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A 5-Trial Adjusting Delay Discounting Task: Accurate Discount Rates in Less Than One Minute

Mikhail N. Koffarnus and Warren K. Bickel
Virginia Polytechnic Institute and State University

Individuals who discount delayed rewards at a high rate are more likely to engage in substance abuse, overeating, or problem gambling. Such findings suggest the value of methods to obtain an accurate and fast measurement of discount rate that can be easily deployed in variety of settings. In the present study, we developed and evaluated the 5-trial adjusting delay task, a novel method of obtaining a discount rate in less than 1 min. We hypothesized that discount rates from the 5-trial adjusting delay task would be similar and would correlate with discount rates from a lengthier task we have used previously, and that 4 known effects relating to delay discounting would be replicable with this novel task. To test these hypotheses, the 5-trial adjusting delay task was administered to 111 college students 6 times to obtain discount rates for 6 different commodities, along with a lengthier adjusting amount discounting task. We found that discount rates were similar and correlated between the 5-trial adjusting delay task and the adjusting amount task. Each of the 4 known effects relating to delay discounting was replicated with the 5-trial adjusting delay task to varying degrees. First, discount rates were inversely correlated with amount. Second, discount rates between past and future outcomes were correlated. Third, discount rates were greater for consumable rewards than with money, although we did not control for amount in this comparison. Fourth, discount rates were lower when $0 amounts opposing the chosen time point were explicitly described. Results indicate that the 5-trial adjusting delay task is a viable, rapid method to assess discount rate.

Keywords: delay discounting, intertemporal choice, amount effect, adjusting amount task, college students

A delayed reward is valued less than that same reward made available immediately, a process known as delay discounting. Individuals who discount delayed rewards at a relatively high rate are more likely to exhibit a range of unhealthy behaviors, including but not limited to drug abuse or dependence (Bickel & Marsch, 2001; Reynolds, 2006), overeating (Weller, Cook, Avsar, & Cox, 2008), and problem gambling (e.g., Petry & Casarella, 1999). As research integrating decision-making patterns in general—and delay discounting specifically—with unhealthy behavior has grown, measuring an individual's discount rate in a variety of contexts has become increasingly desirable. However, traditional intertemporal choice tasks to measure discount rate have practical limitations that preclude their use in certain contexts.

Discount rate is typically measured with intertemporal choice tasks that present a series of discrete choices between a larger quantity of a reward that is delayed and a smaller amount of that commodity that is available immediately. Researchers have employed a variety of algorithms to dictate how these choices are arranged. Commonly, a series of immediately available amounts are offered as options against a constant, larger amount at a defined delay.

These smaller immediate amounts are sometimes drawn from a predefined list of amounts (e.g., Madden, Petry, Badger, & Bickel, 1997) or, more commonly, adjusted based on the individual's choices to identify the point of indifference between the smaller immediate amount and the larger delayed amount (e.g., Du, Green, & Myerson, 2002). These procedures are then repeated for a number of delays, yielding a series of indifference points across delays.

Series of indifference points have been shown to take on a hyperbolic or hyperbolic-like shape as a function of delay (Ainslie, 1975; Mazur, 1987; Green & Myerson, 2004; Rachlin, 2006). Among the specific functions that have been proposed to best describe the shape of discounting curves, one proposed by Mazur (1987) is the most commonly used in the addiction field (see MacKillop et al., 2011) and has the attractive feature of containing a single free parameter that describes an individual's discount rate:

$$V = \frac{A}{1 + kD} \tag{1}$$

where V, the current value of a reinforcer, is a function of the nominal amount of that reinforcer (A), the delay to the delivery of the reinforcer (D), and the discount rate (k).

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Mikhail N. Koffarnus and Warren K. Bickel, Virginia Tech Carilion Research Institute, Virginia Polytechnic Institute and State University.
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Correspondence concerning this article should be addressed to Mikhail N. Koffarnus, Addiction Recovery Research Center, Virginia Tech Carilion Research Institute, 2 Riverside Circle, Roanoke, VA 24016. E-mail: mickyk@vt.edu

This general strategy for obtaining a discount rate has been used successfully in numerous situations, but poses limitations in certain settings. First, typical discounting tasks require a large number of choice trials, which can be time consuming and tedious for individuals with limited attention. Even tasks that use an adjusting algorithm to limit the number of choice trials per delay contain approximately 35 trials and are typically 3 or more minutes in duration (e.g., see Time to Task Completion, Figure 3). Tasks that use a predetermined series of choice trials contain many more trials. Although 3 min is not prohibitive in many contexts, this amount of time can become limiting when participants have a limited attention span, available measurement time is very short, or when the research questions require the administration of many discounting tasks to each participant. A brief discounting assessment, the Monetary Choice Questionnaire (Kirby, Petry, & Bickel, 1999), is commonly used when measurement time is of a concern and is correlated with the adjusting amount procedure (Epstein et al., 2003), but this questionnaire still employs a similar number of choice trials (27) as the adjusting amount procedure and is only designed to assign participants one of 10 discrete k values instead of determining k along a continuum of possible values. Because they have a similar number of choice trials and the adjusting amount procedure allows for a more thorough examination of the discounting curve, the adjusting amount task was chosen as a comparison task in the present study.

As has been discussed previously (Yoon & Higgins, 2008), 1/k is equal to the delay (D) where the current value of a reinforcer (V) is half of its nominal amount (A). This delay, also called the Effective Delay 50% (ED_{50}) is more intuitively understandable as a measure of discount rate and is easily converted from or to a k value. This relationship also suggests that an assessment to directly measure an individual's ED_{50} value for a commodity would be an effective measure of that individual's discount rate for that commodity. With this in mind, we developed the 5-trial adjusting delay task, a brief, flexible discounting measurement that directly assesses ED_{50} and therefore discount rates, and can be easily adapted for use with most any amount of any commodity. This task is an adjusting delay task, which is conceptually similar to the adjusting amount task described above, except the delays are adjusted in a series of trials while the amounts are held constant. Although not commonly used in human participants, adjusting delay tasks are common in the animal literature and have been shown to produce results comparable to adjusting amount tasks (Green, Myerson, Shah, Estle, & Holt, 2007). An adjusting delay task is ideally suited for the direct assessment of an ED_{50} value, but also has the advantage that amount is not adjusted and, therefore, is not required to be divisible into many subunits.

Adjusting amount discounting tasks often require awkward or unfamiliar amounts of a commodity to appear as choice options because many discrete amounts must be available as choices to accurately resolve an indifference point at a given delay. In the adjusting amount task with 5 questions per delay, the larger quantity of the commodity being discounted must be at least 32 (2^5) times the lowest divisible unit that is interpretable. Dividing the commodity into many subunits is not a problem for monetary discounting because specific monetary amounts are meaningful and commonly encountered in daily life (e.g., $427.36). However, when examining discounting of commodities not easily divisible into small subcomponents (e.g., vacations), one is faced with presenting participants with a large number of whole units of the commodity (e.g., 50 vacations) or fractions of the commodity (e.g., 0.13 vacations), both of which are awkward and may not hold value that is proportional to a whole, single unit of that commodity.

Conversely, only delay duration is adjusted in adjusting delay tasks such as the 5-trial adjusting delay task, and, like money, time is easily divisible into many subunits that are familiar to participants and straightforward to interpret. Using this task, for example, a discount rate for two vacations (with the smaller immediate option consistently one vacation) could be obtained.

In the present experiment, we sought to determine if discount rates obtained from the 5- trial adjusting delay task were similar to those obtained with a lengthier task, and whether some manipulations known to affect discount rate could be replicated with the 5-trial adjusting delay task. The first effect we chose to replicate was the amount effect, wherein larger sums of money are typically discounted at a lower rate than lower sums of money (Green, Myerson, & McFadden, 1997). Second, past reinforcers are typically discounted at a similar rate as future reinforcers with discount rates correlated across individuals (Bickel, Yi, Kowal, & Gatchalian, 2008; Yi, Gatchalian, & Bickel, 2006). Third, consumables such as food are typically discounted at a higher rate than generalized reinforcers such as money (Estle, Green, Myerson, & Holt, 2007; Jimura, Myerson, Hilgard, Braver, & Green, 2009). Fourth and finally, if choices within a discounting task are worded such that the amount of money to be received immediately and after a delay, including zero values, is made explicit for both choice options (e.g., "$500 now and $0 in 1 week" vs. "$0 now and $1,000 in 1 week," as opposed to the typical phrasing of "$500 now" vs. "$1,000 in one week"), discount rates are lower (Magen, Dweck, & Gross, 2008; Radu, Yi, Bickel, Gross, & McClure, 2011). We hypothesized that (a) each of these four effects would be replicated with the 5-trial adjusting delay task, (b) discount rates for the same commodity obtained with the 5-trial adjusting delay task and the adjusting amount task would be correlated, and (c) absolute discount rates for the same commodity would be similar with the 5-trial adjusting delay task and the adjusting amount task.

Method

Participants

Participants (N = 111) were recruited from undergraduate psychology courses at Virginia Polytechnic Institute and State University (Blacksburg, VA). To be eligible, participants were required to be at least 18 years of age. After participating in the study, participants received extra credit in their psychology course.

This study protocol was approved by the Virginia Tech Institutional Review Board.

Experimental Design

After reviewing a study information sheet with consent information, participants completed a brief questionnaire of demographic characteristics and cigarette and alcohol use. Participants then completed a series of discounting tasks on a laptop computer. Responses on these tasks were recorded on two-button response device placed in front of the participant, and tasks were presented in a randomized order.

Adjusting Amount Discounting Task

The adjusting amount discounting task uses an adjusting algorithm to determine the amount of immediately available money that is equivalent to $1,000 that is delayed by seven discrete durations of time presented in a randomized order (i.e., 1 day, 1 week, 1 month, 6 months, 1 year, 5 years, and 25 years). At each delay, a choice is first presented between the delayed $1,000 and $500 available immediately. For each trial, the position of the delayed and immediate amounts are randomly assigned the left or right portion of the screen, and the participant chooses the preferred option by pressing the corresponding left or right response button. Depending on the choice made by the participant, the immediate amount then adjusts up (delayed choice) or down (immediate choice) by $250 and a new choice is presented. This continues for five choice trials per delay, with the immediate amount adjusting by an amount half that of the previous adjustment. This results in 32 potential indifference points (2^5) evenly spaced between $0 and $1,000.

5-Trial Adjusting Delay Task

The 5-trial adjusting delay task was created as a way to quickly assess an individual's discount rate with the flexibility to be used with a variety of commodities and situations. This task directly measures the ED_{50} value for a given commodity, a value that is a simple inverse of the discount rate (Yoon & Higgins, 2008). This is done by presenting a series of questions between some amount of a delayed commodity and half that amount available immediately. These amounts remain stagnant while the delay to the larger amount is adjusted to determine the ED_{50} value. The delay series and other parameters are shown in Table 1. The specific delays were chosen to be those that are conveniently formatted as whole (or half when necessary) integers of common durations of time and to result in a series of ED_{50} values that is as evenly distributed as possible on a logarithmic scale. This second consideration was included because k values, and therefore ED_{50} values, are normally distributed in most populations when logarithmically transformed (e.g., Yi et al., 2006). The first choice trial is always between amount of the commodity delayed 3 weeks and of the same commodity available immediately. For the purpose of explanation, the discrete delays are assigned ordinal indexes in Table 1, with the first choice trial being Index 16. Depending on the choice made by the participant, the delay either adjusts up (delayed choice) or down (immediate choice) by eight delays (Index 8 or 24) for the next choice trial. This continues for five choice trials, with the delay index adjusting by an amount half that of the previous adjustment. This results in 32 potential ED_{50} values (2^5) nearly evenly spaced (on a logarithmic scale) between 1 hr and 25 years,

Table 1
Parameters of the Possible Individual Choice Trials in the 5-Trial Adjusting Delay Task

			ED_{50} (days) if last choice is:		k if last choice is:	
Index	Delay choice	No.	Immediate	Delayed	Immediate	Delayed
1	1 hr	5	0.04167	0.05893	24.0	17.0
2	2 hr	4				
3	3 hr	5	0.1021	0.1444	9.79	6.93
4	4 hr	3				
5	6 hr	5	0.2041	0.3062	4.90	3.27
6	9 hr	4				
7	12 hr	5	0.4330	0.7071	2.31	1.41
8	1 day	2				
9	1.5 days	5	1.225	1.732	0.816	0.577
10	2 days	4				
11	3 days	5	2.450	3.464	0.408	0.289
12	4 days	3				
13	1 week	5	5.292	8.573	0.189	0.117
14	1.5 weeks	4				
15	2 weeks	5	12.12	17.15	0.0825	0.0583
16	3 weeks	1				
17	1 month	5	25.28	43.05	0.0396	0.0232
18	2 months	4				
19	3 months	5	74.56	105.4	0.0134	0.00949
20	4 months	3				
21	6 months	5	149.1	210.9	0.00671	0.004741
22	8 months	4				
23	1 year	5	298.2	516.5	0.00335	0.00194
24	2 years	2				
25	3 years	5	894.7	1265.	0.00112	0.000791
26	4 years	4				
27	5 years	5	1633.	2310.	0.000612	0.000433
28	8 years	3				
29	12 years	5	3579.	5368.	0.000279	0.000186
30	18 years	4				
31	25 years	5	7748.	9131.	0.000129	0.000110

Note. ED_{50} = Effective Delay 50%.

the same number of possible indifference points at each delay of the adjusting amount procedure above.

Participants completed this task six times for different commodities and delayed amounts. These included three versions in which the delayed amount was altered: \$10 delayed (vs. \$5 now), \$1,000 delayed (vs. \$500 now), and \$1,000,000 delayed (vs. \$500,000 now). Fourth, participants completed a version presenting choices between \$1,000 delivered at some point in the past and \$500 delivered 1 hour ago. Fifth, an "explicit zero" version was also included, which presented choices between \$1,000 delayed and \$500 now, but with the options presented differently. In this version, delayed options were presented as "\$1,000 in [delay] and \$0 now" versus "\$500 now and \$0 in [delay]." Sixth, a version of the task was completed presenting choices between 10 servings of the participant's preferred snack food delivered after a delay versus 5 servings now.

Data Analysis

For each task, two outcome variables were of primary interest: discount rate and time to completion. Discount rates for the adjusting amount task were obtained using the best-fit parameters of Equation 1 drawn through the indifference points in Microsoft Excel, 2010 release. A modification of criteria proposed by Johnson and Bickel (2008) to evaluate logical consistency of discounting was used to exclude data: participants' 1-day indifference point needed to be at least \$100 greater than their 25-year indifference point, and no more than one indifference point could be more than \$200 greater than the indifference point preceding it. Five participants were excluded for failing to meet these criteria. Data from all five of these participants were also not well fit by Equation 1, with r^2 values all less than 0. One additional participant was excluded despite meeting the Johnson and Bickel (2008) criteria for yielding an r^2 less than 0, because a k value obtained in such cases is not representative of a discount rate present in the underlying data, for 105 total participants for the adjusting amount task. Discount rates for the 5-trial adjusting delay task were calculated by taking the inverse of the obtained ED_{50} value, which is equivalent to the value of k in Equation 1 when fitted to this singular point. Discount rates were log-transformed for all data analyses, although the absolute discount rates are presented in this article for clarity. Time to task completion was calculated from the moment the instruction screen was dismissed for each task to the time that the choice was made by the participant in the final choice trial.

Statistics were computed in IBM SPSS Statistics, Version 21. Discount rates and time to completion for the different tasks were analyzed with generalized linear models using exchangeable correlation structures and generalized estimating equations to account for intrasubject correlation in repeated-measures data (Liang & Zeger, 1986). Participant gender, age, race, and number of drinks per week were entered into the statistical model along with task type. Cigarette smoking status was not entered into the model due to the low incidence of cigarette smoking in this sample (4%). Significance values for pairwise comparisons between tasks were adjusted with the sequential Bonferroni procedure to keep the family-wise Type I error rate to 0.05%. Reported p values reflect this adjustment. The principal component analysis was conducted with the minimum eigenvalue set to 1 and varimax rotation.

Results

At time of participation, participants (64% female) averaged 19.9 years of age (SD = 1.9). Sixty-seven percent were White, 19% were Asian or Pacific Islander, and the remaining 14% were other or mixed race. Four participants (4%) smoked cigarettes and 70% reported some consumption of alcohol, although few participants reported high levels of drinking, with a median drinks per week of 2. There was no main effect of gender, $\chi^2(1) = 3.1$, p = .07, age, $\chi^2(1) = 0.0$, $p = 1.0$, race, $\chi^2(2) = 3.1$, p = .2, or drinks per week, $\chi^2(1) = 2.2$, p = .1) on discount rate.

Comparison Between Task Types

There was a large overall main effect of task on discount rate, $\chi^2(6) = 807.5$, $p < .001$. Mean (SEM) discount rates obtained from each task are shown in Figure 1. Discount rates for \$1,000 of future money were obtained with the adjusting amount task and the 5-trial adjusting delay task to compare task types. A relatively small but consistent tendency observed in these data are for discount rates to be lower with the adjusting amount task ($M_{k\ \mathrm{geometric}}$ = 0.00142), 95% confidence interval (CI) [0.000987, 0.00203], than with the 5-trial adjusting delay task ($M_{k\ \mathrm{geometric}}$ = 0.00259), 95% CI [0.00178, 0.00378], a difference that was statistically significant ($p < .001$). Many differences between the commodities were observed within the 5-trial adjusting delay task. Discount rates for \$1,000,000 were lower than those for \$1,000 ($p < .001$), which were lower than those for \$10 ($p < .001$), replicating the amount effect. Discount rates in the \$1,000 explicit zero condition were also lower than those in the typical \$1,000 condition ($p < .001$), and discount rates for snack foods were above those for \$1,000 ($p < .001$), although they did not differ from discounting of \$10 (p = .1). In addition to these effects, pairwise comparisons for those commodity comparisons not specified above were also statistically significant ($ps < .013$).

Correlations Among Task Types

A correlation matrix relating each of the task types and commodities is presented in Table 2. Discount rates between the 5-trial

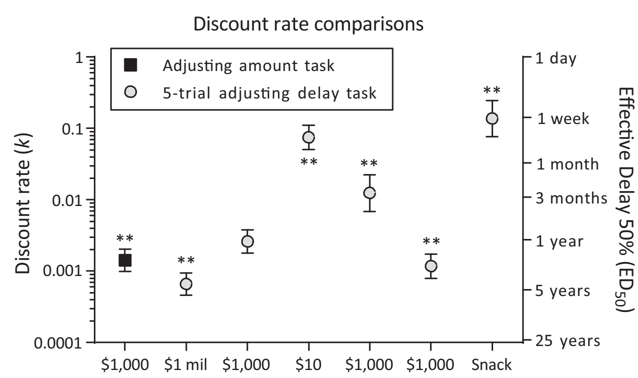

Figure 1. Mean discount rate and 95% confidence interval with each task variant (left axis) and corresponding Effective Delay 50% (right axis). Asterisks indicate a statistically significant difference from the \$1,000 5-trial adjusting delay task rate. Adj. Amt. = adjusting amount; Exp. = Explicit. ** $p < .001$.

Table 2
Pearson Correlations Among the Different Discounting Tasks and Commodities

Task	A	B	C	D	E	F
$1,000 adjusting amount	.49**	.67**	.43**	.43**	.53**	.11
A. $1,000,000 ADT		.67**	.41**	.49**	.44**	.14
B. $1,000 ADT			.47**	.47**	.38**	−.04
C. $10 ADT				.39**	.26*	.18
D. $1,000 past ADT					.32**	.00
E. $1,000 Exp. 0 ADT						.10
F. Snack food ADT						

Note. ADT = 5-trial adjusting delay task; Exp. = Explicit.
* $p < .05$. ** $p < .001$.

adjusting delay task and adjusting amount task were most highly correlated among the correlations observed ($r = .67$, $p < .001$; Figure 2), suggesting that the two tasks were measuring a similar construct. One of the effects we sought to replicate with the 5-trial adjusting delay task was the correlation observed between past and future discounting. In the present study, they correlated significantly with one another ($r = .47$, $p < .001$).

In addition to those correlations that directly tested our hypotheses, the correlations among all tasks are shown in Table 2. Independent of task type, monetary amount, or other framing of choice options, all of the monetary discounting tasks correlated significantly with each other (Pearson r range: .26−.67). Conversely, discount rates for snack foods did not significantly correlate with any of the monetary tasks, although the correlation between snack food and $10 approached statistical significance ($r = .18$, $p = .06$). A principal components analysis revealed two factors with factor loadings that confirm these two groupings of tasks. Discount rates from each of the monetary discounting tasks with amounts of $1,000 or more heavily loaded on one factor, while the snack food task heavily loaded on the other factor. The $10 task had intermediate loadings on both factors, suggesting it has similarities with the snack food task and the larger amount monetary tasks.

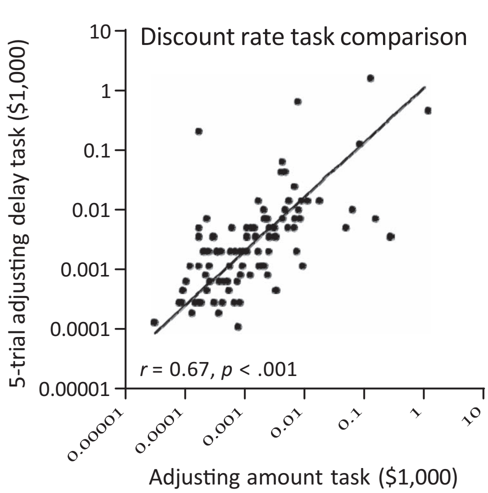

Figure 2. Correlation between the 5-trial adjusting delay task and the adjusting amount task when comparing the same commodity ($1,000).

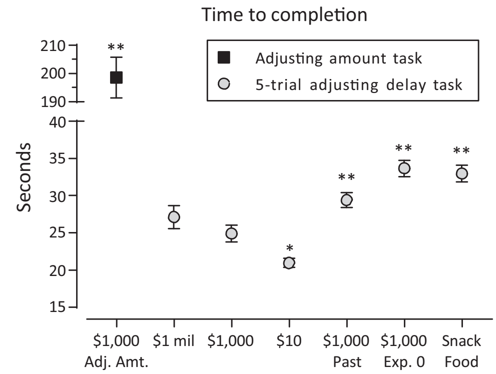

Figure 3. Mean duration and 95% confidence interval of each task variant. Asterisks indicate a statistically significant difference from the $1,000 5-trial adjusting delay task duration. Adj. Amt. = adjusting amount; Exp. = Explicit. * $p < .05$. ** $p < .001$.

Time to Task Completion

The 5-trial adjusting delay task was designed to be as brief as possible while still producing a robust measurement of discount rate. Therefore, time to task completion is an important outcome to consider (see Figure 3). Overall, a large main effect of task was observed on time to completion, $\chi^2(6) = 3{,}339$, $p < .001$. Gender, $\chi^2(1) = 0.3$, $p = .6$, race, $\chi^2(2) = 2.2$, $p = .3$, and drinks per week, $\chi^2(1) = 0.0$, $p = .9$, were not related to task completion time, although older participants tended to complete the tasks more slowly, $\chi^2(1) = 5.3$, $p = .02$. Mean time to obtain discount rates for $1,000 with the adjusting amount task was 198 s ($SD = 38.2$) and 24.8 s ($SD = 12.0$) with the 5-trial adjusting delay task ($p < .001$). Systematic differences in time to completion were observed within the 5-trial adjusting delay task, although mean durations were well under 1 min for all commodities (see Figure 3).

Pairwise comparisons indicated that completion times for each of the commodities differed significantly from each of the others ($ps < .006$), except the comparisons between $1,000,000 and $1,000, $1,000,000 and $1,000 past, and $1,000 with explicit zero and snack food. These differences in completion time may reflect additional consideration by the participants. However, these differences in task completion time also roughly correlated with the average amount of words displayed on the screen to characterize each choice, and may simply reflect the additional time required to read the response options.

Discussion

Our first hypothesis was that four effects in the literature could be replicated with the 5-trial adjusting delay task, which was confirmed. First, discount rate correlated inversely with amount (see Green et al., 1997), such that discount rates for $1,000,000 were less than discount rates for $1,000, which were less than discount rates for $10. Additionally, we found that the task variants loaded on two components, which separated large monetary amounts from snack food discounting, with discounting of $10 loading somewhat on both factors. This is similar to a previous report that discounting of the very small amount of $0.10 loaded onto a separate factor than discounting of $100 (Scheres, Sumiya,

& Thoeny, 2010). Second, discount rates for past outcomes correlated with those for future outcomes (see Bickel et al., 2008; Yi et al., 2006). However, in contrast to previous studies finding similar discount rates between past and future monetary rewards, rates for past outcomes were significantly higher in the present study (see Figure 1). This difference may be due to an idiosyncrasy with the 5-trial adjusting delay task, differences in sample, or the fact that the present study had a much larger sample size than the previous studies, which had fewer than 30 participants each, allowing for the detection of smaller differences in discount rate. Third, discount rates for snack food were greater than discount rates for $1,000 (although similar to discount rates for $10; see Estle et al., 2007; Jimura et al., 2009). Note that we did not determine the value of these snacks to the participants, so we are unable to compare discount rates of snack foods with an equivalent dollar amount in the present study.

Because discount rate varies with amount of a commodity, this limitation does not allow for the comparison of consumable versus generalizable reinforcer in the present data independent from amount, and we cannot conclusively determine if our replication of this effect was simply another replication of the amount effect. Fourth, discount rates in the $1,000 "explicit zero" condition were lower than in the $1,000 nonexplicit zero condition (see Magen et al., 2008; Radu et al., 2011).

Our second hypothesis was that discount rates would correlate between the 5-trial adjusting delay task and adjusting amount tasks for the same commodity. This was also confirmed, and this was also the highest correlation observed between any of the conditions measured (see Table 2).

Our third hypothesis was that absolute rates of discounting would be similar between the 5-trial adjusting delay task and the adjusting amount task. Although they were quite similar, a small but consistent tendency was observed for discount rates to be higher with the 5-trial adjusting delay task (see Figure 1). This may have occurred for at least two reasons. First, although the Mazur (1987) equation is often used to analyze discounting data, frequently there are systematic deviations from this fitted curve. In response to this, researchers have proposed modifications of this equation to better fit indifference curves (e.g., Myerson & Green, 1995; Rachlin, 2006). To the extent these modified discounting formulas better describe the underlying shape of the curve, they may better model the true ED_{50} value that is being directly assessed with the 5-trial adjusting delay task. To test this supposition, we refit the data in the present study from the adjusting amount task with the formula proposed by Rachlin (2006), which adds a free parameter to Equation 1 as an exponent of the delay parameter D and calculated ED_{50} values from these curves. The mean difference in ED_{50} values between the 5-trial adjusting delay task and the adjusting amount task analyzed with Equation 1 was 0.23 (t test, $p < .001$); and with the Rachlin (2006) equation, it was 0.18 (t test, $p = .01$). Although still significantly different, the reduced difference suggests model fitting may have accounted for some of the discrepancy. The second possible reason for the difference between the tasks may have been due to the median delay, which represented the initial question in the 5-trial adjusting delay task (3 weeks), being less than most participants' eventual ED_{50} values ($M_{\text{geometric}} = 385$ days). For the average participant, therefore, the adjusting algorithm adjusted the delays in an ascending sequence, at least initially. This may have slightly biased participants to choose the shorter option, just as an ascending series of amounts can bias participants to choose smaller amounts (Robles & Vargas, 2008). Although this problem has no obvious solution without knowing the ED_{50} of the participant a priori, researchers should be aware of such effects when interpreting results.

The average completion time was much lower for the 5-trial adjusting delay task (approximately 20−35 s) than for the adjusting amount task (approximately 200 s; see Figure 3), and would therefore be of use in any setting where obtaining an accurate approximation of an individual's discount rate in a very short amount of time is desirable. For example, the 5-trial adjusting delay task may be especially useful in hospital settings where duration of patient access is limited, in experiments that measure the effect of some transient intervention on discount rate (e.g., acute administration of a drug with a short half-life), within populations that have limited attention for which a lengthy discounting task may require an unreasonable amount of sustained attention, or as a part of an extensive task battery.

Despite these positive features, some limitations may preclude the use of the 5-trial adjusting delay task in some situations. First, the 5-trial adjusting delay task cannot be used for research that aims to resolve the specific shape of the discounting curve because no series of indifference points is generated. Second, this task does not permit an assessment of whether the participant is responding in a logical manner. When a series of indifference points is generated, researchers have commonly adopted criteria to label some subset of data as unsystematic or illogical and excluded these data from analyses on the assumption that some participants did not understand the task. For example, a series of indifference points that violates the assumption that value should decrease as a function of delay is often excluded (see Johnson & Bickel, 2008), as we have done with the adjusting amount data in the present study. No analogous way exists to eliminate data for participants who respond in an illogical manner for some reason on the 5-trial adjusting delay task, which may add some variability to the resulting data. Finally, the 5-trial adjusting delay task uses an algorithm to adjust the delay to the delayed commodity depending on the responses of the participant. This procedure would be inconvenient to carry out without a computer of some sort running the task, making the conversion of this task into a questionnaire version impractical. In situations where a questionnaire assessment of discounting is a necessity, an instrument such as the Monetary Choice Questionnaire (Kirby et al., 1999) would be more appropriate.

In conclusion, the 5-trial adjusting delay task is an effective tool to accurately measure an individual's discount rate for a commodity with a total measurement duration of less than 1 min. Discount rates from this task are influenced by manipulations that are known to affect discount rate, are correlated with a traditional measure of discount rate, and are of similar absolute levels as a traditional measure of discount rate.

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