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The rich get richer: Students' discounting of hypothetical delayed rewards and real effortful extra credit

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The present research compared choices among students with higher or lower grades for rewards that were devalued by imposing a delay to their receipt (Study 1) or by requiring more work for a larger reward (Study 2). In Study 1, students chose between hypothetical and noncontingent smaller immediate or larger delayed monetary rewards. In Study 2, students chose from among different amounts of real, response-contingent academic rewards (extra credit) that required different amounts of work. The results of both studies were similar: The highest scoring students discounted the value of the delayed money less than did their lower scoring counterparts, and the highest scoring students also chose to do and actually did more extra-credit work than lower scoring students did. Differences in the discounting of devalued rewards might represent a fundamental difference between the highest and lower scoring students.

Students are often faced with decisions such as whether to study or engage in nonacademic activities. Which alternative a student chooses is influenced by several variables, such as how rewarding (or costly) the student finds studying versus its nonacademic alternative and how the rewards of studying change as a function of time to their occurrence or of effort to achieve them. For example, some students will work (e.g., study for an exam or write a paper) for an outcome (e.g., learning the course content or completing the paper) only when the delay to that outcome is short or when the effort to achieve it is low, whereas other students will expend considerable effort over a long period of time to achieve the outcome. It is the influence of these two ways of devaluing a reward—increasing the delay to its receipt and requiring greater effort to earn it—that is explored in this article.

To study how a delay to a reward devalues the reward, researchers have presented participants with a series of choices between rewards that differ in their amounts and delay (Logue, 1995; Rachlin, 2000). For example, a person could be asked to choose between receiving $900 immediately or $1,000 after 1 month, $800 immediately or $1,000 after 1 month, $700 immediately or $1,000 after 1 month, and so on. By systematically varying the size of the smaller immediate reward (e.g., $900, $800, or $700) and the delay to the larger fixed-value reward (e.g., $1,000 after a delay of 1 week, 1 month, or 1 year), psychologists can determine the point at which someone prefers a smaller immediate reward over a larger delayed reward. The point at which someone prefers the smaller immediate reward is the subjective value of the larger reward devalued or discounted by the delay.

All else being equal, delayed outcomes have less value for humans and other animals than do immediate outcomes (Ainslie, 1974; Logue, 1988; Rachlin & Green, 1972). Also, different groups of people discount delayed rewards differently. For example, children discount the value of delayed hypothetical monetary rewards more than adults do (Green, Fry, & Myerson, 1994), and inexperienced college administrators do the same when compared with experienced administrators (Logue & Anderson, 2001). It is these differences between groups of people that led us to wonder whether higher and lower scoring students differentially discount the value of delayed rewards. Related research that asked students to self-report academic management strategies indicates that higher scoring students report more self-regulation (i.e., they study persistently; e.g., Pintrich & de Groot, 1990; VanZile-Tamsen & Livingston, 1999; Winne, 1997). Also, according to students' responses on inventory items and/or teachers' ratings of students' behavior, higher scoring students are less impulsive than their lower scoring classmates (Davids & Sidman, 1962; Merrell, 1990; Rothblum, Solomon, & Murakami, 1986).

In contrast to studies involving self-report inventories on which participants answer questions about study habits and dimensions of personality, we devalued hypothetical (Study 1) and real (Study 2) rewards on two behavioral tasks and then recorded students' choices related to this devaluation. In Study 1, hypothetical monetary rewards were devalued by delaying their occurrence, and students made a series of choices between smaller im-

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mediate versus larger delayed hypothetical monetary rewards (e.g., Green et al., 1994). In Study 2, real academic rewards were devalued by requiring more effort to earn larger rewards, and students were given a single choice to complete different amounts of work for different amounts of extra credit. The general question we sought to answer was whether higher and lower scoring students differed in their choices for outcomes devalued either by delay (Study 1) or by effort (Study 2).

STUDY 1

In this study, students made a series of choices about hypothetical money. The alternatives consisted of choosing between a smaller immediate amount of money or a larger delayed amount of money. It is well established that imposing a delay to receipt of a reward devalues the reward (Logue, 1995; Rachlin, 2000). But who discounts the value of reward more as a function of the delay to its receipt, higher or lower scoring students?

Method

Participants. Ninety-six undergraduate students of traditional college age from introductory psychology, cognitive psychology, and developmental psychology courses volunteered for the study. All participants' data were included in the data analyses, including those of students who did not show any discounting. The participants were given extra credit for their involvement.

Materials and Procedure. The procedure was adapted from Rachlin, Raineri, and Cross (1991) and required participants to make a series of choices regarding hypothetical amounts of money (see also Green et al., 1994). These amounts were printed on standard paper, and the pages were stapled into a booklet. Each page consisted of 30 choices with a common feature: One alternative always consisted of $1,000 after a fixed delay (e.g., 1 month). The other alternative consisted of variable amounts of money delivered immediately. The variable amounts of money ranged from 0.1% to 100% of the delayed fixed amount (i.e., the $1,000). The participants were asked to indicate with a checkmark all the points at which they preferred the immediate amount of money over the delayed money. The immediate reward options were presented in different orders to different participants. On each page of the booklet, there were different delays to receipt of the $1,000. These delays were presented in the order: 1 week, 1 month, 6 months, 1 year, 3 years, 5 years, 10 years, and 25 years. It took about 15 min for the participants to complete the task.

Data analyses. To determine the relationship between the students' discounting of the rewards and their grades, we calculated the students' standardized mean grade over all multiple-choice exams in the course and then separated the students into three groups using splits at the 33rd and 66th percentiles. Analyses of variance (ANOVAs) were used to compare the students' choices at different delays. Also, each student's median, mean, and geometric mean monetary values across the eight delays (which provided rough estimates of a student's degree of discounting without the need for and the concerns of curve-fitting)[1] were correlated with his or her course grade. Statistical significance was determined at the $p < .05$ level for all analyses.

Results and Discussion

Figure 1 shows how the subjective value of $1,000 was discounted by delaying its availability. Although the three groups of students were initially similar, the $1,000 was discounted less by the highest scoring students. An ANOVA showed that the groups discounted the value of $1,000 with increasing delays to its receipt [main effect of delay, $F(7,651) = 133.05, p = .000$], that they differed in their amounts of discounting [main effect of group, $F(2,93) = 4.63, p = .012$], and that there was an interaction between group and delay [$F(14,651) = 2.48, p = .002$]. Fisher's least significant difference (LSD) test

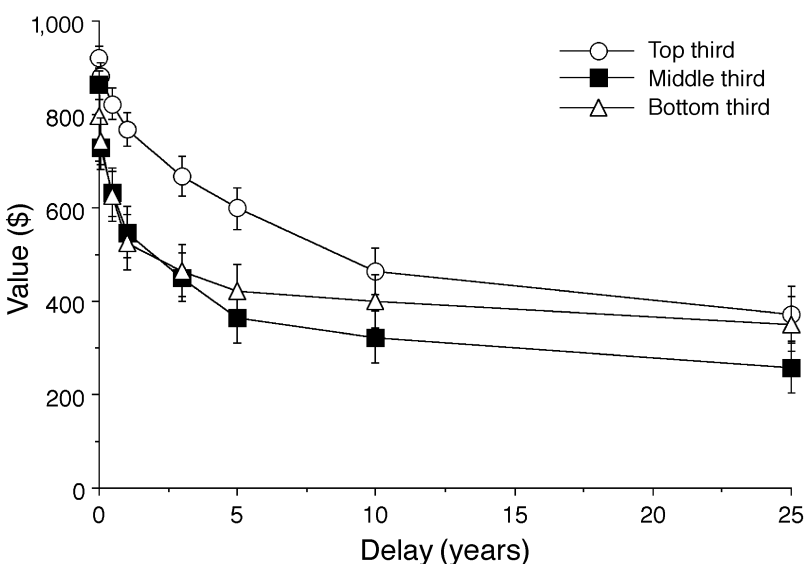

Figure 1. The value of $1,000 as a function of the delay to its receipt for students in the top- (open circles), middle- (solid squares), and bottom-third (open triangles) percentiles. Error bars illustrate the standard errors of the mean.

showed that in general, the highest scoring students discounted the value of $1,000 less than did the students in the middle- and bottom-third percentiles (ps = .007 and .016, respectively) and that the latter two groups did not differ from each other (p = .740). As shown in the graph, the most obvious differences were between the highest scoring students and those in the middle- and bottom-third percentiles at the 1-month through 5-year delays (Fisher's LSD post hoc analyses, ps < .004). There were no statistically significant differences between any pairs of groups at delays of 1 week, 10 years, and 25 years, or between the middle and bottom percentile groups at any delays.

Because splitting the students into three groups instead of two, four, five, or n groups is somewhat arbitrary, we correlated the students' mean standardized grades across the multiple-choice exams with the median, geometric mean, and mean of their choices across all delays. Ideally, the results of this correlation should be consistent with the results of the ANOVAs. Pearson correlations revealed statistically significant relationships between grades and median (r = .293, p < .004), grades and geometric mean (r = .219, p < .032), and grades and mean (r = .235, p < .021). Thus, there was an inverse relationship between the students' grades and how much they discounted the value of delayed hypothetical monetary rewards.

STUDY 2

The previous study showed that the highest achieving students discounted the value of a hypothetical, delayed, noncontingent reward less than lower achieving students did. In Study 2, we sought to determine whether a similar difference would be evident in a naturalistic situation when real, response-contingent academic rewards were devalued by requiring greater amounts of work to earn greater rewards. In this study, the students had a single opportunity at the beginning of a course to choose how much work they would like to complete to earn varying amounts of extra credit. The extra-credit options consisted of completing as many as six extra-credit assignments.

Although lower scoring students need extra credit more than do higher scoring students, and although both types of students indicate that they would like to achieve an A in a course (Silva, 2003), Study 1 suggests that lower scoring students, who have a greater tendency to discount rewards devalued by delay, should also more severely discount the value of the extra credit (the reward) than do higher scoring students when more effort (which devalues the reward) is required to earn more extra credit. In addition, some research suggests that higher scoring students are more likely to take advantage of extra-credit assignments than are their lower scoring classmates (Hardy, 2002). Thus, lower scoring students should both contract to do and actually do less extra-credit work than their highest scoring classmates.

Method

Participants, Materials, and Procedure. Fifty-nine students of traditional college age in introductory psychology courses participated in the study. During the first week of the semester, the students were informed of the extra-credit activities, that they could receive 2 bonus points for completing each of the six activities (for a total of 12 points), and that these points would be added to their course total, out of 100 points. Each activity involved an article from the journal *American Psychologist.* To receive the 2 bonus points for an activity, a student had to find the article in the library, read it, write and submit to the instructor a two-page reaction paper, and pass a multiple-choice quiz about the article by answering four out of six questions correctly. If the students did not pass the quiz, they could take a different quiz about the same article on the next day. If the students did not pass the second quiz, they were asked to write a correction paper that consisted of an explanation of why the answers they got wrong on the second quiz were incorrect, and to provide the correct answers. If the students completed the components of the extra-credit activities they contracted for, they were guaranteed the bonus points.

During the first week of classes, the students had one opportunity to choose the number of extra-credit activities they wished to attempt, from completing none to doing all six. Their choices were tempered by the understanding that once made, their choice could not be altered (i.e., they could not opt for fewer or more activities as the course progressed). Furthermore, all components of all activities had to be completed to receive credit. For example, a student could not receive partial credit for handing in a reaction paper but not taking the quiz, nor could a student receive partial credit for completing four activities when they contracted to complete five. To receive extra credit at the end of the semester, all work contracted for at the beginning of the semester must have been completed by the last day of classes. The students worked at their own pace and were responsible for submitting reaction papers and arranging to take quizzes.

Results and Discussion

The students' mean standardized grades from their examinations were calculated. Using these standard scores, the students were separated into three groups using splits at the 33rd and 66th percentiles. On the basis of these groupings, an ANOVA was performed on the number of extra-credit activities the students contracted for at the beginning of the semester. A significant effect for group was obtained [$F(2,56) = 3.456$, p = .038]. An analysis of mean differences using Fisher's LSD test revealed that the highest scoring students contracted for a greater number of extra-credit activities (n = 20, M = 4.65, SD = 1.57) than did the students in the middle-third (n = 19, M = 3.42, SD = 1.71) and bottom-third (n = 20, M = 3.55, SD = 1.57) percentiles.

To preclude the possibility that arbitrarily separating students into three groups contributed to the observed effects, we correlated the students' mean standardized grades across the multiple-choice exams with the number of extra-credit activities they chose to complete. Pearson correlations revealed a statistically significant relationship between grades and the number of extra-credit activities chosen (r = .265, p < .05). Thus, the higher a student's grade, the more extra-credit activities the student chose to complete.

An additional analysis was conducted to compare students' grades relative to their actual completion of the extra-credit activities. The standard scores of the students who contracted for extra credit and completed and received bonus points at the end of the semester ($n = 11$) were compared with those of the students who never handed in any of the extra-credit activities ($n = 44$). (It should be noted that all students contracted for at least one extra-credit activity.) Students who completed and received credit for their extra-credit activities performed better ($M = 0.633$, $SD = 0.573$) than did students who did not attempt any of the activities ($M = -0.19$, $SD = 1.04$). The difference between the means of these two groups was statistically significant [$t(53) = 2.51$, $p = .008$]. Only 4 students attempted but did not complete their extra-credit work. These students' performance was intermediate ($M = 0.368$, $SD = 0.428$) to those of the students in the other two groups.

In sum, the highest scoring students were more willing than their lower scoring classmates to choose more academic work to improve their course grades. In addition, the highest scoring students actually attempted and completed more of that work than did the other students. It is worth noting again that students could have improved their final course evaluation by more than a full letter grade by completing the available extra-credit assignments. Furthermore, the extra credit was guaranteed if the students did the assignments; there was no way not to earn the extra credit except not to do it, a point that was reiterated several times to the students at the time they were making their choices. (The students were also periodically reminded of this point during the semester and to complete their extra-credit activities.) Finally, because the content of the extra-credit assignments was related to less than 1% of the exam questions, it is unlikely that the relationship between completing extra-credit assignments and students' grades was spurious.

GENERAL DISCUSSION

Study 1 used a modification of a well-established procedure for assessing people's choices for rewards devalued by delays to their receipt. This study showed that the highest scoring students discounted the value of hypothetical, delayed, noncontingent rewards less than did lower achieving students. Study 2 devalued rewards by requiring different amounts of work to earn different amounts of extra credit. In this naturalistic study, we sought to examine the generality of Study 1's results by presenting students with real alternatives related to response-contingent academic rewards. In accordance with the results of the first study, the second study showed that the highest scoring students chose to do and actually did more extra-credit work than their lower scoring classmates (see also Hardy, 2002). Together, these outcomes suggest a fundamental difference between the highest scoring and other students—namely, the degree to which they discount devalued rewards.

It is possible, though, that a variable other than discounting devalued rewards underlies the current results. For example, lower scoring students' choices may reflect (1) their sensitivity to the likelihood that they will have difficulty with academic work (e.g., Pintrich & de Groot, 1990), (2) a history of not being rewarded for hard work (Eisenberger, 1992), (3) an anticipation of having less free time for extra-credit work than higher scoring classmates would have, and/or (4) having less initial interest in psychology than their higher scoring classmates. Any or all of these reasons could motivate students to choose fewer extra-credit options and to devote less time to completing the extra-credit options for which they do contract. Although any of these factors might explain why lower scoring students discount devalued (effortful) rewards more than higher scoring students do, none of the factors explains the choices made in Study 1, which were unrelated to difficulty with academic work, a past history of not being rewarded for effortful work, perceptions of free time, or initial interest in the subject matter. Because similar differences between the highest and lower scoring students were evident in Studies 1 and 2, which were otherwise quite dissimilar, it is parsimonious to explain the results of both studies by the variable that unites them: Higher and lower scoring students differ in the degree to which they discount devalued rewards, regardless of whether the devaluation results from a delay to the reward or from requiring increasingly more effort to earn the reward, and regardless of whether discounting is measured by giving participants a series of choices between two alternatives or a single choice between multiple alternatives.

These results might have implications for academic interventions to assist lower scoring students. Some analyses and research suggest that when working with lower scoring students, it is helpful to assist them in improving their academic self-efficacy or to assist them in developing academic management and self-regulation skills (Hattie, Biggs, & Purdie, 1996; Hofer & Lu, 2003). Whereas such training might help some students, it would seem that lower scoring students' tendency to discount delayed or effortful rewards, such as future grades, might be a more fundamental problem (cf. Steinberg, Dornbusch, & Brown, 1992). To address this issue, efforts might be directed at working with lower scoring students to alter the amount they discount grades relative to the amount of effort expended to achieve the grades they apparently want. That is, perhaps students would benefit more from self-control training (Logue, 1995; Martin & Pear, 2003) and courses whose structures promote steady rates of work leading to large rewards (e.g., courses that use a personalized system of instruction or contracting system; see Buskist, Cush, & DeGrandpre, 1991, and Pear & Crone-Todd, 1999).

REFERENCES

Ainslie, G. (1974). Impulse control in pigeons. *Journal of the Experimental Analysis of Behavior*, **21**, 485-489.

Buskist, W., Cush, D., & DeGrandpre, R. J. (1991). The life and times of PSI. *Journal of Behavioral Education*, **1**, 215-234.

Critchfield, T. S., & Kollins, S. H. (2001). Temporal discounting: Basic research and the analysis of socially important behavior. *Journal of Applied Behavior Analysis*, **34**, 101-122.

Davids, A., & Sidman, J. (1962). A pilot study: Impulsivity, time orientation, and delayed gratification in future scientists and in underachieving high school students. *Exceptional Children*, **29**, 170-174.

Eisenberger, R. (1992). Learned industriousness. *Psychological Review*, **99**, 248-267.

Green, L., Fry, A. F., & Myerson, J. (1994). Discounting of delayed rewards: A life-span comparison. *Psychological Science*, **5**, 33-36.

Hardy, M. S. (2002). Extra credit: Gifts for the gifted? *Teaching of Psychology*, **29**, 233-234.

Hattie, J., Biggs, J., & Purdie, N. (1996). Effects of learning skills interventions on student learning: A meta-analysis. *Review of Educational Research*, **66**, 99-136.

Hofer, B. K., & Lu, S. L. (2003). Teaching self-regulated learning through a "learning to learn" course. *Teaching of Psychology*, **30**, 30-33.

Johnson, M. W., & Bickel, W. K. (2002). Within-subject comparison of real and hypothetical money rewards in delay discounting. *Journal of the Experimental Analysis of Behavior*, **77**, 129-146.

Logue, A. W. (1988). Research on self-control: An integrating framework. *Behavioral & Brain Sciences*, **11**, 665-679.

Logue, A. W. (1995). *Self-control: Waiting until tomorrow for what you want today*. Upper Saddle River, NJ: Prentice-Hall.

Logue, A. W., & Anderson, Y. D. (2001). Higher-education administrators: When the future does not make a difference. *Psychological Science*, **12**, 276-281.

Martin, G. L., & Pear, J. J. (2003). *Behavior modification: What it is and how to do it* (7th ed.). Upper Saddle River, NJ: Prentice-Hall.

Merrell, K. (1990). Teacher ratings of hyperactivity and self-control in learning-disabled boys: A comparison with low-achieving and average peers. *Psychology in the Schools*, **27**, 289-296.

Myerson, J., Green, L., & Warusawitharana, M. (2001). Area under the curve as a measure of discounting. *Journal of the Experimental Analysis of Behavior*, **76**, 235-243.

Pear, J. J., & Crone-Todd, D. E. (1999). Personalized system of instruction in cyberspace. *Journal of Applied Behavior Analysis*, **32**, 205-209.

Pintrich, P. R., & de Groot, E. V. (1990). Motivational and self-regulated learning components of classroom performances. *Journal of Educational Psychology*, **82**, 33-40.

Rachlin, H. (2000). *The science of self-control*. Cambridge, MA: Harvard University Press.

Rachlin, H., & Green, L. (1972). Commitment, choice, and self-control. *Journal of the Experimental Analysis of Behavior*, **17**, 15-22.

Rachlin, H., Raineri, A., & Cross, D. (1991). Subjective probability and delay. *Journal of the Experimental Analysis of Behavior*, **55**, 233-244.

Read, D. (2001). Is time-discounting hyperbolic or subadditive? *Journal of Risk & Uncertainty*, **23**, 5-32.

Richards, J. B., Zhang, L., Mitchell, S. H., & de Wit, H. (1999). Delay or probability discounting in a model of impulsive behavior: Effect of alcohol. *Journal of the Experimental Analysis of Behavior*, **71**, 121-143.

Rothblum, E. D., Solomon, L. J., & Murakami, J. (1986). Affective, cognitive, and behavioral differences between high and low procrastinators. *Journal of Counseling Psychology*, **33**, 387-394.

Silva, F. J. (2003). [Student attitude questionnaire]. Unpublished raw data.

Steinberg, L., Dornbusch, S. M., & Brown, B. B. (1992). Ethnic differences in adolescent achievement: An ecological perspective. *American Psychologist*, **47**, 723-729.

VanZile-Tamsen, C., & Livingston, J. A. (1999). The differential impact of motivation on the self-regulated strategy use of high- and low-achieving college students. *Journal of College Student Development*, **40**, 54-60.

Winne, P. H. (1997). Experimenting to bootstrap self-regulated learning. *Journal of Educational Psychology*, **89**, 397-410.

NOTE

1. This analysis circumvents having to make decisions about curve-fitting such as whether a hyperbolic, exponential, subadditive, or other equation fits the data best, whether to include or exclude a student's data on the basis of the percentage of variance account for a particular fit, and so forth (e.g., Critchfield & Kollins, 2001; Johnson & Bickel, 2002; Read, 2001; Richards, Zhang, Mitchell, & de Wit, 1999). For an alternative to using the mean, median, and geometric mean, see Myerson, Green, and Warusawitharana (2001).

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