Repeated Acquisition and Resistance to Change of Self-Control as a Function of Rule Completeness: A Replication and Extension

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by

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ABSTRACT

From a behavioral perspective, self-control can be defined as choice of a more highly preferred alternative over a less highly preferred alternative despite a longer delay for the more highly preferred alternative. Teaching repertoires of self-control has been useful in treating substance-abuse and other types of patterns of addictive behavior. Given logistical and practical difficulties in the implementation of such treatments with highly verbal individuals, analyses concerning the relation between rule-governance and self-control is warranted. The purpose of the current study is to replicate and extent Canon’s (2005) research on the relation between rule completeness and self-control. A pilot study was conducted with 18 undergraduates from the University of Nevada, Reno in which participants were presented with rules of varying completeness prior to completing a computerized self-control task. Preliminary results suggest that the proportion of self-control responses and delay tolerance can be increased as a function of rule completeness. The proposed research will examine changes in self-control when the completeness of rules is changed in a reversal single-subject design.
Acknowledgments

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Repeated Acquisition and Resistance to Change of Self-Control as a Function of Rule Completeness: A Replication and Extension

Individuals engaged in inflexible patterns of behavior around particular commodities are often described as lacking self-control. In behavioral economic terms, self-control refers to choice of a more highly preferred alternative over a less highly preferred alternative despite a longer delay for the more highly preferred alternative (McKeel & Dixon, 2014). A lack of self-control may be defined as choice for a less highly preferred alternative over a more highly preferred alternative due to the more highly preferred alternative being delayed. As such, both self-control and impulsivity are defined in terms of delay discounting (i.e., the process by which the value of a reward decreases as a function of delay to its receipt; Kirby, Petry, & Bickel, 1996). An individual’s propensity to make self-control choices can be defined in terms of delay discounting rates, as steeper rates correspond to the faster devaluing of rewards. Furthermore, delay discounting rates predict suboptimal and maladaptive patterns of choice, such as addiction (Odum, 2011). In fact, delay discounting predicts addiction so well that it has been incorporated into behavioral definitions of addiction (Bickel, Jarmolowicz, Mueller, & Gatchalian, 2011).

Several studies have examined methods for increasing this form of self-control. Vessells and colleagues (2018) found that signaling the delay to the larger reinforcer could increase self-control. Vessells and colleagues (2018) combined delay fading with delay signaling to increase delay tolerance for children with language deficits. Gokey and colleagues (2013) used delay fading to increase waiting for reinforcer acquisition with children with autism. Likewise, Stevenson, Ghezzi, and Valenton (2016) increased
functional communication while simultaneously decreasing elopement with young children. While these and other techniques (Koffarnus, Jarmolowicz, Mueller, & Bickel, 2013) are effective at increasing self-control choice, they are not practical approaches toward behavior change in everyday life or with individuals with extensive verbal repertoires, considering that such repertoires can contribute to the proliferation of impulsive choice (Levin, Haeger, Ong, & Twohig, 2018).

Given that rules can function as establishing operations which increase the value of reinforcers, rules may be useful in developing repertoires of self-control. As Skinner (1957) states, rules are verbal stimuli that specify contingencies. These types of stimuli typically refer to, either directly or indirectly, antecedents and/or consequences of behavior (Skinner, 1966). In his book About Behaviorism (1974), Skinner emphasizes that rules are advantageous when contingencies are complex or unclear. For example, a doctor can state a simple rule to their patient, such as “watching too much TV gives you headaches”. Rules can also be complex and unclear, such as when the doctor says that “watching some forms of electronic media can produce pain internal stimulation given that fixation on such media lasts substantial durations”. If the goal of such a rule is to decrease watching TV, the former rule is more likely to be effective than the latter. However, other factors contribute to the effectiveness of rules.

Pelaez (2013) distinguishes five dimensions of rules that impact their effectiveness in influencing behavior. They include (1) explicitness (i.e., the degree to which a rule describes a behavioral contingency), (2) accuracy (i.e., the degree to which the contingency specified by the rule corresponds to the contingency it is meant to describe), (3) complexity (i.e., how many related events are described within the rule), (4)
source (i.e., whether the rule is self-generated or generated by another individual), and (5) temporal proximity (i.e., the temporal frame in which the contingency described by the rule would be contacted). Presumably, rules that are more explicit, more accurate, less complex, generated by another person, and describe immediately contactable contingencies are more likely to influence behavior than other rules, still the effectiveness of rules must also consider other contextual variables. While several studies have examined differences in these dimensions on rule-governance, few studies have examined their relation to self-control.

Canon (2005) examined the relation between self-control and a sub-dimension of rule explicitness, completeness, within a computerized choice task. In her study, undergraduates could make either self-control choices that increased the overall rate of reinforcement or impulsive choices that decreased it by pressing buttons on a computer screen. Points were earned by clicking each button, and while the delay for receiving points was always longer when the self-control button was clicked, clicking the self-control button decreased the delay for both response options on subsequent trials. Reflectively, clicking the immediate button always produced points faster but also increased the delay for both response options. While Canon found that the completeness of rules presented prior to task iterations was positively correlated with proportion of self-control choice and negatively correlated with response rigidity when optimal choice was reversed (i.e., when responses no longer adjusted delays), certain analyses were not conducted by Canon.

Because analyses were not performed concerning the relation between points earned and proportion of self-control choice, it was not demonstrated that self-control
choice was indeed self-control. In addition, an analysis concerning terminal adjusted delays was not conducted. Considering that the sustained influence of rules despite contact with contingencies is of interest, analyses concerning the product of their interaction, such as the final delay adjustment, may be used to gauge the degree of rule-governance. Further, other sources of behavioral influence (i.e., demographics), were not accounted for.

The purpose of this study was to systematically replicate and extend Canon’s (2005) work concerning the data analyses described above by examining the relation between rule completeness and rule control over the rate of self-control responses in a similar choice paradigm among UNR undergraduates. Pilot data are examined, and a proposal for continuation of Canon (2005) study is supplied.

Method

Participants

Fifty-one undergraduates—seven more than were deemed necessary by a power analysis based off of data from pilot participants (see Figure 52, p.92)—participated from the University of Nevada, Reno. All participants were recruited through an online subject pool (SONA). Students received SONA credits for their participation in the study. All participants provided consent and presented their rights as research participants through a process approved by the university’s Institutional Review Board. Demographic information collected through a questionnaire presented at the end of the study is presented in Table 1.

Setting and Apparatus
All sessions were conducted in a small computer lab at the University of Nevada, Reno. Each participant sat at an isolated computer terminal equipped with a PC, a monitor, a mouse, a keyboard, and headphones. Participants wore headphones for the duration of the experimental session after consenting to the study and being read preliminary instructions about the task. The experimental task and questionnaire were programmed using Visual Studio Professional 2015. Sessions were conducted every week, depending on the number of participants.

**Procedure**

Each student participated in one session lasting approximately 30 minutes in duration on average. Participants could earn up to $8.00 depending on the number of points earned. Points were equivalent to money (1:1 ratio) until 800 points were earned in the experimental task at which money was not gained with additional points. In the order listed, all participants contacted (1) instructions describing the experimental task, as shown in Figure 1, (2) a rule—or lack of rule—describing the point-production contingency within the task, (3) a representation of the rule as shown in Figure 2, (4) the experimental task as shown in Figures 3-5, (5) a reiteration of the experimental task, (6) a demographic questionnaire as shown in Figure 6, and (7) a reward screen describing how much money they had earned as shown in Figure 7.

**Experimental Task.** Two-buttons, one blue and one yellow, were present on a screen as shown in Figure 3. Above each button as shown in Figure 4 & 5 was a text box containing the text, “Points Earned by Clicking [Color of button]: [Number of points earned by clicking respective button],” that was continuously updated as points were earned by clicking the button below. A textbox containing the text, “Remaining Time:
[Number of seconds left in task],” was present at the top of the screen. Upon clicking either button, a continuous beep was played through the headphones, the Remaining Time textbox disappeared as shown in Figure 4, and both buttons became disabled until the end of a specified delay. At the end of the delay, the beep stopped, the Remaining Time textbox reappeared, the buttons became enabled, a textbox containing the text, “+2 Points,” appeared for two seconds above the button that was clicked, and the textbox above the clicked button was updated to reflect the points earned by clicking that button. The task lasted 650 seconds. Clicking the blue button (i.e., self-control response) always produced points at a delay 3 s more than the delay for points produced by clicking the yellow button (i.e., impulsive response). Each iteration of the task was divided into two conditions—an adjusting-delay (AD) condition followed by a fixed-delay (FD) condition—presented on a multiple schedule (i.e., the conditions were not discriminated). Condition changes occurred after 325 s.

**Adjusting-Delay.** In AD conditions, responses on both buttons changed the delay on both buttons. Delays for both buttons were assigned based on the previous 10 responses. For every impulsive response in the previous 10 responses, 1 s was added to the delay for points produced by either response. Since 10 responses could not be completed prior to starting the task, 5 s were added to each delay by assigning responses a priori (i.e., the first, third, fifth, seventh, and ninth responses were assigned as self-control responses whereas the second, fourth, sixth, eighth, and tenth responses were assigned as impulsive responses).

**Fixed-Delay.** FD conditions were exactly the same as AD conditions except that the delays for points produced by either response did not change. Delays were fixed
according to what they were at the end of the preceding AD condition. Prior to each iteration of the task, a rule was presented to each participant. Participants contacted one of four rules, depending on which group they were randomly assigned to. In the first group (n = 13), the High Completeness Rule group (HCR), participants were presented with the most complete rule: “The blue choice always produces points slower than the yellow choice, but the speed at which you earn points for both buttons depends on your previous choices. If you choose the yellow choice too often, points are earned more slowly for both choices.” In the second group (n = 12), the Medium Completeness Rule (MCR) group, participants were presented with a less complete rule: “The blue choice always produces points slower than the yellow choice, but the speed at which you earn points for both buttons depends on your previous choices.” In the third group (n = 12), the Low Completeness Rule group (LCR), participants were presented with an even less complete rule: “The blue choice always produces points slower than the yellow choice.” In the fourth group (n = 14), the No Rule group (NR), participants were not presented a rule. Instead—or after the rule in the case of other groups—participants were shown the text, “Click Continue to start.”

As the task consisted of two conditions, adjusting delay and fixed delay, which were repeated after presentation of the same rule, the experimental design was effectively a reversal (ABAB). All participants experienced conditions in the same order, regardless of group.

**Demographic Questionnaire.** After completing both iterations of the task participants were asked to complete a demographic survey at the end of the study (Figure 6). The survey included questions concerning gender, age, education, and income. A
Data Analysis. Data were collected on frequency of self-control and impulsive responses, the delay for points produced by each response, and the number of points earned. Proportion of self-control responses were calculated across participants for each condition by dividing the number of self-control responses made by the total amount of responses made (self-control and impulsive responses). Graphs depicting the proportion of self-control responses across conditions and the delay for points produced by self-control responses during FD conditions, FD self-control delays, were created for each participant. Graphs were also created depicting mean proportions of self-control responses and FD self-control delays across groups.

Because participants were divided into multiple groups and exposed to various conditions, two-way ANOVAs with repeated measures were used to compare group and condition effects on proportion of self-control responses and FD self-control delays. To satisfy the requirement of normality for ANOVA analyses, Shapiro-Wilk tests (a = .05) were performed for raw and transformed (i.e., logarithm, square-root, sine-square-root, and hyperbola) values of each of the above dependent variables for mean responding in each condition by each group. As such, sixteen normality tests were conducted for the proportion of self-control responses and eight tests were conducted for FD self-control delays for variable type (i.e., raw and transformed values). The square-root of proportion of self-control responses was selected for subsequent analyses because it had the fewest significant (i.e., indicating non-normality) test results. Non-transformed FD self-control
delays were selected because no set of transformed values had fewer significant test results. For Shapiro-Wilk test results, see Table 2 (P.37).

Linear regression analyses were performed to determine relations between points earned in the task, mean proportion of self-control responses across conditions, and mean FD self-control delays. Participants who achieved 0 s impulsive choice delays in FD conditions (one from the HCR group and one from the MCR group) were excluded from analyses concerning points earned because they earned vastly more points than all other participants. Similar analyses were constructed to depict relations between mean proportion of self-control responses across conditions, FD self-control delays, and demographic variables, namely age, money made in a typical month, money used in a typical month, GPA, and gender, see Table 3 (P.37). Categorical responses for money made, money used, and GPA (e.g., 2.0-2.5) were converted into scalar variables by averaging the values listed (e.g., 2.25). Analyses of demographic variables included and excluded groups as covariates. All statistical analyses were conducted using GraphPad Prism 7.03 and SPSS 25.

Results

Figures 1 through 51 (see Appendix A on P.38) depict proportions of self-control responses across conditions and self-control response delays across FD for all participants organized by group. Across all participants, proportion of self-controlled responses across conditions for 41.177% of participants demonstrated a self-control ABAB effect where the proportion of self-control choices was higher in each AD condition than in the proceeding FD condition. 43.137% of participants demonstrated a self-control BAB effect where the proportion of self-control choices was higher in the
second AD condition than in either FD condition. Of those who demonstrated a self-control ABAB effect, 57.143% also demonstrated a self-control BAB effect. In the HCR group, 46.154% of participants demonstrated a self-control ABAB effect and 46.154% demonstrated a self-control BAB effect. In the MCR group, 25.000% of participants demonstrated a self-control ABAB effect and 33.333% demonstrated a self-control BAB effect. In the LCR group, 66.667% of participants demonstrated a self-control ABAB effect and 25.000% demonstrated a self-control BAB effect. In the NR group, 28.571% of participants demonstrated a self-control ABAB effect and 57.143% demonstrated a self-control BAB effect.

Figures 8 through 11 (P. 29) depict mean square-root of proportions of self-control responses and FD self-control delays. One-way ANOVAs with repeated measures found a significant effect for across conditions for mean square-root of proportions of self-control responses in the HCR group (F = 4.382, p = 0.021) and did not find a significant effect in the MCR group (F = 3.054, p = 0.062), the LCR group (F = 0.247, p = 0.699), or the NR group (F = 2.397, p = 0.114). Sidak’s multiple comparisons tests using stepwise comparisons (i.e., comparisons between sequential conditions) found a significant difference between mean square-root of proportion of self-control responses in the first FD and second AD condition (FD Mean: 0.502, AD Mean: 0.677, p = 0.041) but did not find such an effect between any other conditions in any group.

A two-way ANOVA with repeated measures found a significant effect across conditions (F(3, 141) = 4.729, p = 0.004) and subjects (F(47, 141) = 7.583, p < 0.0001) but not groups (F(3, 47) = 2.416, p = 0.078) for mean square-root of proportion of self-control responses. Tukey’s multiple comparisons test found significant differences in
mean square-root of proportion of self-control responses between the HCR and MCR groups (HCR Mean: 0.677, MCR Mean: 0.406, p = 0.020) as well as the HCR and LCR groups (HCR Mean: 0.677, LCR Mean: 0.414, p = 0.026) in the second AD condition and between the HCR and MCR groups (HCR Mean: 0.568, MCR Mean: 0.306, p = 0.026) (see Figure. 12, p. 33). Another two-way ANOVA with repeated measures found a significant effect across subjects (F(47, 47) = 1.951, p = 0.012) but no significant effect across FD conditions (F(1, 47) = 3.680, p = 0.061) or groups (F(3, 47) = 1.723, p = 0.175) for FD self-control delays. Tukey’s multiple comparisons test found no significant difference in FD self-control delays between any groups in any FD condition (see Figure 13, p.33).

Depict relations between mean square-root of proportion of self-control responses during AD conditions and points earned across the whole session for participants in each group and across all participants. Linear regression revealed significant positive correlations across in the HCR group (slope = 0.001, F(1, 10) = 7.438, p = 0.021, R² = 0.427), the MCR group (slope = 0.003, F(1, 9) = 19.740, p = 0.002, R² = 0.697), the LCR group (slope = 0.002, F(1, 10) = 30.330, p = 0.0003, R² = 0.752), the NR group (slope = 0.002, F(1, 12) = 14.28, p = 0.003, R² = 0.544), and across all participants (slope = 0.002, F(1, 47) = 73.900, p < 0.0001, R² = 0.611) (Figure 14, p. 34).

Depict relations between mean square-root of proportion of self-control responses during FD conditions and points earned across the whole session for participants in each group and across all participants. Linear regression revealed significant positive correlations across in the LCR group (slope = 0.003, F(1, 10) = 28.210, p = 0.0003, R² = 0.738), the NR group (slope = 0.003, F(1, 12) = 21.39, p = 0.001, R² = 0.641), and across
all participants (slope = 0.002, F(1, 47) = 45.970, p < 0.0001, R² = 0.495) but not in the
HCR group (slope = 0.001, F(1, 10) = 1.114, p = 0.316, R² = 0.100), the MCR group
(slope = 0.002, F(1, 9) = 5.071, p = 0.051, R² = 0.360) (See Figure 15, p. 35).

Depict relations between mean FD self-control delays and points earned across
the whole session for participants in each group and across all participants. Linear
regression revealed significant negative correlations across in the HCR group (slope = -
0.018, F(1, 10) = 11.600, p = 0.007, R² = 0.537), the MCR group (slope = -0.035, F(1, 9)
= 42.540, p = 0.0001, R² = 0.825), the LCR group (slope = -0.025, F(1, 10) = 28.210, p =
0.0001, R² = 0.786), the NR group (slope = -0.028, F(1, 12) = 14.830, p = 0.002, R² =
0.553), and across all participants (slope = -0.028, F(1, 47) = 93.580, p < 0.0001, R² =
0.666) (see Figure 16, p. 36).

Table 3 depicts results from linear regressions relating demographic variables to
mean square-root of proportion of self-control responses across AD conditions, mean
square-root of proportion of self-control responses across FD conditions, and mean FD
self-control delays. No significant correlations between any of the demographic variables
and dependent measures were found, even when groups were used as a covariate.
However, using groups as a covariate generally increased the amount of variance
accounted for by each linear regression model, albeit only marginally.

Discussion

These results replicate and extend the work by Canon (2005) and support the
notion that the completeness of rules can differentially affect self-control and persistence
of rule-governance given changes in contingencies under mixed-schedules of
reinforcement. Significant differences in mean square-root of proportion of self-control
responses in the second AD condition between the HCR and both the MCR and LCR groups suggests as well as a significant difference in the same measure in the second FD condition between the HCR and MCR groups suggest that, even after initial exposure to contingencies, contact with complete rather than incomplete rules can increase self-control and maintain such responding even when the self-control contingency is absent.

Extending Canon’s analysis from examining only proportion of self-control responses to FD self-control delays offers a valuable perspective on various controlling variables. Proportion of self-control responses cannot necessarily inform within-condition changes in responding; however, analyzing differences in the delay at the end of AD conditions can elucidate the interaction of rules and direct reinforcement contingencies. Considering that no significant differences in FD self-control delays were evident across groups in either FD condition, there is limited evidence that rules maintained differential responding within AD conditions.

Differences in persistence of ‘self-control’ responding during FD conditions are unlikely to be solely contributed to proportion of self-control responses in preceding AD conditions. While positive correlations between mean square-root of proportion of self-control responses were apparent for responding in both the LCR and NR groups across both types of conditions, no positive correlation was found for the HCR and MCR groups in the FD condition. This suggests that increased completeness of rules may have decreased persistence of self-control responding. Given that the proportion of self-control responses for HCR were similar to NR and MCR were similar to LCR, relative response rates alone in the preceding AD conditions were unlikely to produce systemic differences in persistence alone. Such analyses extend Canon’s findings in valuable ways, as they
both demonstrate that the self-control contingency actually produced measurable self-control across participants and allow for changes in persistence to be detected across mixed-schedules. Larger sample sizes would help confirm these findings.

Strangely, given that demographic variables such as age, income, and education are often related to delay discounting rates, no relation between such variables and self-control was evident in the current study. This may be due to a lack of sensitivity on part of the dependent measures employed in this study. For example, the predictability of delay discounting measures stems from analyses of indifference between rewards at various delays. Proportion of self-control choice and FD delays may imply some point of indifference between a less delayed reward that increases delays on subsequent trials and a longer delayed reward that reduces delays on subsequent trials, but the measures examined here do not examine such indifference. Furthermore, if such indifference were detectable, it would be expected to change towards preference for reward maximization with repeated exposure to contingencies with nonhuman animals. Human animals, especially those with extensive verbal repertoires, may not alter their responding in such a way. If such fixation is due to rule-governance, though, the predictability of such a measure of indifference would not likely be the same as those produced in the vastly different verbal context of typical delay discounting questionnaires. Future research should address differential predictive utilities of such indifference that could be produced in an elongated version of this study (i.e., one with more reversals and longer conditions) with degrees of behavior change given changes in rules.

Limitations of this study should be addressed in future research. While the sample size of each group was large enough to detect significant differences with respect
to proportion of self-control responses when that data was transformed using square-root functions, raw data outputs suffered from non-normal distributions. Increasing the sample size sufficiently may make such transformations unnecessary. Furthermore, the predictability of data collected may have been impacted by limited exposure to particular contingencies. Incorporating steady-state criteria may be optimal given research goals concerning the predictive utility of such tasks.

Additionally, the social validity of this task may be in question in three aspects. First, differential contingencies are often able to be discriminated in every day life. Using mixed rather than multiple schedules was necessary to examine persistence given current research questions but incorporating multiple schedules may be ideal for determining persistence given changes in present stimuli arrangements. Second, individual often contact different rules concerning the same contingencies. The current study examined changes in responding given non-discriminated changes in contingencies in the context of a single rule presentation, but persistence may also be measurable with respect to changes in responding given changes in rules presented. Such an analysis may be helpful in determining the extent to which individual will behave impulsively despite instructions to do otherwise. And third, experimental control was not demonstrated across all individual responding. While about half of all the participants demonstrated conditional control of self-control responding through either ABAB or BAB replication, about half did not. While this may be due to a number of factors, including rule-governance, it may also be due to limited exposure to experimental contingencies and stimuli. Given small group sample sizes, the extent to which conditions or rules-controlled behavior on an individual level is not addressable.
References


Analysis of Behavior, 96, 427-439.


Figures of Experimental Task

Hello. We invite you to play our game and earn as much money as possible in approximately 45 minutes.

The rule of the game is simple. You will be given a series of trials, interspersed with periods during which the screen will change and choices will not produce points. On each trial, you must make a choice between two alternatives, the yellow button or the blue button, by clicking on your choice with the mouse. You will earn the same amount of points for both choices. Points earned for choices will appear in a respective Points Earned box after a short delay. Points will be converted to money and given to you at the end of the game.

Expert players can earn up to $10.00 in a relatively short period of time. The way to make money is to make as many choices as possible before the end of the game. You will see a timer that keeps you informed of how much time you have left which to make your choices and earn money.

When you have finished reading these instructions, you may start playing the game by clicking on the start button. Remember your goal is to make as many choices as you can within the time remaining as indicated on the screen so you can earn as much money as possible.

Figure 1. Main instruction page of the experimental task.

Here's a hint: The blue choice always produces points slower than the yellow choice, but the speed at which you earn points for both choices depends on your previous choices. If you choose yellow too often, points will be earned more slowly for both choices. Click Start to begin the game.

Figure 2. A representation of the rule.
Figure 3. Experimental task.

Figure 4. Button disappeared.

Figure 5. Points earned.
Figure 6: Demographic questionnaire.

Figure 7: Reward screen
Figure 8. Mean proportion of self-control responses across conditions (*top*) and mean delay for points produced by self-control responses across fixed-delay conditions (*bottom*) for High Completeness Rule group (HCR). AD = Adjusting-delay; FD = fixed-delay.
Figure 9. Mean proportion of self-control responses across conditions (top) and mean delay for points produced by self-control responses across fixed-delay conditions (bottom) for Medium Completeness Rule group (MCR). AD = Adjusting-delay; FD = fixed-delay.
Figure 10. Mean proportion of self-control responses across conditions (*top*) and mean delay for points produced by self-control responses across fixed-delay conditions (*bottom*) for Low Completeness Rule group (LCR). AD = Adjusting-delay; FD = fixed-delay.
Figure 11. Mean proportion of self-control responses across conditions (*top*) and mean delay for points produced by self-control responses across fixed-delay conditions (*bottom*) for No Rule group (NR). AD = Adjusting-delay; FD = fixed-delay.
Figure 12. Mean square-root proportion of self-control responses across conditions and across groups and conditions. AD = Adjusting-delay; FD = fixed-delay; HCR = High Completeness Rule group; MCR = Medium Completeness Rule group; LCR = Low Completeness Rule group; NR = No Rule group.

Figure 13. Mean delay for points produced by self-control responses across fixed-delay conditions across groups and conditions. Asterisk denotes significant difference ($p < .05$). AD = Adjusting-delay; FD = fixed-delay; HCR = High Completeness Rule group; MCR = Medium Completeness Rule group; LCR = Low Completeness Rule group; NR = No Rule group.
Figure 14. Correlation between mean square-root of proportion of self-control responses across adjusted-delay (AD) conditions and points earned during the entire session for HCR (top left), MCR (top right), LCR (middle left), NR (middle right), and all groups (bottom left). Line depicts linear best-fit.
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Figure 16. Correlation between mean fixed-delay (FD) delays and points earned during the entire session for HCR (top left), MCR (top right), LCR (middle left), NR (middle right), and all groups (bottom left). Line depicts linear best-fit.
### Tables

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<th>Demographic Questions</th>
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<td>How old are you?</td>
</tr>
<tr>
<td>Approximately how much money do you use each month?</td>
</tr>
<tr>
<td>Approximately how much money do you make each month?</td>
</tr>
<tr>
<td>What is your gender?</td>
</tr>
<tr>
<td>How familiar are you with the concept of self-evaluation?</td>
</tr>
<tr>
<td>How many collage credits will you have completed by the end of this semester?</td>
</tr>
<tr>
<td>What is your GPA?</td>
</tr>
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Table 1. Demographic questioner
<table>
<thead>
<tr>
<th>Function</th>
<th>AD 1</th>
<th>FD 1</th>
<th>AD 2</th>
<th>FD 2</th>
<th>AD 1</th>
<th>FD 1</th>
<th>AD 2</th>
<th>FD 2</th>
<th>AD 1</th>
<th>FD 1</th>
<th>AD 2</th>
<th>FD 2</th>
<th>Pass %</th>
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<tbody>
<tr>
<td>x</td>
<td>0.912</td>
<td>0.856</td>
<td>0.915</td>
<td>0.938</td>
<td>0.892</td>
<td>0.852</td>
<td>0.848</td>
<td>0.770</td>
<td>0.852</td>
<td>0.905</td>
<td>0.788</td>
<td>0.753</td>
<td>0.881</td>
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<tr>
<td>sqrt(x)</td>
<td>0.915</td>
<td>0.861</td>
<td>0.955</td>
<td>0.929</td>
<td>0.916</td>
<td>0.900</td>
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<td>0.910</td>
<td>0.915</td>
<td>0.944</td>
<td>0.927</td>
<td>0.871</td>
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<tr>
<td>log(x+1)</td>
<td>0.213</td>
<td>0.038</td>
<td>0.477</td>
<td>0.377</td>
<td>0.254</td>
<td>0.158</td>
<td>0.364</td>
<td>0.162</td>
<td>0.215</td>
<td>0.244</td>
<td>0.556</td>
<td>0.353</td>
<td>0.944</td>
</tr>
<tr>
<td>1/(x+1)</td>
<td>0.913</td>
<td>0.861</td>
<td>0.926</td>
<td>0.826</td>
<td>0.006</td>
<td>0.878</td>
<td>0.888</td>
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<td>0.009</td>
<td>0.887</td>
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<td>sin(sqrt(x))</td>
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<td>0.677</td>
<td>0.248</td>
<td>0.251</td>
<td>0.186</td>
<td>0.284</td>
<td>0.101</td>
<td>0.277</td>
<td>0.222</td>
<td>0.662</td>
<td>0.53</td>
<td>0.033</td>
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Table 2. Shapiro-Wilk test results. AD = Adjusting-delay conditions; FD = fixed-delay conditions; x = variable value; Yes = test result indicates normality; No = test result does not indicate normality.
Table 3. Linear regressions of dependent measures and demographic variables. Prime variables denote that the linear regression included experimental groups as a covariate. AD = Adjusting-delay conditions; FD = fixed-delay conditions.
Appendix A

List of Figures Showing Individual Data

HCR Group:
Figure 1: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 004.
Figure 2: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 006.
Figure 3: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 011.
Figure 4: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 013.
Figure 5: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 020.
Figure 6: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 024.
Figure 7: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 027.
Figure 8: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 032.
Figure 9: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 036.
Figure 10: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 040.
Figure 11: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 044.
Figure 12: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 046.
Figure 13: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 051.

MCR Group:
Figure 14: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 003.
Figure 15: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 008.
Figure 16: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 012.
Figure 17: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 014.
Figure 18: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 017.
Figure 19: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 022.
Figure 20: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 026.

Figure 21: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 031.

Figure 22: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 035.

Figure 23: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 038.

Figure 24: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 043.

Figure 25: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 048.

LCR Group:

Figure 26: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 007.

Figure 27: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 009.

Figure 28: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 015.

Figure 29: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 019.

Figure 30: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 023.

Figure 31: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 028.

Figure 32: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 029.

Figure 33: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 033.

Figure 34: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 039.

Figure 35: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 041.

Figure 36: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 047.

Figure 37: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 049.

NR Group:

Figure 38: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 001.

Figure 39: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 002.
**Figure 40**: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 005.

**Figure 41**: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 010.

**Figure 42**: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 016.

**Figure 43**: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 018.

**Figure 44**: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 021.

**Figure 45**: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 025.

**Figure 46**: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 030.

**Figure 47**: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 034.

**Figure 48**: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 037.

**Figure 49**: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 042.

**Figure 50**: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 045.

**Figure 51**: Proportion of self-control responses across conditions and delay for points produced by self-control responses across fixed-delay conditions for Participant 050.

**Figure 52**: Power analysis input screen.
Figure 1. Proportion of self-control responses across conditions (top) and delay for points produced by self-control responses across fixed-delay conditions (bottom) for Participant 004. AD = Adjusting-delay; FD = fixed-delay
Figure 2. Proportion of self-control responses across conditions (top) and delay for points produced by self-control responses across fixed-delay conditions (bottom) for Participant 006. AD = Adjusting-delay; FD = fixed-delay.
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Figure 51. Proportion of self-control responses across conditions (top) and delay for points produced by self-control responses across fixed-delay conditions (bottom) for Participant 050. AD = Adjusting-delay; FD = fixed-delay.
Figure 52. Power analysis input screen. Values for the power analysis were derived from mean proportion of self-control responses across groups in the second AD condition from pilot data.