Delay Discounting of Self-Determined and Experimenter-Determined Commodities

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Abstract

Research suggests that individuals prefer self-determined reinforcers over experimenter-determined ones. The present study had 518 college students complete a delay-discounting task in which the commodity was cigarettes, a grocery store gift card, casino tokens, cash, or the choice of the four. The least amount of delay discounting was observed for the group that was given a choice, although the difference was not significantly different from two of the individual commodities (casino tokens & cash). The results support the conclusion that participants place a high value on having choice. These results have practical implications for teachers, researchers, and/or businesses who want to provide incentives for their students, participants, or customers, respectively. The results also highlight the usefulness of measuring delay discounting.
Keywords: Delay discounting, Self determination, Value, College sample

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Self determination has long been a concept of great interest to psychologists. For instance, self determination was a critical concept in the person-centered therapy and theory of personality that was forwarded by Carl Rogers (Patterson & Joseph, 2007). More recently, self-determination theory has emerged (e.g., Deci & Ryan, 2008) as a general theory of human behavior and motivation that has been applied in a wide variety of situations (e.g., education, Kaufman & Dodge, 2009; worker satisfaction & productivity, Kuvaas, 2009). The common theme related to self determination is that it is a good thing; people are happier, more motivated, and more productive when they can exercise self determination than when they cannot.

Although behavioral psychologists have historically eschewed internal or personality variables as explanations for behavior, they too have explored the idea that situations that involve self determination are functionally different than situations that do not involve self determination. For instance, Graff, Libby, and Green (1998) found that participant-selected reinforcers maintained higher rates of free-operant responding, and produced less challenging behaviors, than did experimenter-selected reinforcers in two male participants with severe developmental disabilities. Geckeler, Libby, Graff, and Ahearn (2000) failed to replicate this effect on free-operant responding in three boys with Autism, but did find that when participant- and experimenter-selected reinforcers were available in a concurrent-choice procedure, all three boys showed a response preference for the alternative that allowed them to choose their own reinforcer. These results replicated those of a previous study (i.e., effect of self-determined choice only in the concurrent-schedule situation; Graff & Libby, 1999), which had studied four boys with either developmental disabilities or attention-deficit disorder.

More recently, Tiger, Hanley, and Hernandez (2006) studied the effect of reinforcer choice on the behavior of preschool children. Results indicated that five of the six children showed an initial preference for choosing their own reinforcer, although this preference did not persist throughout the entire condition for several of the children. Tiger et al.'s fourth study demonstrated that the children continued to choose the reinforcer-choice option despite the fact that the response requirement for doing so was higher than the no-choice reinforcer option.

Overall, these studies support the idea that an outcome that allows the individual to determine his/her own reinforcing consequences can be a more effective or preferred reinforcer than the identical outcome that is not chosen by the individual.

Determining whether outcome choice is indeed a more powerful reinforcing consequence than a predetermined outcome has a number of potential implications, especially if that outcome can be demonstrated in an adult sample. For instance, the implication for individuals in the field of marketing would be that offering potential customers a self-chosen prize for visiting a business or website might be a more effective promotion than simply offering a predetermined prize. Instructors might find that students' work improves if their efforts result in a self-chosen outcome rather than an instructor-chosen outcome. Researchers who employ human participants in laboratory studies with the incentive of winning a prize (e.g., a gift card) for good performance may find improved performance if participants are offered a self-determined reward rather than an experimenter-chose one.

The study of delay discount affords one measure of the value of an outcome or commodity. Delay discounting occurs when the value of an outcome is devalued because it is delayed in time. For instance, if someone owed you $100 but was not going to be able to pay you for a month, you might accept $95 immediately rather than waiting a month for the full amount. If so, that outcome would indicate that the delay of one month has discounted the value of the $100 by at least 5%. The typical outcome is that the longer the delay to the full amount of a particular outcome, the more individuals tend to discount its value (e.g., see Chapman, 1996; Beck & Triplett, 2009).

There are multiple ways to measure delay discounting. One is to ask participants to make a series of binary choices (e.g., would you prefer $95 today or $100 in one month; e.g., see Smith & Hantula, 2008) where the amount of the immediately available commodity is adjusted across choices. The subjective value of the commodity at that delay is determined at the point at which the participant switches from preferring the delayed commodity to the immediate one. By making such determinations across different delays, one can calculate a "discounting curve," which determines the "rate" of discounting. Other methods include having the participant identify the indifference point at each delay from a series of experimenter-presented choices (e.g., Beck & Triplett, 2009) or having the participant self generate the indifference point (i.e., the fill-in-the-blank method; e.g., Chapman, 2009).

One factor known to systematically alter rates of delay discounting is the absolute value of the commodity or outcome, a finding that has been labeled the *magnitude effect* (Chapman, 1996; Thaler, 1981). For instance, in the above example, the delay of one month decreased the relative value of $100 by at least 5%. However, if the amount of money you were owed was $10,000 rather than $100, research suggests that you would be less likely to discount that amount by 5% (i.e., $500) over a month. In general, the research literature supports the finding that the higher the value of the commodity or outcome, the less individuals discount it when it is delayed. With that being the case, the measure of delay discounting can be considered a dependent variable for the value of a particular commodity or outcome.

If a self-determined choice of outcome has a higher value than a predetermined outcome, then that difference should be reflected in the rate at which individuals discount those outcomes when they are delayed. The present study was designed to investigate this prediction. A sample of college students was recruited to complete a delay-discounting task. The hypothetical commodity involved in the task varied across groups. For four of the groups, there was one experimenter-determined commodity, which was always valued at $100. The commodity for the fifth group was their choice of the four commodities. Given the theoretical and empirical research that suggests that self-determined choices have a higher value than predetermined ones, we predicted that participants in the choice group would display the least delay discounting relative to participants in the other groups, who were faced with a predetermined commodity.

Method

Participants

The original sample of participants was 571 undergraduates psychology students enrolled at the University of North Dakota. Participants from this original sample were excluded if they failed to complete all of the questions on the delay-discounting task (or provided a value of $0 for every option). When these respondents were excluded, the final sample consisted of 518 participants (330 females, 188 males). The mean age of these participants was 19.61 years (SD = 2.10 years) and they reported a mean grade point average of 3.17 out of 4.00 (SD = 0.55). The vast majority of respondents self identified as Caucasian (472; 91.1%), with 14 (2.7%) individuals self identifying as American Indian, 23 (4.4%) as Asian, Black, or other ethnic minority, and 9 (1.7%) not providing a response. Four hundred ninety five (95.6%) participants reported being single or in a relationship, 10 (1.9%) reported being married, 2 (0.4%) reported being divorced or widowed, and 11 (2.1%) failed to provide a response. In terms of annual income, 453 participants (87.5%) reported an annual income of less the $10,000 per year, 38 (7.3%) reported an annual income between $10,000 and $25,000, 9 (1.7%) reported an annual income above $25,000, and 18 (3.5%) did not provide a response.

Materials and Procedure

Participants completed the study in their psychology class. Each participant received a packet that included three items. The first was an informed consent form, as approved by the Institutional Review Board at the University of North Dakota, that outlined the study and the expectations / risks involved. The second was a demographic survey that asked about the information reported above. The third was a delay-discounting task.

The commodities involved in the delay-discounting task were $100 in cigarettes, a grocery store gift card worth $100, $100 in casino tokens, $100 in cash, or the participant's choice of those four commodities. The exact phrasing of the question(s) used in the discounting task can be found in the Appendix. The present study employed the fill-in-the-blank method for measuring delay discounting (Chapman, 1996; Smith & Hantula, 2008; Weatherly, Derenne, & Terrell, in press). With this particular method, the participant is asked to generate and provide a specific amount of the particular commodity that s/he would accept immediately rather than waiting a certain amount of time for the full amount. The present study utilized five time delays (one week, one month, six months, one year, and five years). Thus, the delay-discounting task

consisted of five questions. For each commodity (group), the order of the questions was randomly determined (independently across commodities / groups) and all participants completing the task for that particular commodity answered the questions in the same random order. Further, distribution of the different questionnaire packets was done randomly within each class. In other words, when the packets were distributed within a particular class, approximately an equal number of respondents were completing the delay-discounting task for each of the five commodities / groups.

Data Preparation

Several legitimate methods exist to analyze data from delay-discounting tasks. One is to fit the indifference points (i.e., in the present study, the values provided by the respondents) with the following hyperbolic equation (e.g., Mazur, 1987):

$$V = A / (1 + kD) \quad \text{(Equation 1)}$$

In Equation 1, V is the subjective value of the delayed outcome, A is the amount of the commodity, D is the delay to the full amount of the commodity, and k is a free parameter that describes the rate of delay discounting. High values of k indicate steep rates of (i.e., more) discounting; low values indicate little or no discounting.

A second method is to determine the area under the curve (AUC) that is created by the indifference points across the different delays. AUC can be determined with the following equation (Myerson, Green, & Warusawitharana, 2001):

$$(x_2 - x_1)\ [(y_1 + y_2)/2] \quad \text{(Equation 2)}$$

When using Equation 2, the value of AUC can vary between 0.0 and 1.0. Low values of AUC indicate a great amount of discounting of the commodity; high values represent little or no (i.e., 1.0) discounting.

Although Equation 1 has been used in numerous studies on delay discounting, the present study utilized Equation 2 and AUC as the dependent measure. We did so for several different reasons. First, as outlined by Myerson et al. (2001), Equation 1 assumes that the pattern of delay discounting will follow a certain (hyperbolic) form. Equation 1 has successfully described numerous published data sets, but we had no theoretical reason to assume that the present data would be hyperbolic in nature and Equation 2 does not presume the data will follow a certain pattern. Second, k in Equation 1 has a lower, but no upper, bound, which commonly results in a skewed distribution that requires data transformation before parametric analyses can be conducted. AUC in Equation 2, on the other hand, does not pose this problem. Third, and perhaps most importantly, Equation 1 did not provide a good fit for many of the respondents' data. Specifically, Equation 1 accounted for less than 70% of the variance in the delay-discounting data for 365 of the 518 participants. It accounted for over 90% of the variance for only 63 participants. Because of this poor fit, we determined that utilizing Equation 2 and AUC would be the most conservative approach.

Results

The initial step in data analysis was to apply the exclusion criteria to the sample (described above). After applying the criteria, the number of participants who completed the delay-discounting task for cigarettes, the grocery story gift card, casino tokens, cash, or their choice of those four commodities was 94, 117, 106, 110, and 89, respectively. Figure 1 presents the mean AUC that was observed for each commodity / group. As predicted, the least amount of discounting (i.e., highest AUC value) was observed for the group who had their choice of the four commodities. However, the absolute difference between the AUC values for this group and for several of the other commodities / groups was not large.

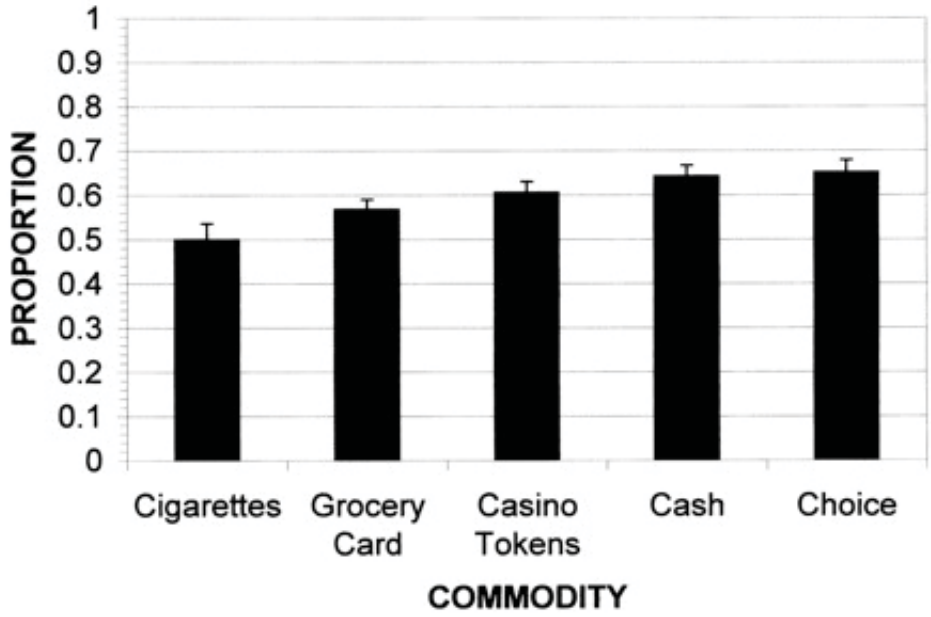

Figure 1. Presented is the mean AUC value for each commodity / group. The error bars represent one standard error of the mean for that particular commodity / group.

Results from statistical analyses were consistent with these visual impressions. A one-way analysis of variance conducted on participants' AUC values in each group resulted in a significant main effect of group, $F(4, 513) = 4.78$, $p = .001$, $\eta^2 = .036$. Planned pairwise comparisons confirmed that participants in the choice group displayed significantly less delay discounting than participants in the cigarette ($p < .001$) and grocery story gift card ($p = .033$) groups, but did not significantly differ in their amount of delay discounting relative to the casino tokens ($p = .255$) or cash ($p = .824$) groups. Results from these analyses were considered significant at $p < .05$.

Discussion

The present study was designed to determine whether less delay discounting would occur when the commodity involved a choice of items than when the commodity was a single item.

Such an outcome was observed, although the difference in discounting between the choice commodity and two of the individual items was not statistically significant. Overall, these results support the conclusion that choice (i.e., self determination) of an outcome can have a greater value to individuals than the same outcome when it is not self determined.

One could potentially argue that the difference between the choice group and the cigarettes group may be linked to the fact that few of the participants smoke and therefore the cigarettes had little or no value to begin with. Other studies from our laboratory have also found that participants discount cigarettes to a greater extent than many other commodities (including money; see Weatherly et al., in press b). However, the counterargument that can be made with the current procedure is that all items were scaled in terms of the same monetary value (i.e., $100). Additionally, the indifference points that the participants provided were in dollars, not in cigarettes. That is, participants were not asked how many cigarettes they would accept, but rather how much money they would accept immediately rather than waiting for the $100 in cigarettes.

Finding that significantly more discounting was observed for the grocery store gift card than for the choice group has several practical implications. Offering gift cards as an incentive (e.g., for research participation; e.g., Dillen & Dixon, 2008) has become relatively common practice. The present results suggest that such an incentive may be less than its face value. Phrased differently, if researchers want to continue to use this practice, they might find that an increased incentive is a choice of different types of gift cards (e.g., to different retailers). In fact, by offering a choice of different cards, researchers may find that the monetary value of the gift cards can be reduced (e.g., $20 cards instead of $25 cards) without decreasing the incentive that they provide. However, given the present results, perhaps a better solution when possible would be to provide participants with cash as an incentive (e.g., McDougall, Terrance, & Weatherly, in press).

As for why the gift card was discounted to a greater extent than the cash or choice options, the explanation may itself be linked to delay discounting. Whereas cash can be spent immediately, gift cards present an additional delay in that one must go to the grocery store to collect the gift card's value. However, two issues should be noted when considering the legitimacy of this possible explanation. One is that participants differed in how they discounted the $100 gift card and the $100 in casino tokens, both of which would seem to invoke a similar additional delay in obtaining their actual value. Next, as with cigarettes, participants were asked how much cash they would accept immediately rather than waiting for the gift card.

Failing to find a significant difference in discounting between the choice group and the casino tokens group may be somewhat surprising for several reasons. For one, the vast majority of the present sample was below the legal age to gamble in North Dakota (i.e., 21 years of age). Furthermore, the nearest casino is over 50 miles from campus. Despite these facts, the participants basically treated the casino tokens as equivalent to cash money. Then again, given the popularity of gambling (see Petry, 2005, for a review), perhaps such a result should not be considered unexpected.

The failure to find a significant difference between the choice and cash groups may be less than surprising. In fact, one could possibly argue that the cash group was also a choice group. That is, with cash, one could obtain any of the other three commodities employed in the present study. Thus, if one is trying to provide an incentive and cannot reasonably provide a self-determined choice of incentive, then offering cash may be the best option.

The failure to find a significant difference between the discounting rates in the self-determined commodity group and the casino-token and cash groups may in fact help address the issue of what is the underlying value of self determination. One argument would be that, by allowing self determination across successive trials / choices, one can negate the decrease in reinforcer effectiveness that would be expected through the process of habituation (e.g., McSweeney & Murphy, 2009). A second argument is that by allowing choice among alternative reinforcers, the respondent always has the option of choosing his/her preferred reinforcer (e.g., participants in the choice group in the present study were mentally choosing cash). Although not definitive, given that the participants in the present experiment A) were choosing among hypothetical outcomes and B) made only five choices overall, the present results would seem to favor the latter, rather than the former, explanation.

For researchers in the field of delay discounting, the failure of Equation 1 to adequately fit the present data is worth noting. The present study utilized the fill-in-the-blank method for measuring discounting. Prior studies have used this technique and found that Equation 1 provided an adequate fit to the data (e.g., Smith & Hantula, 2008). However, several studies from our laboratory (e.g., Weatherly, Derenne, & Terrell, 2010, in press; Weatherly, Terrell, & Derenne, 2010) have utilized this method and, to date, Equation 1 has failed to provide adequate fits to any of those data sets. These failures may represent weaknesses in the fill-in-the-blank method, in Equation 1 to describe delay discounting, or both. Regardless, researchers who are intent on using Equation 1 as their dependent measure may want to choose another technique for collecting delay-discounting data (e.g., the binary-choice method; see Smith & Hantula, 2008). Researchers who are intent on using the fill-in-the-blank procedure should be forewarned that they may need an alternative measure of discounting other than Equation 1.

The present study may have translational value for individuals or businesses who are trying to provide an incentive for people. First of all, studying how people discount certain consequences or commodities may provide an indirect measure of what people value, which may provide a more accurate piece of information than asking the people directly. Secondly, the present results suggest that one may be able to save resources. That is, by offering people a choice of reward, one may find that smaller rewards maintain just as much behavior as larger rewards when only one reward is offered. With that said, the present results also support the conclusion that providing a choice will not always increase the value of the outcome, as was documented by the non-significant differences in discounting between the choice, casino-tokens, and cash groups. It is also the case that the present study employed only college students, so research on other adult populations would be warranted before broad conclusions are made. Further, it should be noted that although significant differences were found in the present study, the effect size that was observed was small (Cohen, 1988). Thus, choice of the outcome was only a small, albeit significant, influence on the observed rates of delay discounting.

With that said, the present procedure was easily conducted, taking participants less than five minutes to complete. People interested in determining what incentives might work in their particular situation may wish to adopt a delay-discounting procedure. Doing so could potentially provide them, both quickly and easily, with the information they desire.

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Appendix

in X = (A) in cash, (B) in casino tokens, (C) in cigarettes, (D) gift card for a local grocery story, or (E) in cash, $100 in casino tokens, $100 worth of cigarettes, or a $100 gift card for a local grocery store.

Y time = one week, one month, six months, one year, or five years

Question

You have won a raffle in which the prize is $100 *in X*. However, it will be *Y time* before you receive the prize. What is the smallest amount of money you would accept today rather than having to wait *Y time* for your prize?
