and sensitivity to task magnitude, task difficulty, and delay to task completion were measured. The effects of manipulating values of those parameters on self-control then were assessed. For all participants, self-control increased as a function of one or more changes in task parameter values. In Study 2, the effects of a commitment response on self-control was assessed. Results indicated that for all participants, levels of self-control were higher when the opportunity to commit to the immediate aversive event was available.

Key words: aversive events, self-control, task delay, task difficulty, task magnitude

Self-control often is defined as the selection of a larger delayed reinforcer instead of a smaller more immediate reinforcer (Ainslie, 1975), yet also can be defined as the selection of an immediate less aversive event over a delayed but relatively more aversive event. Problems with self-control may occur in classrooms when demands are presented to individuals who find completing those tasks aversive (see Vollmer, Borrero, Lalli, & Daniel, 1999, for an example involving positive reinforcement). The individual must choose between complying with the demand, thus exposing him- or herself to the aversive task, and engaging in some type of escape response (e.g., requesting a break or engaging in problem behavior). Although escape responses often delay task completion, they also frequently result in a worsening of the environment. This is especially true of problem behavior, which can lead to more intrusive prompting, loss of opportunity to contact positive reinforcers, and potentially aversive

events such as verbal reprimands or response cost. Despite a paucity of applied research, several methods to increase self-control with aversive events examined in the basic literature may be applicable to classroom situations.

One intervention to increase self-control with aversive events is via manipulation of the response and structural parameters of the aversive event itself. For instance, Deluty (1978) explored the effects of changes in parameters of contingent electric shock on rats' lever pressing in a concurrent operants arrangement. Depending on which lever the rat pressed, one of two shock arrangements occurred that differed in (a) delay to shock presentation, (b) duration of shock, or (c) both. Results indicated that the rats preferred (selected) shocks that either were delayed or were shorter in duration. When delay and magnitude were placed in competition (i.e., immediate but short shock vs. delayed but longer shock), responding was impulsive; that is, allocation favored the larger later shock. However, increases in the delay to both alternatives or in the duration of the delayed shock produced a switch in responding from impulsive behavior (larger later shock) to self-control (smaller sooner shock).

Similar results have been found for aversive events other than electric shock. For instance, a series of studies involving pigeons used interruption of variable-time food delivery by either

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Correspondence regarding this article should be addressed to Christopher Perrin, Melmark, Inc., 2600 Wayland Road, Berwyn, Pennsylvania 19132 (e-mail: chrisperrin@melmark.org).

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a fixed-ratio or a fixed-interval work requirement as the aversive event (Mazur, 1996, 1998). In both studies, pigeons reliably engaged in impulsive behavior with respect to task completion by choosing the larger delayed task over a smaller more immediate task. However, as the size of the delayed task increased, self-control increased. In another example, Grusec (1968) had children choose between various arrangements of aversive events that included eating unpleasant food, memorizing lines of boring poetry, spending time with an unpleasant teacher, and completing difficult tasks in front of the class. When the magnitude (e.g., amount of food, number of lines of boring poetry) of the alternatives was equal, the children chose the delayed alternative approximately 50% of the time. However, as the magnitude of the delayed alternative increased, choice of the immediate alternative became more likely. In a preliminary applied study, Lerman, Addison, and Kodak (2006) examined the effects of manipulating the parameters of academic tasks on the self-control of two children with autism. Two task parameters—magnitude (e.g., the number of discrete trials required) and delay—were manipulated. The findings of this study were mixed. For one participant, levels of self-control were affected by changes in the magnitude of the immediate alternative and increases in the delay to both alternatives. The second participant's choice was less sensitive to parameter manipulations, with minimal changes in self-control.

Another approach to increasing self-control with aversive events that has been suggested by basic research is giving the participant an opportunity to commit to the smaller sooner alternative before the choice is presented. The function of this manipulation is similar to that of increasing the delay to both alternatives. That is, at the time of commitment, the consequences of both alternatives are temporally distal; thus, motivation to avoid either alternative is low. Deluty, Whitehouse, Mellitz, and Hinline

(1983) examined rats' engagement in a commitment response (i.e., pressing a lever) for a smaller sooner shock. Across all conditions, the commitment response produced a brief shock following a 5-s delay. If the commitment response did not occur, a choice between an immediate brief shock and a long shock following a 5-s delay was presented after a delay to choice interval. Results indicated that, as the delay to choice increased, the likelihood of the occurrence of commitment responses also increased.

Additional support for the use of commitment responses to increase self-control can be found in the basic literature that has examined reinforcing events. For instance, in a study by Rachlin and Green (1972), pigeons were given a choice between a small amount of food available immediately and a larger amount of food available after a 4-s delay. Response allocation was toward the key associated with the smaller sooner reinforcer. However, when an option to commit to the larger later reinforcer was provided, response allocation shifted as a function of the extent of the delay from the point of commitment to the point of choice. The effects of a commitment response on self-control with reinforcers also were examined in a study by Ainslie (1974). Although results varied, 3 of the 10 pigeons consistently committed to the larger later reinforcer. When the commitment response was placed on extinction during the control condition, responses on the key stopped and the smaller sooner reinforcer was chosen at the point of choice.

Collectively, results of these basic investigations suggest that manipulating the parameters of the aversive events and providing opportunities to commit to smaller sooner aversive events may increase the likelihood of self-control. Therefore, the purpose of the current study was to examine the effects of parameter manipulations and a commitment response on the self-control of elementary school children in

the context of academic task completion. In the first study, we sought to replicate and extend the basic and applied research showing that manipulations in the parameters of aversive events influence self-control. Specifically, we manipulated the magnitude, difficulty, and delay to completion of mathematics problems. In the second study, we sought to extend findings of basic research showing that the availability of a commitment response influences self-control.

STUDY 1

METHOD

Participants and Setting

Children who attended an urban private school for individuals with autism were invited to participate by a recruitment letter. All children met the following requirements for participation: (a) They had basic computer skills (e.g., use of keyboard to enter responses and mouse to click on buttons on the screen), (b) they had basic arithmetic skills (single-digit addition or subtraction), (c) they were identified by their teachers or parents as needing improvement with arithmetic, and (d) their parents or guardian consented to the child's participation in the study. Two boys and two girls with a diagnosis of autism were referred for participation. Krista was 10 years old, and Pru, Dante, and Nate were 8 years old. All of the children had a history of noncompliance or other problem behavior associated with task completion.

All sessions were conducted in a small room located adjacent to the supervisors' office. The entrance to this room was unobstructed, providing a clear view of the office. The room contained a table, chairs, a computer, and a storage cabinet. Sessions were conducted 3 to 4 days per week at different times throughout the day to accommodate the participants' schedules. The total length of participation in the study was 21 days for Dante, 17 days for Nate and Pru, and 19 days for Krista.

Apparatus and Data Collection

All experimental tasks were completed using either a laptop or desktop computer equipped with a keyboard, an external mouse, and a computer program designed for the study. The program provided a menu from which the experimenter selected the parameters for two sets of mathematics problems. The parameters included the delay to the presentation of each task, the magnitude of each task (number of mathematics problems), and the difficulty of each task (e.g., sums to 19). Participants selected tasks by using the mouse to place a pointer over a button on the screen and then clicking the mouse button. All responses to mathematics problems were entered using the number keys on the keyboard followed by pressing the "Enter" key or using the mouse to click the "Check" button on the screen.

All data were collected by the computer program. Frequency data were collected for choice of each task. Choice of a task was defined as placing the mouse pointer over the button on the computer screen assigned to that task and depressing the left mouse button such that the program registered the button press.

Procedural fidelity data were collected by an independent observer on at least 25% of sessions for all participants. The observer recorded whether the experimenter entered the session parameters as per the session log, provided the participant with attention during the session, and correctly recorded the output data totals on the session log. Levels of procedural integrity were 100% for all participants.

General Procedure

The purpose of Study 1 was to examine the effects of manipulations of various task parameters on self-control. Task delay, magnitude, and difficulty were manipulated using a concurrent-schedules design within a reversal design. All sessions consisted of two forced-choice trials followed by five free-choice trials. Each trial consisted of responding on two links. In the first link, the targeted response was

Figure 1. Computer screen during the choice presentation (left) and mathematics problem presentation (right).

choice between two task alternatives. The second link consisted of completing the chosen task alternative (e.g., one mathematics problem immediately or 10 mathematics problems following a 60-s delay). Forced-choice trials were conducted to expose the participant to the task parameters arranged for each alternative. During forced-choice trials, the experimenter pointed to an alternative and told the child to “choose this side.” No other attention was provided during a session. The order of the alternatives during the forced-choice trials was randomized across sessions.

Free-choice trials began immediately following the completion of the second forced-choice trial. Both forced-choice and free-choice trials began with the choice screen (see Figure 1), which displayed two alternatives. Each alternative had a label (e.g., smaller sooner) and a selection button. The choice screen remained visible until an alternative was selected by clicking on the button associated with that alternative. Mathematics problems were presented one at a time (see Figure 1). No time limit was in effect for children to answer a problem. Correct responses resulted in feedback in the form of “Correct,” whereas incorrect responses resulted in feedback in the form of “Incorrect, Try Again.” Following two incorrect responses for a problem, the correct answer was displayed on the screen, after which the program presented the next event in the trial. Correct responding was not required

to meet task requirements; however, accuracy was high for all participants (Dante, 89%; Nate, 92%; Krista, 93%; Pru, 89%). Participants completed the tasks with no occurrence of problem behavior or attempts to leave the table; however, the programmed consequence for these behaviors was to block and ignore.

Baseline Assessments

The purpose of the baseline assessment was to determine each participant’s sensitivity to avoiding task completion and to high and low values of each task parameter (task delay, task magnitude, and task difficulty). During the avoidance condition, alternatives consisted of a break and task completion. Choosing the break option resulted in a blank screen for the remainder of the trial (e.g., 30 s), whereas choosing the task option resulted in presentation of mathematics problems. In the subsequent conditions, task alternatives varied along one task parameter while all other parameters were held constant. High and low values of delay and magnitude were chosen by the experimenter prior to the assessment. Difficulty levels were determined by accuracy and rate of mathematics problem completion during a preexperimental skill assessment using procedures similar to those described by Neef, Shade, and Miller (1994). Problems completed accurately and at a high rate were considered low difficulty, whereas problems completed at a

Table 1
Task Parameter Values for Both Choice Alternatives During Each Condition of the Baseline Assessment

Task parameter	Avoidance baseline		Delay baseline		Magnitude baseline		Difficulty baseline	
	Task A	Task B	Task A	Task B	Task A	Task B	Task A	Task B
Delay (seconds)		0	0	60	0	0	0	0
Magnitude	0	10	5	5	1	10	5	5
Difficulty		low	low	low	low	low	low	hard
Break	yes	no	no	no	no	no	no	no

lower rate or with less accuracy were considered medium (Krista only) or high difficulty. Table 1 depicts the parameter values for each condition of this assessment.

Self-Control Assessments

The purpose of the self-control assessment was to determine whether manipulations in the task parameters affected each participant's self-control (i.e., choice of the more immediate task). Figure 2 diagrams the procedures for a basic trial from the self-control assessment. During each phase, at least one task parameter was placed in direct competition with task delay (e.g., low-magnitude immediate task vs. high-magnitude delayed task). If self-control was demonstrated in the first phase, the value of the parameter placed in competition with task delay (task magnitude for Dante and Nate or task difficulty for Pru and Krista) was adjusted until the participant no longer demonstrated self-control (i.e., allocation

no longer favored the immediate alternative). Next, task parameters were manipulated systematically across subsequent phases until self-control once more was demonstrated. Finally, a reversal of the parameter manipulations was conducted to demonstrate experimental control. Table 2 depicts the parameter values for each task alternative during the self-control assessment.

RESULTS

Baseline assessment. Results of the avoidance baseline are shown in the first phase of each participant's graph in Figure 3. Three of the four participants demonstrated high levels of task avoidance, suggesting that mathematics problem completion was an aversive event. Dante's responding was distributed evenly between the two alternatives, suggesting that he had no preference between avoiding and completing tasks. During the remaining conditions, similar response patterns were observed

Figure 2. Components of a self-control assessment trial in which A is the delay to both alternatives and D is the delay to the later alternative (left). Components of a commitment choice trial in which T is the commit delay and D is the trial delay (right).

Table 2
Task Parameter Values for Both Choice Alternatives During Each Phase of the Self-Control Assessment

Child	Variable	Phase 1		Phase 2		Phase 3		Phase 4		Phase 5		Phase 6		Phase 7	
		A	B	A	B	A	B	A	B	A	B	A	B	A	B
Dante	Delay (seconds)	0	60	0	60	10	70	20	80	30	90	0	60	30	70
	Magnitude	1	10	5	10	5	10	5	10	5	10	5	10	5	10
	Difficulty ^a	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Nate	Delay	0	60	0	60	10	70	0	60	10	70				
	Magnitude	1	10	5	10	5	10	5	10	5	10				
	Difficulty ^a	L	L	L	L	L	L	L	L	L	L				
Pru	Delay	0	60	10	70	30	90	30	90	30	90	30	90		
	Magnitude	5	5	5	5	5	5	1	5	5	5	1	5		
	Difficulty ^b	L	H	L	H	L	H	L	H	L	H	L	H		
Krista	Delay	0	60	0	60	10	70	0	60	10	70				
	Magnitude	5	5	5	5	5	5	5	5	5	5				
	Difficulty ^c	L	H	M	H	M	H	M	H	M	H				

^a Dante and Nate were able to complete only addition problems sums to 19.
^b Addition (sums to 9) was low difficulty (L), addition (sums to 19) was high difficulty (H).
^c Addition (sums to 9) was low difficulty (L), single-digit subtraction was medium difficulty (M), addition (sums to 19) was high difficulty (H).

for all participants, with their choice allocated toward low-magnitude tasks and delayed tasks. During the difficulty baseline, both Pru and Krista allocated their choice toward low-difficulty mathematics problems.

Self-control assessment. Results of the self-control assessment for Dante and Nate were similar and are depicted in Figure 4. In the first phase, when both children could choose between completing a small immediate task or a large delayed task, both children demonstrated self-control by allocating choice toward the immediate task ($M = 55\%$, range, 0% to 80% for Dante; $M = 73\%$, range, 0% to 100% for Nate). Increasing the magnitude of the immediate task to five mathematics problems resulted in a switch in both children's response allocation, suggesting low levels of self-control ($M = 24\%$, range, 0% to 80% for Dante; $M = 15\%$, range, 0% to 20% for Nate). Changes in the delay to both alternatives affected both children's self-control, but the extent of the delay necessary to produce changes differed across children. Dante's allocation switched toward the more immediate alternative when the delay was 30 s ($M = 70\%$, range, 60% to 80%), whereas Nate's allocation switched when the delay value was 10 s ($M = 63\%$, range, 20%

to 80%). During the reversal, both children demonstrated low levels of self-control when the delay to both alternatives was removed ($M = 25\%$, range, 0% to 60% for Dante; $M = 36\%$, range, 20% to 40% for Nate) and moderate to high levels of self-control when the delay was reintroduced ($M = 65\%$, range, 60% to 80% for Dante; $M = 72\%$, range, 60% to 80% for Nate).

Results of the self-control assessment for Pru are also depicted in Figure 4. In the first phase, when Pru could choose between immediate completion of low-difficulty problems and delayed completion of high-difficulty problems, she allocated all of her choice to the delayed alternative. Increasing the delay to both alternatives by 10 s (Phase 2) and then 30 s (Phase 3) had no effect on her responding. Pru did not demonstrate self-control until the magnitude of the more immediate task was decreased to one mathematics problem in Phase 4 ($M = 93\%$, range, 80% to 100%). Low levels of self-control were recovered when the magnitude of the immediate task returned to five ($M = 13\%$, range, 0% to 40%). High levels of self-control were then restored when the magnitude was once more decreased to one problem ($M = 92\%$, range, 60% to 100%).

Figure 3. Results of the baseline assessment for Dante, Nate, Pru, and Krista.

Figure 4. Results of the self-control assessment for Dante, Nate, Pru, and Krista. Numbers indicate the delay values (in seconds) and the task magnitude and task difficulty associated with each choice.

Results of the self-control panel for Krista are depicted in Figure 4. In the first phase, when Krista could choose between immediate completion of low-difficulty problems and delayed completion of high-difficulty problems, she demonstrated self-control by allocating her choice toward the immediate alternative ($M = 95\%$, range, 80% to 100%). Increasing the difficulty level of the immediate task to medium resulted in decreased choice of the immediate alternative ($M = 51\%$, range, 40% to 60%). Her allocation switched toward the more immediate alternative when a 10-s delay to both alternatives was introduced ($M = 90\%$, range, 80% to 100%). During the reversal, she demonstrated lower levels of self-control when the delay to both alternatives was removed ($M = 60\%$, range, 40% to 100%) and high levels of self-control when the delay was reintroduced ($M = 95\%$, range, 80% to 100%).

DISCUSSION

The purpose of Study 1 was to examine the effects of manipulating task parameters on self-control. For all participants, levels of self-control were affected by changes in task parameters. Pru demonstrated self-control when the magnitude of the task alternatives differed. Dante and Nate demonstrated higher levels of self-control when there was a large difference in magnitude between the two alternatives (nine mathematics problems) than when the difference was smaller (four mathematics problems). Similarly, Krista demonstrated higher levels of self-control when the difference in the difficulty of the alternatives was greater than when it was smaller. Systematic increases in the delay to both alternatives resulted in increased self-control for Dante, Nate, and Krista. These findings are consistent with those of previous research that has manipulated task parameters (Deluty, 1978; Lerman et al., 2006; Mazur 1996, 1998).

In addition, the findings of the present study add to the literature by demonstrating that changes in task difficulty can affect self-control.

As with changes in task magnitude, changes in the difficulty level of the immediate alternative were related inversely to self-control. Variations in task difficulty can be conceptualized as changes in response effort. That is, in the present study, mathematics problems that were more difficult required increased effort to solve accurately. Thus, tasks that require more effort to complete would be more likely to produce avoidance responses than those that require less effort.

One interesting finding was the sensitivity demonstrated by some participants to increases in the delay to both alternatives. Response allocation for both Nate and Krista switched following the introduction of a 10-s delay. One possible explanation for this is the varying degree to which this change was discriminable for each alternative. The introduction of a delay prior to immediate task completion is a relatively salient change, whereas the addition of time to the delay for the delayed alternative is likely to be more difficult to discriminate. Another explanation is that the addition of a pretask delay in the immediate alternative resulted in two intertrial intervals with no work requirement, one before the task and one after. The delayed alternative, however, remained at just one work-free intertrial interval. Thus, responding may have been controlled more by the number of work-free periods than by the task parameters.

In summary, all participants demonstrated an increase in self-control following a manipulation of at least one task parameter. Furthermore, the introduction of a delay before the choice resulted in increased self-control for three of four participants. In the present study, the delay was introduced between the point of choice and the tasks. An alternate way to arrange such a delay is before the point of choice via a commitment response. The advantage of a commitment response is that, when demonstrated, the option of the impulsive response is never presented. Thus, at a point in time when motivation to avoid both alternatives

Table 3
Task Parameter and Commit Delay Values for Each Phase of the Commitment Assessment

Child	Variable	Commitment		Baseline		Commitment		Baseline		Commitment	
		A	B	A	B	A	B	A	B	A	B
Dante	Delay (seconds)	0	60	0	60	0	60	0	60	0	60
	Magnitude	5	10	5	10	5	10	5	10	5	10
	Difficulty	L	L	L	L	L	L	L	L	L	L
	Commit delay		30				30				45
Nate	Delay	0	60	0	60	0	60				
	Magnitude	5	10	5	10	5	10				
	Difficulty	L	L	L	L	L	L				
	Commit delay		10				10				
Pru	Delay	0	60	0	60	0	60				
	Magnitude	5	5	5	5	5	5				
	Difficulty	L	H	L	H	L	H				
	Commit delay		30				30				

is low, the commitment response binds the individual to the self-control alternative, removing the impulsive alternative. The effects of such an arrangement were examined in Study 2.

STUDY 2
METHOD

Participants and Setting

Three children who participated in Study 1 (Dante, Pru, and Nate) served as participants. As in Study 1, sessions were conducted in a small room equipped with a table, chairs, a computer, and a storage cabinet. Sessions were conducted 3 to 4 days per week at different times throughout the day to accommodate the participants' schedules. The total length of participation in the study was 10 days for Dante, 4 days for Nate, and 5 days for Pru.

Apparatus and Data Collection

The apparatus was identical to that used in Study 1. The computer program collected all data in the same manner as in Study 1. In addition, frequency data were collected for commitment responses, which were defined as placing the mouse pointer over the commit button on the computer screen and depressing the left mouse button such that the computer registered the button press.

An independent observer collected procedural fidelity data on at least 25% of sessions for all

participants. Data were collected as to whether the experimenter entered the session parameters as per the session log, provided the participant with attention during the session, and correctly recorded the output data totals on the session log. Levels of procedural integrity were 100% across participants.

Procedure

The purpose of Study 2 was to determine the effects of a commitment response on the children's self-control with task completion. Two conditions, baseline and commitment, were compared using a concurrent-schedules design embedded within a reversal design. Each session began with forced-choice trials to give participants experience with the contingencies associated with each task alternative and, if available, the commitment response. The procedures for this study were the same for each participant; however, values for each parameter and the commit delay (see Table 3) were individualized based on performance in Study 1. Participants completed the tasks with no occurrence of problem behavior or attempts to leave the table; however, the programmed consequence for these behaviors was to block and ignore.

Baseline. Procedures during baseline were similar to those for the self-control assessment. Each trial consisted of a choice between an immediate and delayed task that also differed by

either magnitude (Dante and Nate) or task difficulty (Pru).

Commitment. The right panel of Figure 2 diagrams the procedures for a trial during the commitment condition. All procedures for this condition were identical to those during baseline except that the opportunity to engage in a commitment response was provided prior to the choice screen. At the start of each trial, a commitment button appeared in the center of the computer screen for 5 s. Clicking on the commit button resulted in the removal of the button and a commit delay (see T in Figure 2). Following the commit delay, the immediate task was presented instead of the choice screen. If the participant did not click the commit button, the button was removed after 5 s and, following the same commit delay, the choice screen was presented with the same alternatives as in the baseline condition.

RESULTS

Figure 5 depicts the results of the commitment assessment for Dante, Nate, and Pru. During the first phase when the opportunity to commit to the immediate task was available, all participants demonstrated self-control by engaging in moderate levels of commitment responses ($M = 75\%$, range, 60% to 100% for Dante; $M = 80\%$, range, 60% to 100% for Nate; $M = 80\%$, range, 60% to 100% for Pru). During trials when the commitment response did not occur, Dante and Nate selected the delayed alternative ($M = 15\%$, range, 0% to 20% for Dante; $M = 15\%$, range, 0% to 20% for Nate) more often than the immediate alternative ($M = 10\%$, range, 0% to 20% for Dante; $M = 5\%$, range, 0% to 20% for Nate), whereas Pru always selected the immediate alternative. When the commitment response was not available (Phase 2), all participants demonstrated low levels of self-control. Dante and Nate selected the immediate alternative at moderately low levels ($M = 45\%$, range, 40% to 60% for Dante; $M = 40\%$ for Nate), whereas Pru always selected the immediate

alternative. When the commitment response was reintroduced, all participants demonstrated self-control. Dante engaged in the commitment response at moderate levels ($M = 78\%$, range, 40% to 100%), whereas Nate and Pru engaged in the commitment response at high levels ($M = 96\%$, range, 80% to 100% for Nate; $M = 100\%$ for Pru). During trials when the commitment response did not occur, Dante overwhelmingly allocated his choice toward the delayed alternative ($M = 20\%$; range, 0% to 60%) and Nate always selected the delayed alternative. During the second reversal, Dante demonstrated low levels of self-control when the commitment alternative was not available (mean choice of immediate alternative = 40%). Reintroduction of the commitment response with a longer commit delay resulted in high levels of commitment responses ($M = 90\%$, range, 80% to 100%). During trials when the commitment response did not occur, Dante always selected the delayed alternative.

DISCUSSION

The purpose of Study 2 was to examine the effects of a commitment response on self-control. For all participants, levels of self-control were differentially higher in the commitment response condition than in baseline. Furthermore, when the opportunity to commit was available, all participants engaged in high levels of commitment responses. These findings are consistent with those of basic research, which demonstrated that rats committed to a smaller more immediate shock that avoided a larger delayed shock when the opportunity to commit was available (Deluty et al., 1983). In addition, Deluty et al. (1983) found that the likelihood of a commitment response increased as a function of the extent of the commit delay. Similar findings were observed in the present study for Dante. That is, when the commit delay was 30 s, Dante demonstrated moderate levels of commitment responses. However, increasing the commit delay to 45 s resulted

Figure 5. Results of the commitment response assessment for Dante, Nate, and Pru. Phase labels indicate the commit delay (T), the delay values (D), and the task magnitude or difficulty levels for each task alternative.

in higher and more stable levels of commitment responses.

Another area of similarity between the findings of the present study and those of basic research is the likelihood of self-control on trials in which the commitment response did not occur. Deluty et al. (1983) found individual differences in levels of self-control at the point of choice (e.g., choice of the smaller sooner alternative during trials when the commitment response did not occur). Similar idiosyncrasies were observed in the present study, with Dante and Nate demonstrating low levels of self-control and Pru demonstrating high levels of self-control on trials in which they did not engage in the commitment response. One possible explanation for this difference is the extent to which the participants attended to the computer screen. Because the commit button was available for only 5 s, the likelihood was high that the opportunity to commit would be missed if the participant did not attend to the screen. On trials during which Pru did not commit, she often vocalized that she had "missed the button," which suggests that she was not attending to the computer screen. The increasing trend in commitment responses suggests that her attending may have been reinforced by the opportunity to commit.

GENERAL DISCUSSION

The purpose of the current two experiments was to examine variables that affect self-control in the context of academic task completion by elementary school children. Study 1 manipulated task magnitude, task difficulty, and delay to task completion on self-control, whereas Study 2 introduced a commitment response prior to obtaining the selected reinforcer. The findings indicated that both interventions improved participants' demonstrated self-control (defined as the completion of mathematics problems).

Results suggest that direct comparisons of the effectiveness of these interventions are warranted.

For instance, Dante and Nate demonstrated higher levels of self-control in the commitment assessment than in the self-control assessment, despite the values for each task parameter being similar across assessments. In addition, during the commitment assessment, Pru demonstrated self-control when the magnitude of the task alternatives was equal, something that did not occur during the self-control assessment. If direct comparisons yield similar differences, this would support the use of a commitment response despite the fact that it procedurally requires more work on the part of the teacher or therapist.

Although self-control increased for all participants in the present study, some variability was observed in responding. In addition, increasing self-control may only reduce the motivating operation for escape behavior rather than remove it completely. Thus, it may be necessary to combine interventions to increase self-control with escape extinction to ensure completion of the chosen task. However, combining these interventions might also be used as a way to mitigate the side effects of escape extinction. Reduction of these side effects may increase the ability of parents and caregivers to implement extinction successfully.

The avoidance assessment was conducted to measure the extent to which, given a choice, each participant would avoid task completion. This assessment demonstrated that a break was more preferred than math problem completion. Without a comparison condition in which button presses did not result in avoidance of math problems, however, the extent to which math problems functioned as a negative reinforcer could not be determined. Future studies should measure baseline levels of the avoidance response or measure the extent to which contingent presentation of the aversive event suppresses an operant.

One limitation of measuring relative preference during the avoidance assessment can be found in Dante's data set. Dante did not demonstrate a preference for either alternative, suggesting that completion of mathematics

problems was not an aversive event. However, clear preferences were observed for low-magnitude tasks and delayed task completion. In addition, low levels of self-control were observed during some phases of the self-control assessment. It is possible that the task avoidance assessment did not capture the extent to which mathematics problem completion was aversive for Dante. Task completion as well as a break under impoverished conditions may have been aversive, resulting in the observed indifference. In the current study, a break devoid of attention and activities was necessary to control for extraneous variables, but in the natural environment such is not the case. In addition, choice arrangements measure relative preference. In the task avoidance assessment, task completion was as aversive as the break for Dante. However, when both alternatives required task completion, clear preferences emerged.

Another limitation is that levels of mathematics problems were not mutually exclusive. For instance, all problems that were included in the addition sums below 9 category were included in the addition sums below 19 category. As a result, when these levels were placed in direct competition, it is possible that the problems presented by the computer program did not differ significantly across alternatives, which may have affected responding. This may explain why manipulations in task difficulty did not result in a change in response allocation during Pru's self-control assessment. It is possible that her responding was not affected because the probability of a low-difficulty mathematics problem in the delayed alternative was similar to that in the immediate alternative. In the future, investigators should ensure that there is no overlap across levels of mathematics problems.

In the present study, we assessed a limited number of values for each of the task parameters. In Study 1, both task magnitude and difficulty had only three values: low, medium, and hard. In the case of task difficulty,

the computer program and skill level of the participants limited the number of values available. In addition, only one delay value was assessed for Krista and Nate, whereas three values were assessed for Dante and Pru. The limited range of values for each parameter may account for the lack of effect of some parameter manipulations on responding. Assessing a larger sample of parameter values may be beneficial when designing applied interventions to promote self-control.

In the future, it may be beneficial to assess preference across all task parameters. During Study 1, when task difficulty varied across alternatives, changes in the delay to both alternatives did not affect Pru's self-control. Pru's allocation changed immediately following a magnitude manipulation, however. It may have been beneficial, therefore, to include a phase in which task magnitude and task difficulty levels were placed in direct competition during the task parameter assessment. The results of such a comparison might have indicated that Pru's choice was more sensitive to task magnitude than to task difficulty, thereby better informing the self-control assessment. Neef and Lutz (2001) used an assessment similar to this when they designed interventions to increase self-control with reinforcing events for two adolescents with attention deficit hyperactivity disorder. After demonstrating preference for high and low values of reinforcer rate, quality, delay, and response effort, each dimension was placed in direct competition with the other dimensions. Classroom interventions that incorporated the most influential reinforcer dimension then were shown to be more effective than a comparison intervention.

Finally, future research should examine the extent to which, once taught, a repertoire of self-control will generalize and be maintained. In the present study, all participants demonstrated increased levels of self-control, but these changes appeared to be transient in nature; low levels of self-control were recaptured quickly during reversal phases for all participants. It

should be noted that the phases in both studies were brief. It is possible that continued exposure to training trials would facilitate self-control in other situations. The ultimate utility of any intervention that increases self-control with aversive events would be one that results in a generalized repertoire.

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