9-2012

Normative Arguments From Experts and Peers Reduce Delay Discounting

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Abstract

When making decisions that involve tradeoffs between the quality and timing of desirable outcomes, people consistently discount the value of future outcomes. A puzzling finding regarding such decisions is the extremely high rate at which people discount future monetary outcomes. Most economists would argue that decision-makers should turn down only rates of return that are lower than those available to them elsewhere. Yet the vast majority of studies find discount rates that are significantly higher than market interest rates (Frederick et al., 2002). Here we ask whether a lack of knowledge about the normative strategy can explain high discount rates. In an initial experiment, nearly half of subjects did not spontaneously cite elements of the normative strategy when asked how people should make intertemporal monetary decisions. In two follow-up experiments, after subjects read a "financial guide" detailing the normative strategy, discount rates declined by up to 85%, but were still higher than market interest rates. This decline persisted, though attenuated, for at least one month. In a final experiment, peer-generated advice influenced discount rates in a similar manner to "expert" advice, and arguments focusing on normative considerations were at least as effective as others. These studies show that part of the explanation for high discount rates is a lack of knowledge regarding the normative strategy, and they quantify how much discount rates are reduced in response to normative arguments. Given the high level of discounting that remains, however, there are other contributing factors to high discount rates that remain to be quantified.

Keywords

intertemporal choice, behavioral economics, financial education

Disciplines

Psychology

Judgment and Decision Making, Vol. 7, No. 5, September 2012, pp. 566–589

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Abstract

When making decisions that involve tradeoffs between the quality and timing of desirable outcomes, people consistently discount the value of future outcomes. A puzzling finding regarding such decisions is the extremely high rate at which people discount future monetary outcomes. Most economists would argue that decision-makers should turn down only rates of return that are lower than those available to them elsewhere. Yet the vast majority of studies find discount rates that are significantly higher than market interest rates (Frederick et al., 2002). Here we ask whether a lack of knowledge about the normative strategy can explain high discount rates. In an initial experiment, nearly half of subjects did not spontaneously cite elements of the normative strategy when asked how people should make intertemporal monetary decisions. In two follow-up experiments, after subjects read a "financial guide" detailing the normative strategy, discount rates declined by up to 85%, but were still higher than market interest rates. This decline persisted, though attenuated, for at least one month. In a final experiment, peer-generated advice influenced discount rates in a similar manner to "expert" advice, and arguments focusing on normative considerations were at least as effective as others. These studies show that part of the explanation for high discount rates is a lack of knowledge regarding the normative strategy, and they quantify how much discount rates are reduced in response to normative arguments. Given the high level of discounting that remains, however, there are other contributing factors to high discount rates that remain to be quantified.

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1 Introduction

1.1 Background

Many of the decisions we make involve tradeoffs between the quality and timing of desirable outcomes. What *should* people do when faced with such intertemporal tradeoffs? Discussions of this question usually focus on *how* people should make these tradeoffs (i.e., exponential vs. hyperbolic discounting), rather than on *to what extent* they should discount future rewards. A notable exception is the case of monetary rewards, where the normative argument is that individuals should compare any intertemporal tradeoff against the other borrowing and investment opportunities available to them.[1] In practice, this argues that the rate of discounting ought to be similar to the current market interest rate, at least for most individuals (Fisher, 1930; Read, 2004). For example, consider a person given a choice between receiving a smaller amount of money at a sooner time and a larger amount at a later time. If this person could borrow the smaller amount while waiting for the larger payoff, and if the larger amount is enough to repay this loan plus interest and still leave the individual with a profit, then the larger, later reward is the better choice, *regardless of when the person would want to spend the money*.

Most studies of delay discounting, however, have observed discount rates considerably higher than market interest rates (Thaler, 1981; Ainslie & Haslam, 1992; Coller & Williams, 1999; Frederick et al., 2002; Reynolds, 2006; Chabris et al., 2008). Although most of these studies involve explicit choices in the laboratory between monetary amounts now or in the future, high discounting rates are also observed in field experiments where normative considerations should be relevant, such as consumers deciding whether to spend additional money now on an energy efficient appliance that will save them money later (Hausman 1979; Ruderman, Levine, & McMahon, 1987; Gately, 1980). Many studies cite discount rates in the range of several hundred percent per year (Frederick et al., 2002 for review). In contrast, the current prime rate is around 3% (Federal Reserve).

We thank Stav Atir, Allison Oakes, Shikha Saxena, and Jessica Stump for assistance in data collection, and Joseph McGuire, Karin Cox, and Betty Kim for comments on previous drafts of this manuscript.

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[1] Another notable exception is discussion regarding the normative discount rate for policy evaluation, particularly in the realm of environmental policy (Baron, 2000; Baron, 2008; Horowitz, 1996; Moore & Viscusi, 1990).

This extremely high rate of discounting is puzzling—why do people appear to diverge so dramatically from the normative strategy?

There are several possible explanations for the high discount rates observed in these experiments. One possibility is that people discount according to the normative strategy, but also have normatively relevant reasons to favor the immediate reward. For example, subjects may think that the delayed reward carries some risk: they may not trust that they will receive a delayed payment from the experimenter, or they may believe that their own future is uncertain. If subjects believe that the delayed reward is uncertain, this would warrant a greater preference for the certain immediate payment, and the observed discount rate would be higher. A different possibility is that there is a knowledge gap, and that subjects either may be simply unaware of the normative strategy, or might apply it to this task incorrectly. Alternatively, people may not perceive that the normative strategy is relevant. For example, subjects might not think about these tradeoffs in terms of money, but rather in terms of the objects that could be purchased with the money (Zauberman & Lynch, 2005). If they are considering tradeoffs of non-fungible items instead of money, the normative monetary strategy is not applicable.

Determining what factors contribute to high discounting would have significant practical implications. Policy makers are often interested in what influences people's financial decisions—for example, what persuades individuals to save more for retirement or to avoid high-interest "pay-day" loans (Zhong, 1994; Joo & Grable, 2000; Hershey & Mowen, 2000; Skiba & Tobacman, 2008). Moreover, high discount rates are also associated with addiction. Cigarette smokers (Audrain-McGovern et al., 2004; Mitchell, 1999; Bickel et al., 1999), heavy or problem drinkers (Vuchinich & Simpson, 1998; Petry, 2001a), illicit drug users (Bickel & Marsch, 2001; Kirby et al., 1999; Madden et al., 1997), and pathological gamblers (Petry, 2001b) exhibit higher monetary discount rates than normal healthy adults. A better understanding of high discount rates might further clarify the link between discounting and addiction. Information about what influences discount rates in the laboratory may therefore prove relevant to a number of issues in public health and policy-making.

1.2 Summary and main contributions

A set of four experiments was conducted to explore whether lack of knowledge of the normative strategy can explain high discount rates. We designed an online survey to poll subjects regarding their reasoning behind intertemporal decisions (Experiment 1), to determine which of several possible explanations for high discounting are most often mentioned. Although several of the possibilities mentioned above received some support, the results implied that a large fraction of subjects either were unaware of the normative strategy or were not applying it to the task appropriately. If people are not considering the normative strategy or are applying it incorrectly, then providing them with information about the normative strategy and how to apply it to the task should reduce discounting. We tested this prediction in a series of three additional experiments. Experiment 2 tested this hypothesis by providing subjects with a "financial guide" that explained the normative strategy. To reduce any demand effects, the guide emphasized what information subjects should consider, and explicitly stated that this information could lead one to be more or less patient. Providing this information significantly reduced discounting immediately after the manipulation and for at least one month, but did not lower discount rates nearly as far as the normative strategy would prescribe. Experiment 3 tested the effectiveness of a much more strongly worded version of the financial guide, which reduced discounting further, though still not as low as market interest rates. The failure of even strongly worded normative arguments to reduce discount rates to the level of market interest rates led us to compare normative arguments to other approaches. In Experiment 4, arguments referencing the normative strategy were at least as effective as other potential arguments in reducing discount rates. Since this experiment used short paragraphs written by other subjects, it also demonstrates that information regarding the normative strategy is effective when it does not come from the experimenter (who was blinded to the content of the paragraphs) and when it does not reference "experts".

Combined, these studies confirm that lack of knowledge about the normative strategy does contribute to high monetary discounting. Normative arguments reduce discount rates. These interventions produce at least as large a change in discounting as other previously described manipulations of the tangibility and perceived distance of future timepoints (Peters & Büchel, 2010; Kim, 2010). On a practical level, our results suggest that education regarding normative considerations should not be dismissed as being an ineffective way to change financial decision making. However, our results also contain a puzzle, in that none of the interventions tested reduced discounting to the level that the normative strategy would prescribe. Other factors, such as transaction costs or perceptions of the future, must also contribute to high discounting, and further experiments are needed to quantify the contribution of these other considerations. In terms of practical implications, simply providing information about normative considerations alone will not reduce discounting to normative levels, so future work should investigate com-

bining multiple arguments, tailoring arguments to individuals, and other approaches.

2 Experiment 1—Online survey

Several factors might contribute to high levels of monetary discounting. Among them are perceived risk, thinking about consumable goods rather than money, and a lack of understanding of the normative strategy. This experiment asked subjects to describe what considerations they think are important when making intertemporal choices, to examine which, if any, of these factors are cited spontaneously.

2.1 Methods

2.1.1 Subjects

Individuals recruited through Amazon's Mechanical Turk completed a short intertemporal choice task on Qualtrics (Qualtrics Labs Inc., Provo, UT) and then responded to two question prompts. Amazon's Mechanical Turk is considered a fast and reliable source of experimental data, with results typically not differing between in-lab and online experiments (Paolacci et al., 2010; Horton & Chilton, 2010; Buhrmester et al., 2011; Mason & Suri, 2012). We restricted participation to US-based participants. Of the 151 subjects who began the survey, 93 completed it. Subjects were paid \$0.50, and the survey was estimated to take no longer than 30 minutes.[2] The average age of subjects who completed the survey was 32.5 years (SD = 12 years), and 73.6% of subjects were female. All subjects provided informed consent in accordance with the procedures of the institutional review board at the University of Pennsylvania.

2.1.2 Procedures

The temporal discounting task consisted of 51 choices. This task was modeled after the short questionnaire designed by Kirby (Kirby & Marakovic, 1996). Each choice was between a smaller monetary reward received immediately and a larger monetary reward received after a delay. Choices were presented one at a time. Amounts for the smaller reward ranged from \$10-\$34, and amounts for the larger reward were \$25, \$30, or \$35. Delays ranged from 1- 180 days. All subjects saw the same choices, though the choices were presented in a different random order for each subject.

In this experiment, the main variable of interest was not discount rates but rather the open-ended response questions. For this reason, subjects were only given a flat participation payment, and not paid according to their choices on the discounting questionnaire. In all other experiments, subjects were paid in an incentive-compatible manner according to one of their choices.

After completing the intertemporal choice task, each subject answered two questions: (1) "Why did you choose the way you did?" and (2) "If you had to persuade other people to make the same choices that you just did, what would you say? Include a numerical example. Please write a paragraph (8–10 sentences) explaining your answer. Minimum word count: 180." Several pilot experiments were conducted to determine these stipulations for the second question, which was designed to produce lengthy answers containing specific examples, rather than the brief, vague explanations seen in pilots

2.1.3 Data analysis

Analyses focused on the second question, "If you had to persuade other people to make the same choices that you just did, what would you say?" Responses to the first question, "Why did you make the choices that you did?" were more likely to involve very specific personal considerations (i.e., receipt dates for paychecks or due bills). The second question was intentionally framed to produce general explanations and advice to others.

Responses were scored by 2 individual raters (NS, TW) on whether the writer mentioned: (1) the risk of waiting or general uncertainty about the future, (2) purchases or other things the money could be spent on, (3) the difference in money between the two options (e.g., "five more dollars"), (4) the ratio of money in the two conditions (e.g., "25% more"), and (5) opportunity costs (e.g., investing, saving, interest rates, and/or the time value of money). After rating the arguments individually first, the 2 raters agreed on categorizations by discussing points of contention.

Discount rates in this experiment were calculated assuming an exponential[3] discounting model: $SV = Ae^{-kD}$, where SV is the subjective value of the delayed option,

[2] The payment rate, as presented on the HIT, was \$1 per hour. However, the average response time was 18 minutes, giving an effective rate of \$1.67 per hour. The presented rate of \$1 per hour is slightly lower than the estimated reservation wage (\$1.38; Hornton & Chilton, 2010). The attrition rate in this study (38%) is within the range of attrition seen in other studies using MTurk (Chandler & Kapelner, 2010; Kelley, 2010; Willett et al., 2012).

[3] Since the normative strategy involves exponential discounting, we report the fits from an exponential discount model. However, both hyperbolic and exponential models were fit to all data. The hyperbolic model fit the function: SV = A / (1+k*D) (Mazur, 1987). In this experiment, the fits (r^2) of exponential and hyperbolic models were not significantly different (Wilcoxon sign-rank test, p=0.3), and the results reported in the text did not differ for exponential versus hyperbolic discount rates. Note that the stimuli used were optimized for detecting differences in the rate of discounting rather than the shape of the discount function, so we refrain from interpreting comparisons between the fits of the hyperbolic and exponential models.

Table 1: Survey response category percentages.

	Future risk	Other purchases	Monetary differences	Money %s or ratios	Investing, saving, etc.
Overall	16%	29%	58%	37%	47%
High discounters	22%	26%	67%	39%	33%
Low discounters	11%	32%	49%	34%	62%

A is the monetary amount of the delayed option, D is the time delay in days, and k represents the discount rate. A higher k value indicates steeper discounting of a delayed reward. Discount rates were estimated using a logistic regression model, implemented in Matlab (Mathworks, Natick, MA). In some cases, this regression would not be well estimated because subjects selected all immediate or all delayed rewards. To deal with this issue, we determined the lowest and highest discount rates that we could reliably estimate, and constrained our estimates to this range. In this experiment, the discount rates of four subjects were at the lowest extreme of this range, and none were at the high extreme.

For purposes of comparison, subjects were split at the median (k=0.0094) into high (n=46) and low (n=47) discounters. The median discount rate was in a reasonable range compared to in-lab behavioral testing (see Experiments 2, 3, and 4). We compared the percentage of high and low discounters that mentioned each consideration using Chi square tests, and also performed a logistic regression of log-transformed discount rates on the likelihood that subjects mentioned each consideration.

2.2 Results

The most frequently recommended strategy (mentioned by 58% of subjects) was to consider the difference in the two amounts being offered. Comparatively fewer subjects (37%) recommended that others consider ratios of amounts. The second highest percentage (47%) of subjects mentioned opportunity costs, such as interest rates or savings accounts. Of the five categories scored, the least frequently mentioned factors were the risk inherent in waiting into the future (16%) and items that could be purchased (29%).

To examine whether the percentages of subjects recommending these strategies differed depending on discount rate, subjects were split into two groups at the median discount rate. The largest difference between the high and low discounting groups was in mentioning opportunity costs, with the low discounting group being more likely to mention opportunity costs (62%) than the high discounting group (33%) (Chi square p=0.016). There was also a trend for the high discounting group to be more likely to mention considering differences in amounts (67% vs. 49%, Chi Square p=0.065). Roughly equal percentages of high and low discounters mentioned risk, purchases and ratios between amounts (all comparisons *ns*). See Table 1 for all percentages.

A logistic regression was performed to further explore the relationship between discount rates and the likelihood that subjects would mention each consideration. There was a significant negative relationship between log-transformed discount rates and the likelihood of mentioning opportunity costs (odds ratio = 0.4, p = 0.004). There was also a moderately significant positive relationship between discount rates and mentioning future risk (odds ratio = 2.5, p = 0.051). All other models were *n.s.* Those with higher discount rates were therefore less likely to mention opportunity costs, and more likely to mention risk inherent in waiting into the future. However, note that the overall rate of mentioning future risk is rather low (16% of respondents) compared to opportunity costs (47% of respondents).

2.3 Discussion

The responses to the online survey support some of the theoretical explanations for high discounting, but not others. First and foremost, we found substantial evidence that not all subjects consider the normative strategy to be an important element in intertemporal choices, and that those who do might be making mistakes in its application. If subjects were considering these tradeoffs normatively by comparing the interest rates available in the experiment to those available to them on the market, they should recommend that others consider relative percentages or ratios of money rather than differences in amounts. Yet we found that more subjects mentioned differences in monetary amounts than ratios, and that less than half of responders recommended comparing ratios at all. Finding that more subjects recommended paying attention to differences in amounts is in line with recent descriptive models of intertemporal choice, such as the tradeoff model (Scholten & Read, 2006). This model suggests that individuals focus on weighing attribute differences (i.e., amount or delay) between the choice options, rather than comparing their overall values.

Furthermore, if subjects were considering these tradeoffs normatively, they should mention opportunity costs. While many subjects did mention opportunity costs, there was still a considerable proportion (53%) who did *not* recommend considering the key element from a normative point of view. Opportunity costs was the category that differed most clearly between patient and impatient subjects. Patient subjects were more likely to recommend that others consider opportunity costs than those who were relatively impatient, with 62% of patient subjects mentioning opportunity costs and only 33% of impatient subjects doing so. This suggests that those who exhibit higher discount rates may be less aware of normative considerations.

In addition, the percentage of high discounting responders (33%) that mentioned opportunity costs suggests that these responders might not have considered opportunity costs accurately. This was directly evident in some individuals' responses. For example, one subject stated, "Would you rather have $19 now or $23 in 55 days. It's pretty simple. Why would I wait almost 2 months more for 4 extra dollars? I could make more money with the $19 now and turn it into a profit by using it for something else to invest in." In this case, a 141% annual interest rate was implied. Since such rates of return are unlikely, especially for any large percentage of the population in the US, these statements suggest that some subjects were not accurately calculating interest rates. This raises another possible factor contributing to high discounting, which is that even when people are aware of normative considerations, they may not be able to apply them correctly to the task at hand.

These findings regarding the importance of knowledge about normative considerations are potentially related to individual differences in discounting. While the associations between discounting and personality traits are generally low, stronger correlations have been found between discounting and cognitive ability (Shamosh & Gray, 2008; Hirsh et al., 2008; Burks et al., 2009). One potential explanation for this association involves the awareness of and ability to implement the normative strategy. Individuals of higher cognitive ability may be more likely to be exposed to normative arguments about opportunity costs, for example through schooling, and may be better able to accurately calculate interest rates in order to apply normative considerations correctly.

In contrast to the above findings, we did not find as strong evidence for two alternative hypotheses about the explanation for high discounting: that subjects were concerned about the risk or uncertainty involved in a delayed payment or that subjects were considering consumable goods—items that could be purchased with the money rather than the money itself. Although there is a positive relationship between discount rates and the likelihood of mentioning risk, only a minority of subjects mentioned risk as a consideration.

One limitation of this experiment is that the question we asked subjects, "if you had to persuade other people to make the same choices that you just did, what would you say," might not provide the most accurate picture regarding the reasons subjects made the choices they did, especially if subjects do not have conscious access to the reasons for their choices. This question does provide an accurate picture of what subjects consider compelling arguments, since subjects' explicit goal was to be persuasive. In this respect, it is interesting that opportunity costs, which are normatively relevant, are the factors mentioned most often in favor of low discounting. We designed the next experiment to see whether exposure to this argument can reduce discount rates.

3 Experiment 2—Financial guide and interest rate instruction session

If lack of knowledge is an important contributor to high discount rates, explicitly informing subjects about the normative argument should reduce discounting. In Experiment 2, some subjects were asked to read a "financial guide," which explained what information people should consider normatively. This guide focused on what information people should consider, specifically opportunity costs, rather than on what they should choose. It provided examples where these considerations would warrant more choices of the delayed reward and examples where these considerations would warrant fewer choices of the delayed reward, so as to not directly imply that subjects should become either more or less impatient. To address the possibility that subjects might already know this information but mistakenly underestimate the returns offered in the experiment, some subjects viewed examples of the interest rates implied between choice options. The effects of the guide and the interest-rate examples were examined individually and together, in a 2x2 design.

3.1 Methods

3.1.1 Subjects

Eighty individuals from the University of Pennsylvania community participated in this experiment, with 20 individuals in each of 4 experimental conditions. The mean age was 22.2 years (SD=5.3 years), and 66% of subjects were female. Students made up 80% of the subject pool; 17.5% of subjects were employed full-time and 2.5% were unemployed. All subjects provided written informed consent in accordance with the procedures of the

institutional review board at the University of Pennsylvania.

All subjects were asked to return about one month after their first session for a second session. Of the original 80 subjects, 70 (mean age = 22.3 years, SD=5.5 years; 69% female; 84% students, 16% employed) were willing to return for a second session roughly one month after the first (average delay = 30 days, SD=5.1 days).

3.1.2 Intertemporal choice task

The temporal discounting task consisted of 102 choices. Subjects completed the task 3 times (two sets at the first session, and one set at the second session), with new choices each time. The task was presented in E-Prime (Psychology Software Tools, Pittsburgh, PA), but was otherwise as described in Experiment 1.

At each session, subjects were informed that they would be paid according to their choice on one randomly selected trial, in addition to a show-up payment of $10. Subjects received payments via debit card (Kable & Glimcher, 2007, 2010) regardless of whether the randomly selected trial involved an immediate or delayed payment. For delayed payments, the incentive payment did not become available on the card until after the delay period.

At session 1, 37.5% of payments were immediate, and the average immediate payment was $23.36. The average delayed payment was $29.47, and the average delay was 26 days. At session 2, 51.25% of payments were immediate, and the average immediate payment was $25.54. The average delayed payment was $30, and the average delay was 30 days. By the date of their second appointment, 89% of subjects had already received an incentive payment from the experimenter. Whether or not a payment had been successfully received before the second appointment did not affect the degree of change in discount rates (see below).

3.1.3 Procedures

At session 1, subjects first completed 2 practice trials, followed by 102 trials of the intertemporal choice task. After completing this first set of choices, subjects underwent one of the four experimental manipulations and then immediately completed the second set of 102 choice trials. At session 2, approximately one month later, subjects returned to the lab and completed the third set of 102 choice trials. The second session was run by a different experimenter, and no mention was made of the manipulation seen at the first appointment. Discount rates were calculated separately for each 102-item set.

3.1.4 Financial guide

The financial guide outlined in detail the elements of the normative decision strategy, but did not explicitly recommend that subjects become more or less impatient. The key aspect of the normative strategy is that the subject should not turn down a rate-of-return from the experimenter that outperforms what the subject could achieve outside of the experiment. The text emphasized that choosing in accordance with the normative strategy does not require changing one's preferences regarding consumption. Subjects could "have it both ways," such that if they strongly preferred to spend the smaller amount immediately, they could borrow that amount from another source while waiting for the larger amount, and might be able to make a profit after repaying the loan. If they could do so, then the larger, delayed option would be the better choice regardless of their preferences regarding consumption. Alternatively, if subjects would prefer to make the most money possible, they should consider whether investing the amount of money available immediately would yield a higher amount at the end of the delay period than the delayed option offers. If their potential investment would be worth more than the delayed option, then the immediate option would be the better choice. To aid in comparison, a figure included in the guide illustrated the increasing value of money when invested at several different interest rates (or, comparably, the increasing amount owed after borrowing money at several different interest rates).

The guide also emphasized that the normative strategy depends on individual circumstances. Some subjects may not have a credit card, an interest-bearing bank account, or other convenient ways to borrow and invest money. If subjects prefer having money to spend today, and do not have other borrowing opportunities, then they might justifiably accept a smaller, immediate option that others with borrowing opportunities would reject. Similarly, if they prefer a larger amount of money, but do not have any investment opportunities, then they might justifiably accept a larger, later payment that others with investment opportunities would reject.

See the Appendix for the full guide.

3.1.5 APR manipulation / interest rate instruction

For the APR (annual percentage rate) manipulation, subjects first read a short definition of APR. They then were presented with 51 choice pairs that they had previously seen. For each pair, subjects were presented with the original choice options, the implied interest rate (APR) between them, and the option they had chosen previously. Subjects were not given the opportunity to change their choices, but were asked to simply pay attention to the screen. The APRs ranged from 7% to 9000%.

3.1.6 Data analysis

Discount rates were estimated separately for each set of questions, and calculated as in Experiment 1.[4] Two subjects had discount rates estimated at the lower bound of the range, and none at the upper bound. Because discount rates are not normally distributed, all statistics in this experiment were performed on the log-transform of the discount parameter k. The average discount rates reported are transforms of the mean log discount rate. Error bars in Figure 1 are calculated as within-subject standard error, as in Morey (2008).

Because of the large variability in discount rates across the population, between-group differences are difficult to detect. There was not a between-treatments difference in discount rates in this experiment. A multivariate ANOVA on each timepoint showed a nonsignificant effect of the guide at both timepoints after the manipulations (immediately after, $F(1,69) = 0.504$, $p = 0.48$; one month later, $F(1,69) = 1.785$, $p = 0.186$). However, discount rates within subjects are very reliable without intervention (see test-retest reliability below), so within-subject analyses are both justified and more powerful. Analyses of this experiment and those following will use within-subject comparisons.

3.2 Results

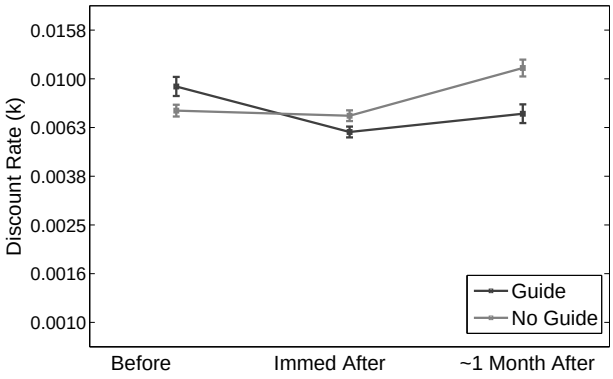
3.2.1 Session 1

The four different experimental conditions were (1) reading the financial guide alone ("Guide"); (2) reading the financial guide and viewing the APR manipulation ("Guide+APR"); (3) viewing the APR manipulation alone ("APR"); and (4) viewing neither the guide nor the APR manipulation ("control"). At session 1, subjects in all conditions performed the delay discounting task twice.

A repeated measures ANOVA used the log transform of discount rates as the dependent variable, the first and second choice sets as the within-subjects factor, and dummy variables coding whether subjects saw the financial guide and the APR manipulation as between-subjects factors. The results indicated a significant 2-way interaction between choice sets and exposure to the financial guide ($F(1,76)=10.707$, $p=0.002$). There was not a significant 2-way interaction between choice sets and exposure to the APR manipulation ($F(1,76)=0.004$, $p=0.947$), or a significant 3-way interaction between choice sets, exposure to the financial guide, and exposure to the APR manipulation ($F(1,76)=0.371$, $p=0.545$). Thus, only the financial guide had a significant impact on behavior.

[4]Except for the first and third timepoints of the guide only and control conditions, the exponential discounting model provided a significantly better fit than the hyperbolic model (Wilcoxon sign-rank test, $p < 0.05$). The results reported in the text do not differ for exponential versus hyperbolic discount rates.

Figure 1: Discount rates before and after reading financial guide. Average discount rates (on log scale) at each of three timepoints, grouped by whether or not subjects read the financial guide. Error bars are calculated for the within-subject comparison, as described by Morey (2008).



Because we did not observe a significant effect of the APR manipulation, the four manipulations are collapsed into two groups below. The subjects who read the financial guide showed a significant reduction in discount rates, moving from a mean of k=0.0093 to k=0.0061 (t-test on log transform, $p<0.0001$). Those who did not read the guide showed no significant change in discount rates, with the mean moving from k=0.0074 to k=0.0071 (t-test on log transform, $p=0.44$).

Since subjects in the control condition did not see either manipulation, we were able to obtain a measure of the test-retest reliability of our task. Discount rates did not change significantly in this condition, with the average for the first test at k=0.0054 and for the second test at k=0.0050 (t-test on log transform, $p=0.84$). Test-retest reliability, measured as the correlation between the log-transformed discount rates at the two tests, was 0.956. This demonstrates that, without intervention, discount rates in this task are consistent within individuals, on a given day.

3.2.2 Session 2—One month later

All subjects in Experiment 2 were asked to return roughly one month after the first appointment. At this time, they completed the delay discounting task with a different experimenter, with no mention made of their previous appointment. Of the 20 subjects in each condition, the following numbers returned one month later: 16 from the Guide condition; 20 from the Guide+APR condition; 16 from the APR condition; and 18 from the Control condition.

A repeated measures ANOVA used the log-transformed discount rates as the dependent variable, the three choice sets as the within-subjects factor, and dummy variables coding exposure to the financial guide and APR manipulation as between-subjects factors. The results indicated a significant 2-way interaction between choice sets and exposure to the financial guide ($F(2,132)=9.303$, $p=0.001$). There was no significant 2-way interaction between choice sets and exposure to the APR manipulation ($F(2,132)=0.222$, $p=0.75$), or 3-way interaction between choice sets, exposure to the financial guide and exposure to the APR manipulation ($F(2,132)=0.117$, $p=0.844$).

Again, because we did not observe a significant effect of the APR manipulation, the four manipulations are collapsed into two groups below. For subjects who read the financial guide at the first appointment, the average discount rate decreased immediately after the manipulation. One month later, the average discount rate showed a non-significant increase relative to immediately after reading the guide (from $k=0.0061$ immediately after to $k=0.0072$ one month later; t-test on log transform, $p=0.147$) and remained significantly lower than before reading the guide (from $k=0.0093$ before to $k=0.0072$ one month later; t-test on log transform, $p=0.032$). This demonstrates that there was an effect of the financial guide that lasted for at least one month. Although there was a trend for some rebound in discount rates one month after the manipulation, discount rates were still significantly lower than at the first, naïve test. See Figure 1 for average discount rates across time.

We also observed higher discount rates one month later in subjects who did not receive the financial guide, relative to the second test (t-test on log transform, $p=0.002$). This was not attributable to whether subjects had received immediate or delayed payments from session 1. Examined across all subjects, payment category (immediate payment or delayed payment received before second session, vs. delayed payment received after second session) did not have a significant effect on the degree of change in discount rates (difference in log k) from sets 2 to 3 (ANOVA, $F(2,69)=1.556$, $p=0.217$) or from sets 1 to 3 (ANOVA, $F(2,69)=0.591$, $p=0.445$). The significant reduction of discounting that we observed in subjects who did read the guide was in the opposite direction of the drift observed in those who did not read the guide, so if anything, this finding suggests that the above results underestimate the effects of the guide.

3.3 Discussion

This experiment used a 2x2 design to examine the effects of providing information regarding the normative strategy (the financial guide) and the implied interest rates in the choices the subjects face (the APR manipulation). If subjects discount highly because they are unaware of the normative strategy, reading the financial guide should reduce discounting. Results from this experiment indicate that this is in fact true for many subjects. Subjects who read the guide exhibited a significant 35% reduction in discounting. This effect lasted at least one month, with discount rates remaining 23% lower one month later.

Viewing the APR manipulation did not have a significant effect on discounting. It could be that the information in the guide provided enough clarification about interest rates for any subjects who were unclear, and that viewing the APR manipulation alone was not enough information to change behavior. Our results suggest that misunderstanding interest rate calculations was not a major contributor to high discount rates in this experiment.

Although the financial guide reduced discounting significantly, it did not lower discount rates nearly as far as the normative strategy would prescribe. The average discount rate of the subjects who read the financial guide was equivalent to an annual interest rate of about 320%. However, the financial guide employed a neutral tone and provided no general recommendation that subjects become more or less impatient. This neutral wording was used to eliminate any possibility of experimenter demand effects, but it might also have obscured an understanding of the normative argument. To rule out the possibility that the extremely high discount rates that remain in this experiment are due to people still not fully understanding the normative argument or its implications, we performed the next experiment, which used a very strongly worded guide that makes explicit recommendations for what to choose.

4 Experiment 3—Prescriptive financial guide

In this experiment, we tested whether a more strongly worded argument could reduce discounting further than the manipulations described in Experiment 2. Here the guide emphasized that, because most delayed choices yield very high rates of return and most subjects do have flexible financial opportunities, the normative strategy, in the case of the choice options presented here, is to almost always choose the delayed reward. We were interested in whether or not, when the argument is put in strongest possible terms, people would reduce their discounting to the level of market interest rates.

4.1 Methods

4.1.1 Subjects

Twenty individuals from the University of Pennsylvania and surrounding community participated (75% female; 70% students, 20% employed, 10% unemployed). The mean age was 26 years (SD = 10.7). All subjects were asked to return roughly one month after their first appointment for a second session. Of the original 20 subjects, 17 (82% female; 76% students, 12% employed, 12% unemployed; mean age 26, SD = 11.6) were willing to return for a second session (average delay = 30 days, SD = 6 days). All subjects provided written informed consent in accordance with the procedures of the institutional review board at the University of Pennsylvania.

4.1.2 Intertemporal choice task

The temporal discounting task consisted of 51 choices. Subjects completed the task 3 times (two sets at the first session, and one set at the second session). The particulars of the task and payment are otherwise identical to Experiment 2.

At session 1, the average payment was $27.45. Forty-five percent of these payments were immediate (average $25.44) and 55% were delayed (average $29.09). For delayed payments, the average delay was 53.5 days. At session 2, the average payment was $25.18. Thirty-five percent of those payments were immediate (average $18.60) and 65% were delayed (average $31.00). For delayed payments, the average delay was 53.2 days.

4.1.3 Procedures

Subjects first completed 2 practice trials, followed by 51 trials of the intertemporal choice task. Then subjects read the financial guide and immediately afterward completed the second set of 51 intertemporal choices. One month later, subjects returned to complete the third set of 51 intertemporal choices. This session was run by a different experimenter, with no mention made of the guide read at the previous session. Discount rates were calculated separately for each set of 51 trials.

4.1.4 Financial guide

Like the financial guide used in Experiment 2, this guide outlined in detail the normative decision strategy, that subjects should not turn down a rate-of-return from the experimenter that outperformed what they could obtain outside the experiment. The guide also presented scenarios that allowed the subject to "have it both ways," making the most profit from the experiment while still spending or saving money according to their personal preferences.

However, unlike the balanced argument in Experiment 2, which emphasized that the normative strategy could lead to different subjects making different decisions in this task, the guide in this experiment strongly emphasized that in most cases, the normative strategy would lead subjects to make more patient choices. The guide pointed out that because most of the larger, delayed options in this experiment yielded very high returns, the best strategy was almost always to choose the delayed option. The guide explained that, since the rate of return from most of the choices in the experiment was higher than what is available on the market, a simple way to implement the "best strategy" was to always accept the larger amount of money. It then described the more sophisticated approach of comparing subjects' own borrowing and investment opportunities to the interest rates offered in the experiment. Assuming that all subjects had such financial opportunities, the larger, later option was almost always the more valuable choice given the range of options offered in these experiments. For example, if subjects chose all delayed options offering an annual rate of return greater than the current prime rate (3%), they would select the delayed option 100% of the time in this experiment. Even if subjects chose the delayed option only when it offered a rate of return greater than 20%, they would still select the delayed option 82% of the time in this experiment.

This presentation of the normative strategy did make some generalizations, both about the choices offered (that they had high returns) and about the personal finances of the subjects. In some ways, then, it may not have been the fairest representation of the normative argument. However, since the goal of this experiment was to test for the strongest possible effect, we erred on the side of overstating the normative argument.

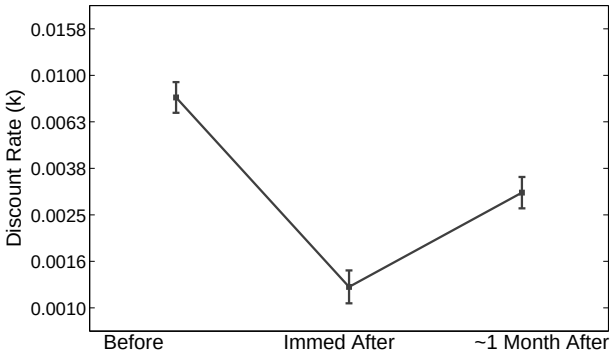
See the Appendix for the full guide.

4.1.5 Data analysis

Discount rates in this experiment were calculated as in Experiment 1.[5] Three subjects had discount rates estimated at the lower bound of the range, and none at the upper bound. Again, statistical analyses were performed on the log-transformed discount rate, and the average discount rates reported are transforms of the mean log discount rate. Error bars in Figure 2 are calculated as within-subject standard error, as in Morey (2008).

[5] There were no significant differences between fit of the exponential and hyperbolic models in this experiment (Wilcoxon sign-rank test, all $p > 0.3$), and the results reported in the text do not depend on whether exponential or hyperbolic rates are used.

Figure 2: Discount rates before and after reading prescriptive financial guide. Average discount rates (on log scale) at each of three timepoints. Error bars are calculated for the within-subject comparison, as described by Morey (2008).



4.2 Results

4.2.1 Session 1

Discount rates (k) were calculated for each subject (n=20) from choices before and immediately after reading the guide at session 1. There was an 85% decrease in discount rates after reading the guide (t-test on log transform, p<0.0002). The average discount rate declined from k = 0.0080 to k = 0.0012. Discount rates did not cluster around the discount rate illustrated in the guide (k = 0.0005), suggesting that overall, subjects did not simply implement the illustrated decision rule. Very few subjects (n = 2) selected all the delayed options immediately after reading the guide,[6] suggesting that subjects also did not follow the simpler version of the decision rule put forth in the guide, which was to always take the larger amount of money.

4.2.2 Session 2—One month later

Subjects were asked to return roughly one month after their first session and were tested by a different experimenter, with no reminder of the guide read at session 1. For these subjects (n=17), discount rates were calculated from choices on the third set of discounting questions and compared to the two sets from the first session. A repeated-measures ANOVA showed a significant change in discount rates over time (F(2,32)=16.46, p<0.0001).

The average discount rate at the second session, approximately one month after reading the guide, was k = 0.0030. This discount rate was significantly higher than immediately after reading the guide (k = 0.0012; t-test on log transform, p=0.009). However, this discount rate was also significantly lower than before any intervention (k = 0.0080; t-test on log transform, p=0.013). Thus, although subjects were steeper discounters one month after reading the guide, they still discounted significantly less than before reading the guide. See Figure 2 for average discount rates over time.

[6] A third subject chose all delayed options only at the one-month timepoint.

4.3 Discussion

When subjects read a financial guide including not only an explanation of the normative strategy but also specific recommendations to choose more delayed options, we observed an even stronger immediate reduction in discount rates. There was an 85% decrease in discount rates in Experiment 3, compared to a 35% decrease in Experiment 2. As seen in Experiment 2, the effect of the financial guide persisted for at least one month; discount rates remained significantly lower at the one-month timepoint than at the original test.

Interestingly, the rebound in discount rates from immediately after reading the guide to one month later was reliable in this experiment, whereas it was not reliable in Experiment 2. This difference in the degree of rebound is significant (repeated-measures ANOVA with discount rates as within-subjects factor and experiment as between-subjects factor; F(1,51)=10.69, p=0.002). One possibility is that the larger decline in discount rates in this experiment provides more opportunity for discount rates to rebound. Another possibility is that the guide used in this experiment induced strong experimenter demand effects, which account for much of the larger observed decline in discount rates, and that the rebound in discount rates one month later reflects the reduction of these effects with a new experimenter.

The observed reduction in discount rates did not occur because subjects chose to follow either of the suggested decision rules. The financial guide suggested that the "simplest version of the best strategy" was to always choose the larger, later option. However, very few subjects (2 out of 20) adopted this strategy after reading the guide; nearly all continued to select a mixture of immediate and delayed rewards. The guide also described an implementation of the "sophisticated version of the best strategy," assuming a 20% annual interest rate. Again, there was no clustering of subjects around this discount rate.

Immediately after reading the guide, the average discount rate was equivalent to an APR of about 48%. This APR is not completely outside a reasonable realm: taking into account possible penalties and late fees, the interest rate on a credit card could approach this level. However, this APR is not as low as typical market interest rates. Even with a very strongly worded, clear, and understandable argument for the normative strategy, and the possible

presence of demand effects, the average individual still did not shift to discount at the level of typical market interest rates.

These results show that normative arguments, while effective, still do not lead people to discount at the level of market interest rates. This raises the question of whether normative arguments are more or less effective at changing discounting than other possible arguments. We conducted the next experiment to begin exploring this question. We also manipulated the source and framing of the arguments presented, to test whether information needs to come from an authority to be effective.

5 Experiment 4—Peer-generated advice

Experiment 4 examined whether the source and framing of information presented affected discount rates. In contrast to the materials presented in Experiments 2 and 3, the advice presented to subjects in Experiment 4 was written by other subjects, rather than by the experimenter. These paragraphs varied on two dimensions—whether they encouraged subjects to be more patient or more impatient (argument type), and the content of the argument. Two arguments (one patient, one impatient) relied on reasoning about financial opportunity costs, as required by the normative strategy, while two arguments encouraged subjects to engage in episodic future thought and imagine how they might use the money now or in the future.

5.1 Methods

5.1.1 Subjects

Sixty-four individuals from the University of Pennsylvania and the surrounding community participated in this study, with 16 people in each of the four experimental conditions. The mean age was 21 years (SD=2.17 years) and 62.5% of the subjects were female. The majority of the subjects (91%) were students, with the remaining individuals being either employed full-time (6%) or unemployed (3%). All subjects provided written informed consent in accordance with the procedures of the human subjects review board at the University of Pennsylvania.

Each subject received a set show-up payment of either $5 or $10, depending on whether they participated only in this 30 min. study (44% of subjects) or this study and an additional, unrelated 30 min. study. Additional winnings were then determined based on subject's responses in the choice trials. Seventy percent of the payments were immediate, with the average immediate reward being $24.36. The other thirty percent of the payments were delayed, with an average delayed reward of $28.95 and an average delay of 45 days.

5.1.2 Procedures

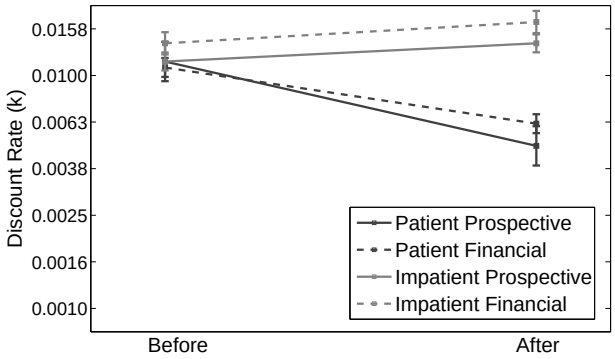
The task and payment details are as described in Experiment 3. Subjects completed two practice trials, followed by 51 intertemporal choice trials. They saw one of four experimental manipulations, and then completed the second set of 51 choice trials. All four experimental manipulations required subjects to read one of the four peer-generated paragraphs, selected at random (experimenter blinded), and then to rate the paragraph's persuasiveness and helpfulness (five-point scale, with 1 being not persuasive/helpful and 5 being extremely persuasive/helpful). Subjects were told that after completing some monetary decisions, they would be viewing one of several possible paragraphs that were written by other people who had completed the same experiment. They were asked to read the paragraph carefully, as they would be asked to rate the persuasiveness and helpfulness of the paragraph later. They were also informed that the experimenter did not know which of the paragraphs they would be reading.

5.1.3 Peer-generated advice paragraphs

The paragraphs were taken from subjects' responses to the second question in Experiment 1, "If you had to persuade other people to make the same choices that you just did, what would you say?" The list of 93 original arguments was narrowed down to 44 paragraphs by selecting the strongest and most coherent arguments. An additional 8 paragraphs were taken from a similar survey of University of Pennsylvania students enrolled at the Wharton school. These 52 paragraphs were then rated by another set of 278 subjects through online surveys; 170 subjects were recruited through Amazon's Mechanical Turk, and 108 from the University of Pennsylvania's psychology department subject pool. The survey asked subjects to complete a short delay discounting task and then to read ten randomly selected paragraphs, and (1) indicate if the paragraph would have made them more likely to take the "now" option (i.e. more impatient), the "later" option (i.e. more patient), or neither, and (2) rate the strength of the argument from 1 to 5 (5 being the strongest).

The arguments that received the highest ratings were then sorted according to whether they advised patience or impatience, and by whether they utilized primarily financial reasoning or prospective thought. For example, the "impatient prospective" paragraph includes, "Imagine that you are worried about paying your electric bill, the baby sitter, the dentist for your child. The economy is tanking, half your peers have lost their jobs this month. ... A smaller amount of money given today... provides

Figure 3: Discount rates after reading peer-generated advice. Average discount rates (on log scale) grouped by content and type of advice paragraph read. Error bars are calculated for the within-subject comparison, as described by Morey (2008).



a financial cushion and a margin of security." The "patient financial" paragraph includes, "I know the numbers are small, but think about it this way — would you rather have $20,000 today or $22,000 three months from now? ... If you annualize the return, that would be a 40% return per year! If you took the $20,000 today and put it in a savings account, (earning about 1%) in three months you would only have $20,050. The difference is $1950!" See Appendix for the full paragraphs.

The four experimental conditions were paragraphs that encouraged patience using predominantly prospective thought (patient-prospective), encouraged patience using financial reasoning (patient-financial), encouraged impatience using prospective thought (impatient-prospective), and encouraged impatience using financial reasoning (impatient-financial). One of the highest-rated paragraphs was chosen from each condition, such that the final 4 paragraphs did not significantly differ on argument strength in the initial rating surveys. The lengths of the paragraphs were also roughly equal, from 193 to 233 words.

5.1.4 Data analysis

Discount rates were estimated separately for each set of questions, and calculated as in Experiment 1.[7] In this experiment one subject was at the upper bound and one at the lower bound of the estimation range. As above, statistical analyses were performed on the log-transformed discount rate, and the average discount rates reported are transforms of the mean log discount rate. Error bars in Figure 3 are calculated as within-subject standard error, as in Morey (2008).

As in Experiment 2, a between-groups ANOVA was conducted on discount rates immediately following the manipulation. In this experiment, there is a significant group effect of argument type ($F(1,64)=7.124$, $p=0.01$); after the manipulation, subjects who read the patient paragraphs were significantly more patient than those who read the impatient paragraphs. There was no significant effect of argument content ($F(1,64)=0.323$, $p=0.572$), or an interaction ($F(1,64)=0$, $p=0.99$). However, as discussed in Experiment 2, within-subject analyses of discount rates are both justified and more powerful, and are therefore the focus of the results section below.

5.2 Results

Subjects in all conditions performed the delay discounting task twice. After completing the task once, subjects read one of the four peer-generated paragraphs, rated the paragraph on its persuasiveness and helpfulness, and then completed the task a second time. A repeated-measures ANOVA using the log transform of discount rates from the first and second set as the within-subjects factor and the argument type (patient or impatient) and content (financial reasoning or prospective thought) as between-subjects factors indicated a significant relationship between discount rate tests and the patience condition ($F(1,60)=23.8$; $p<0.0001$). The average discount rate of subjects viewing patient arguments decreased from $k=0.0111$ to $k=0.0056$ (t-test on log k, $p<0.0001$), while the discount rates of subjects viewing impatient arguments increased, although less reliably, from $k=0.0126$ to $k=0.0153$ (t-test on log k, $p=0.057$).[8] There was no significant effect of argument content ($F(1,60)=0.717$, $p=0.401$), and no significant interaction between argument type and content ($F(1,60)=0.463$, $p=0.5$).

The analysis above indicates that the argument type (patient or impatient) did have a significant effect on behavior, but does not ask whether patient or impatient arguments were more effective. To address this, a repeated-measures ANOVA was performed using adjusted log-transformed discount rates, such that change in discount rates was signed in the same direction for the patient and impatient conditions. Because this analysis is done on log-transformed discount rates, these discount rates and changes are normally distributed. The within-subjects variable was the adjusted discount rate, and the between-subjects variables were the argument type and content conditions. There was a significant effect of argument

[7] Exponential and hyperbolic fits did not differ at the first measurement of this experiment (Wilcoxon sign-rank test, $p = 0.98$), but exponential fits were significantly better at the second measurement (Wilcoxon sign-rank test, $p=0.002$). In this case, all the results reported in the text but one do not depend on which model is used. The exception is the analysis of change in the group viewing "impatient" arguments, as noted in footnote 8.

[8] Using hyperbolic fits, this increase in discount rates for impatient arguments does reach significance at $p=0.02$.

Table 2: Average argument ratings.

	Persuasiveness	Helpfulness
Patient-financial	2.69 (SD=0.70)	2.88 (SD=0.96)
Patient-prospective	3.31 (SD=1.01)	2.44 (SD=1.15)
Impatient-financial	3.75 (SD=0.86)	3.31 (SD=1.01)
Impatient-prospective	4.31 (SD=0.60)	3.00 (SD=0.82)

type ($F(1,60)=7.517$, $p=0.008$), with those in the patient condition having a larger change in discount rates than those in the impatient condition. There was no effect of argument content ($F(1,60)=0.463$, $p=0.5$), and no significant interaction between argument type and content ($F(1,60)=0.717$, $p=0.401$). The patient paragraphs, then, changed behavior more drastically than the impatient paragraphs, but the degree of change was not affected by the content of the argument.

To examine whether argument conditions affected persuasiveness and helpfulness ratings differently, a multivariate ANOVA was performed using argument type and content as between-subjects factors. The average persuasiveness and helpfulness ratings are in Table 2. The ANOVA indicated a significant effect of argument type on persuasiveness ratings ($F(1,63)=25.97$, $p<0.0001$) and a moderately significant effect on helpfulness ratings ($F(1,63)=4.059$, $p=0.048$), with "impatient" paragraphs being rated as more persuasive and helpful than "patient" paragraphs. There was also a significant effect of content type on persuasiveness ratings ($F(1,63)=8.609$, $p=0.005$), with "prospective" paragraphs being rated as more persuasive than "financial" paragraphs, but not on helpfulness ratings ($F(1,63)=2.283$, $p=0.136$). There was no significant interaction between ratings, argument type, and argument content for persuasiveness ($F(1,63)=0.024$, $p=0.878$) or helpfulness ($F(1,63)=0.063$, $p=0.802$). Average ratings can be found in Table 2.

Persuasiveness ratings were not significantly correlated with the absolute percent change in discount rates ($r=0.136$, one-tailed $p=0.142$), though helpfulness ratings were ($r=0.277$, one-tailed $p=0.013$).

5.3 Discussion

In Experiment 4, we asked whether peer-generated advice could change discount rates. Subjects read advice that suggested patience or impatience, and utilized financial reasoning or prospective thought. We observed that discount rates could be significantly increased or decreased depending on the type of advice (patient or impatient) read. This was true for subjects who read either advice emphasizing financial reasoning or advice emphasizing prospective thought.

The reduction in discounting resulting from peer advice emphasizing financial reasons for patience was of comparable size to the reduction observed in Experiment 2, which utilized a neutral presentation of the normative strategy. The effects seen in our previous experiments, then, do not depend either on the source of the advice or on the particulars of the message. The financial reasoning paragraphs used here conceptually resembled the normative argument as presented in Experiments 2 and 3, but did not include all the particulars. Presenting some elements of the normative strategy in the form of advice from others is enough to reduce discounting. Again, however, normative arguments do not reduce discounting to anything near the level of market interest rates.

Interestingly, patient advice emphasizing financial reasoning and patient advice emphasizing prospective thought reduced discounting to a similar degree. Further experiments could utilize more than one exemplar for each category, to confirm these observed differences, or lack thereof, between advice types. Although the advice emphasizing financial reasoning and normative considerations was rated least persuasive, it was not any less effective than the advice relying prospective thought. This is noteworthy, given that opinions about the efficacy of normative instruction are often pessimistic.

We were able to shift discount rates not only towards increased patience, but also towards increased impatience. In the impatient condition, as well as in the patient condition, there was no difference between the subjects who read paragraphs using financial reasoning and paragraphs relying on prospective thought. The fact that advice mentioning financial opportunity costs had the potential to *increase* discount rates, and to do so with equal effectiveness to advice relying on prospective thought, highlights the fragility of people's understanding of the normative strategy.

However, we did observe that the "patient" paragraphs caused significantly greater change in discount rates than the "impatient" paragraphs (50%, compared to 21%). This is despite the fact that the patient arguments were rated as less persuasive and less helpful than the impatient arguments. It thus appears that, although impatient arguments are effective at changing behavior and are rated as more persuasive and helpful, patient arguments are still significantly more effective in changing behavior.

6 General discussion

In experimental studies of intertemporal choice, people generally discount the value of monetary rewards at a rate that far exceeds the market interest rate (Frederick et al., 2002; Reynolds et al., 2006). This set of experiments

shows that one important factor contributing to high rates of discounting is a lack of understanding of the normative strategy, and that providing information regarding the normative strategy results in sustained reductions in discounting. These experiments also demonstrate that providing such information is not enough to reduce discounting to levels near those of market interest rates. Below we discuss the potential remaining reasons for high discounting, and the implications of these findings for designing more effective interventions to reduce discounting.

In an online survey (Experiment 1), only half of the responders spontaneously referred to opportunity costs—interest rates, investments, etc.—as a factor to be considered when making intertemporal choices. The other half of the responders, then, did not mention the most important consideration from a normative point of view. Of those who did refer to opportunity costs, about a third were high discounters, suggesting that many who mentioned this strategy may not have been using it appropriately. These results suggest that many people are unaware of the normative strategy or how it applies to this task, and that some who try to apply the normative strategy do so inappropriately, perhaps because of incorrect estimates of interest rates.

To examine whether addressing these knowledge gaps would reduce discounting, the next experiment (Experiment 2) tested the effects of learning about the normative strategy and/or about interest rates. People who learned about the normative strategy and how to apply it to the task exhibited lower discount rates, suggesting that not all subjects could (or did) apply the normative strategy spontaneously. This reduction in discounting was not temporary, and lasted for at least a month. However, although discounting was significantly reduced, observed discount rates were still very impatient relative to market interest rates. As demonstrated in Experiment 3, even using strong prescriptive language and providing simple heuristics, which made the normative strategy clear, did not reduce discount rates to the level of market interest rates. Finally, Experiment 4 compared the effect of the normative argument to that of other arguments. Arguments that referenced normatively relevant factors (financial opportunity costs) and those encouraging subjects to engage in episodic future thought were similarly effective at changing discount rates. Normative arguments, while perhaps not being any more effective than other arguments, are at least not any less effective. It was also possible to convince people to become more impatient, even when referencing financial opportunity costs. However, arguments in favor of greater patience resulted in shifts that were proportionally larger and more reliable.

Two previous studies reported results related to these findings. Coller and Williams (1999) showed that providing APY comparisons between available market options and the choices in the experiment decreased discount rates by 30%. Similarly, Read et al. (2005) found that framing choices as between taking a smaller amount of money now or investing it at a given interest rate reduced discount rates by up to 57%. Here we did not show the APR of each choice, but rather provided examples of different APRs as part of an explicit normative argument about why rates of return should be relevant to the discounting task. In addition, discount rates were measured both immediately after subjects were given this information as well as one month later, to determine whether any observed changes were lasting. Across three experiments, we found similar or steeper reductions in discounting (35–85%) than Coller and Williams (1999) and Read et al. (2005), and demonstrated that these reductions persisted (at 23–61%) for at least one month.

Though providing normative instruction did reduce discount rates, even with the strongest possible wording in Experiment 3, discount rates still remained above market interest rates. This set of experiments quantifies how much lack of knowledge about the normative argument contributes to high discount rates. There are several other possible contributing factors to high discount rates, which remain to be further explored and quantified. While the simplest explanation might be that subjects simply ignore normative considerations, it is worth also considering potential normative reasons for the continued high rates of discounting.

One possibility is that subjects felt that the future payment was associated with some degree of inherent risk (Benzion et al., 1989; Keren & Roleofsma, 1995; Dasgupta & Maskin, 2005; Bommier, 2006; Halevy, 2008; Gerber & Rohde, 2010). If subjects did not trust that they would receive the delayed payment from the experimenter, whether due to a default on the part of the experimenter or some other unexpected event, then they would be justified in demanding a greater rate of return. However, in Experiment 1 we saw that only 16% of responders spontaneously mentioned risk as a consideration in their choices. Additionally, if risk were a factor in increasing discount rates, we would have expected a difference in discount rates at the month time point between subjects who had already received a delayed payment and those who had not. This was tested in Experiment 2, and no effect was apparent. Risk considerations alone do not seem to be able to account for the high levels of discounting that remained in our experiments.

Another possibility is that subjects may have been credit-constrained. The expectation that discount rates should be near market interest rates assumes that subjects have borrowing opportunities available. It seems unlikely that this would not be the case in the university under-

graduate population that we tested. The most likely major source of credit for these subjects is a credit card. Taking into account possible penalties and late fees, the interest rates on credit cards could approach 50% annually, which is close to the median discount rate we observed immediately after subjects read the guide in Experiment 3. Discount rates in Experiments 2 and 4 were larger this, though. So credit constraints alone seem unlikely to account for the high levels of discounting that remained in our experiments.

A third possibility is that subjects could have expected their baseline levels of consumption to have increased by the end of the delay period, making the future reward relatively less valuable (Frederick et al., 2002, Gerber & Rohde, 2010). Rather than being impatient, then, subjects were being (overly) optimistic. This possibility merits some consideration, though it is unclear why many of our subjects (university students) would have expected a large change in consumption in such a short timeframe (at most six months).

A final possibility is that subjects faced transaction costs in implementing the normative strategy. Subjects might have perceived borrowing money from another source to require a greater amount of effort (for example, remembering their credit bill, not losing the experiment payment card over the course of several months, etc.) and felt that this additional effort was not worth the marginal gain in earnings. If there were transaction costs, subjects could have been licensed to discount according to when they wanted to consume. This explanation would predict that subjects would be more likely to move towards the normative strategy for larger monetary amounts, since the marginal gain would then outweigh any transaction costs. Future research should test this possibility.

The considerations described above are all normative reasons why subjects might continue to discount at a high rate. However, it is also possible that subjects in our experiments simply ignored normative considerations altogether, or weighed them along with other factors. These other factors might suggest different interventions from the ones used here, which might prove more successful at changing discount rates. Two other potential factors are concreteness and perceived temporal distance.

The way people consider time-money tradeoffs could be affected by the relative concreteness of the present versus the future (Trope & Liberman, 2003; Malkoc & Zauberman, 2006; Rick & Loewenstein, 2008). Immediate events tend to be more concrete, more tangible, and easier to imagine, while delayed events tend to be more abstract, more intangible, and harder to imagine. This suggests that manipulations that change the way people construe future events could change discount rates, if these make the receipt of future payments more tangible. The "prospective" arguments in Experiment 4 provide an example of one way to manipulate the tangibility of the future. The prospective argument encouraging patience described potential future situations in which individuals would enjoy having an additional amount of money, or regret having accepted a smaller amount of money sooner.

Peters and Büchel (2010) also found that increasing the tangibility of the future reduced discount rates. In their study, intertemporal choices were accompanied by a reference to an event the subject had planned for that date (e.g., "vacationing in Paris"). They observed a modest decrease (22%) in discount rates when future reward dates were accompanied by a reference to a discrete future event.

Another potential factor is perceived temporal distance. People who perceive the future reward as closer should be more patient than those that perceive it as farther away. Kim (2010) manipulated temporal distance by having subjects read facts framed to reduce ("the average lifespan is 80 years") or enhance ("the human brain begins to deteriorate at age 40") the relative temporal distance to a delayed reward. Those in the latter condition discounted at a significantly higher rate.

However, while manipulations of tangibility or perceived temporal distance do affect discount rates, none of these effects are larger than those we demonstrated here with normative arguments. An important question for future research is whether combining different kinds of arguments or tailoring arguments to specific individuals results in any larger effects on discounting, since normative information is not the entire solution.

Another important question for future research is how generalizable the effects we observed are. Although not complete reductions, Experiments 2 and 3 demonstrate that the effects we observed persist on the same experimental task for at least a month. But would similar manipulations also affect behavior outside the laboratory environment? Would these effects transfer from a discounting task to other decision contexts where interest rates or opportunity costs are normatively relevant (such as a consumer's decision whether to purchase an more expensive yet energy-efficient appliance)?

One potential concern is the extent to which our results might be affected by experimenter demand effects (Nichols & Maner, 2008). Throughout these experiments, we took systematic measures to mitigate this concern. First, our subjects were motivated to reveal their true preferences, since the choices in all of our experiments were incentive-compatible and had real monetary consequences, which were substantial relative to typical subject payments. If subjects were changing their behavior based on expectations alone, they were "paying" to do so. Further, in Experiment 2, the financial guide was carefully written to not privilege patient shifts over im-

patient shifts. It focused on *how* subjects should think about their choices rather than *what* they should choose. In Experiment 4, the arguments were explicitly labeled as being generated by other subjects. Subjects knew that there were multiple experimental conditions and that the experimenter was blinded to their condition assignment, so it was more difficult to infer what the experimenter expected in each condition. Demand effects might be a factor in Experiment 3. However, the primary aim of Experiment 3 was to examine whether the strongest possible manipulation could reduce discount rates to the level of market interest rates, regardless of the reason for this shift. It is noteworthy that even here, despite the clear recommendations made in the guide, subjects did not follow either of the choice rules that were explicitly suggested to them.

In the field, there is inconsistent evidence about the effectiveness of financial education, including attempts to encourage retirement savings in the workplace and efforts to impart general financial knowledge to high school and college students (Bernheim, 2003; Clark & d'Ambrosio, 2003; Mandell, 2006; Borden et al., 2007; Martin, 2007). Although many studies report that financial education changes people's intentions regarding spending or investing, fewer studies are able to measure whether altered intentions do actually carry through to changes in behavior (Choi et al., 2004; Lusardi & Mitchell, 2007; Lusardi, 2008). Several authors claim that given the inconsistent evidence and high cost, financial education should not be continued in its current forms; however, reviews of the topic note greater success when interventions are targeted to a very specific behavior and point in time (Fox et al., 2005; Hathaway & Khatiwada, 2008; Lusardi, 2008; Mandell & Klein, 2009; Willis, 2008). Interventions like ours, that address a specific type of choice immediately before people make those choices, are among the more successful.

It will undoubtedly disappoint and surprise some that providing normative arguments did not reduce discount rates to the level of market interest rates. However, normative arguments did induce changes that are at least as large, if not larger, than those seen with other manipulations. Given these findings, efforts to reduce discounting should not ignore normative instruction, though more effective interventions might combine normative and other arguments, or tailor arguments to the specific individual. On a practical level, the type of manipulation tested here may prove useful, even if the effects are time- and context-limited. Many financial decisions, such as allocating retirement funds or taking out a loan, are made largely at one point in time, and are already subject to the social influences of experts. Changing the information and advice provided at the time of these choices can have profound practical impacts on decision-making.

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Appendix

Contents:

1. Experiment 2—Financial guide

How do you decide which option you prefer?

There are several things you might think about when deciding whether you prefer to receive a larger amount of money in the future or a smaller amount of money now. However, most financial advisors would recommend that you also consider your other financial opportunities when making these decisions. They would say that the best

choice for you will depend on what other opportunities you have.

Maybe you want to spend money today. Then, if given a choice between $20 now and $30 in a month, you might want to accept the $20 now because you would prefer to spend the money right away. On the other hand, maybe you want to make the most money possible in the experiment. In this case, if given a choice between $20 now and $20.50 in a year, you might want to accept the $20.50 in a year because you would prefer to receive the largest amount of money.

Both of these possible goals—to spend money today and to make the most money possible – might be achieved in more profitable ways if you also considered the financial opportunities available to you outside of the experiment. That is, if you have other opportunities, you might be able to spend *more* money now *without* taking the smaller, immediate option in the experiment. Similarly, if you have other opportunities, you might be able to make *more* money overall *without* taking the larger, later payment.

You can borrow or invest money in several different ways.

In this experiment, you can think about each choice as a potential loan or investment. Choosing the smaller, immediate payment over the larger, delayed option is comparable to taking out a loan—to obtain a smaller amount of money now, you forfeit a larger amount of money later. Likewise, choosing the larger, delayed payment over the smaller, immediate option is comparable to making an investment—to obtain a larger amount of money later, you give up a smaller amount of money now.

Outside of the experiment, you might have other ways of borrowing and investing money. You could borrow money by using your credit card, getting a loan from your bank, or asking a friend for money. You could invest money by putting it in a savings account, purchasing a certificate-of-deposit, or buying stocks and bonds.

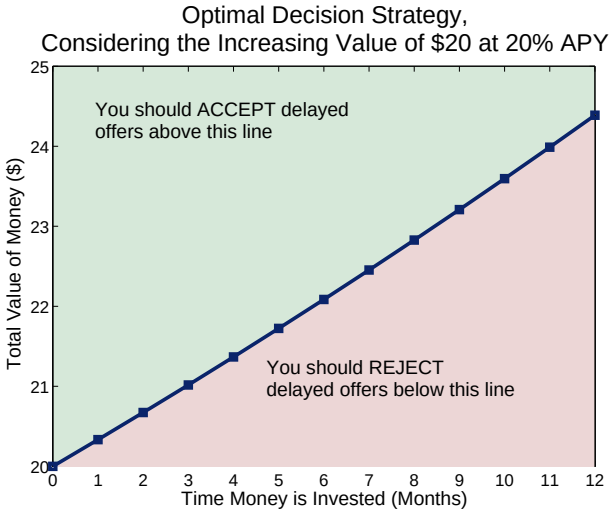
You can use interest rates to compare the choices in this experiment to your other financial opportunities.

An economist or financial advisor would recommend that you compare the opportunities offered in this experiment to the other opportunities available to you outside the experiment. You may know the interest rates that you pay on your other loans or that you earn on your other investments. To compare your choices in this experiment to your options outside the experiment, then, you can think about these choices in terms of interest rates.

The graph below might help you do this. Both borrowing and investing involve interest rates in a similar way. Each line shows, for a different interest rate, the increasing value of $20 if borrowed or invested at that rate for different lengths of time.

When you *borrow* money, you accumulate interest on the amount you borrowed until you repay the loan. One way to use this graph is to think of each line as showing how the amount of money you would have to repay after borrowing $20 grows over time. For example, the red line shows that if you borrowed $20 for a year at an annual interest rate of 20% (compounded monthly), you would have to pay back $24.39 at the end of the year. Choosing $20 now over $24.39 in a year, therefore, is like borrowing money at a 20% annual interest rate.

Likewise, when you *invest* money, you earn interest on your deposit until you withdraw the money. Another way to use the graph is to think of each line as showing how the amount of money you would earn by investing $20 grows over time. For example, the green line shows that if you invested $20 for a year at an annual interest rate of 10% (compounded monthly), you would receive $22.09 at the end of the year. Choosing $22.09 in a year over $20 now, then, is like investing money at a 10% annual interest rate.



You can "have it both ways."

You can use interest rates to compare the choices in this experiment to your other financial opportunities. This comparison is important, because if your other financial opportunities are better, then you can "have it both ways" in this experiment.

Returning to our previous two examples will make this concrete. What if you really want to spend money now? Having other borrowing opportunities means that you could take the larger, delayed payment and still enjoy spending money right away. Given a choice between $20 now and $30 in a month, you could simply accept the smaller, immediate option and spend the money today. However, this would be like borrowing money at a high

annual interest rate of 600%. You might have a credit card with a lower annual interest rate of 20%. If you do, instead of choosing to receive $20 now, you could choose $30 in a month, and still spend $20 today by charging it on your credit card. Then, when you receive the $30 from the experiment, you could pay off the charge on your credit card. At this point, you would still have an additional amount ($9.70) left over. Notice that this way you get what you want—spending the money today—and also gain additional money that you would not have had if you chose the immediate option.

Alternatively, what if you really want to make the most money possible? Having other investment opportunities means that you could take the smaller, immediate payment and still get a larger amount of money later. Given a choice between $20 now and $20.50 in a year, you might want to accept the $20.50 in a year because you prefer to receive the larger amount of money. However, this would be like investing money at a low annual interest rate of 2.5%. You might have a savings account that earns a higher annual interest rate of 5%. If you do, instead of choosing $20.50 in a year, you could choose $20 now, and put that money in your savings account. Then, in a year, you would have $21.02. At this point, you would have the $20.50 that you originally wanted, plus an additional amount ($0.52). Notice that this allows you to get what you want—the larger amount of money—and also earn additional money that you would not have had if you chose the delayed option.

Consider *your* opportunities for borrowing and investment.

All of this advice depends on your financial situation. You might not have a credit card or other convenient ways to borrow money. Even if you do have a credit card, you may have reached your credit limit or be behind on your payments. You might not have a bank account that earns interest, or other convenient ways to invest money. Obviously, if you don't have these other opportunities, then you can't use them in the ways suggested above.

This means that you might make decisions that people with different opportunities might not necessarily make. If you want money to spend today, and you do not have any other borrowing opportunities, then you might accept a smaller, sooner option that other people would reject. If you want the greatest amount of money, and you do not have any other investment opportunities, then you might accept a larger, later option that other people would reject.

Everyone is different.

Everyone will come into this experiment with a different financial situation. For some, considering your other opportunities might lead you to choose the larger, later option more frequently. For others, considering your other opportunities might lead you to choose the smaller, immediate option more often.

Choose what is best for you.

If you think these are good recommendations for you, then you should consider your other financial opportunities when making decisions in this experiment. Remember that you will be paid according to the choice you make on one randomly selected trial, so you should choose the option on every trial that you think is truly best for you.

2. Experiment 3—Prescriptive financial guide

You are more impatient than most participants.

When given the choice between receiving a smaller amount of money sooner or a larger amount of money later, you usually choose to receive the money as soon as possible. Most participants in our experiments are more patient—they are more willing to wait for larger amounts of money.

Your impatience is costing you money.

Because you usually choose to receive the money as soon as possible, you are likely to earn less money than other participants. You would receive the most money from us, of course, if you chose the larger amount of money regardless of the delay.

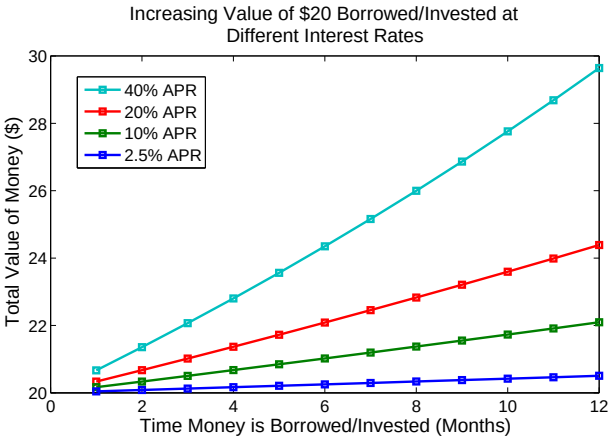
Any expert would tell you that there is a single best strategy in this experiment.

If you were to ask any expert—for example, an economist, someone working in business, or a financial advisor—all of them would tell you that there is a single best strategy in this experiment. Since the choices in our experiment involve money, which can be invested or borrowed, there is a way to definitively determine which option best achieves your goals.

The simple version of the best strategy is to always accept the larger amount of money.

As you will read below, any expert would advise you to accept the larger amount of money, as long as it is worth more than what the immediately available amount would be after investing it over the delay. Since this will almost always be the case with our delayed offers, a simple rule that is very close to the best strategy would be to choose the larger amount of money, regardless of the delay.

The sophisticated version of the best strategy takes into account the rate of return that you could earn on investments.



How should you decide which is the more valuable option in our experiment? If you were to ask any expert, they would tell you that you should approach this decision by thinking about how much the immediate payment would be worth in the future if invested at some interest rate during the given delay. If the immediate option plus the interest from its investment is larger than the delayed option, then it is the better choice; if the delayed option is larger than the immediate option plus interest, then it is the more valuable option.

Consider the example of choosing between $20 today and a larger amount of money in a year. If you were to accept the offer of $20 and invest it at the very high compounding interest rate of 20% per year, you can see from the graph that you would earn a growing amount of interest on that money every month. At the end of the year, the $20 that you invested originally will be worth $24.43. If your choice were between $20 today and $21 in a year, the immediate offer would be the more valuable one. However, if your choice were between $20 today and $25 (or anything greater) in a year, the later amount would more valuable. Since you will probably not be able to find such a high, profitable interest rate, and since we are usually offering you much larger delayed sums than those in the graph, you are almost always better off taking the larger, delayed option in our experiment.

The best strategy lets you "have it both ways."

But what if you *really wanted* $20 today, rather than $25 in a year? You are *still better off* following the best strategy. In this case, you should borrow the $20 from another source, and wait for the $25 we would pay you in a year, rather than foregoing the larger offer and taking the $20 today from us. If you had enough money, you could "borrow" $20 from your bank account at 0% interest. If not, you could borrow money from another source, for example, by taking a cash advance from a credit card. Credit cards tend to have high interest rates, up to 20% per year. Even at this high rate, though, you could borrow $20 from your card to spend today and only owe $4.38 of interest in a year. So you could borrow $20 today and spend it, then pay off your credit card when you receive the $25 from us a year from now, and still have some extra change to spare—money which you would not have had if you took the $20 from us rather than another source.

You are not required to follow this advice—your choices are up to you.

Although we believe that we have provided you with the best advice possible, your selections are still up to you. Remember that you will be paid according to the choice you make on one randomly selected trial, so you should choose the option on every trial that you truly think is best.

3. Experiment 4—Peer-generated advice paragraphs

Patient, financial reasoning

With the rate of savings accounts today, if you are given the option of taking $20 today or $22 three months from now, you should choose the $22 three months from now. I know the numbers are small, but think about it this way...would you rather have $20,000 today or $22,000 three months from now? That is a 10% return on your money in only three months! You would not be able to do that in the stock market very easy and that would entail lots of risk! If you annualize the return, that would be a 40% return per year! If you took the $20,000 today and put it in a savings account, (earning about 1%) in three months you would only have $20,050. The difference is $1950! What would be so important that you would need to have money today and can't wait just a few months down the road to get even MORE money. The percentages are the same for the lower numbers. The amounts are guaranteed, so just take the later payment. Resist the urge to take the money today, delay your gratification and get more in the future!

Patient, prospective thought

You might as well wait to get the money. It's like putting money in the bank. Sometimes you can't touch the money for a certain period of time, but you will have more in the long run because of the interest gained. Just pretend the money isn't there at all. You will be glad you did when you are paid at the end of a few weeks. The money may come in handy when you really need it if you save it--to pay bills or save for something you've been wanting. If you get it now, you will probably just spend it on something you don't really need, like going out to a restaurant or buying something frivolous that you'll regret later. It is much better to have patience and earn a better reward than to enjoy a small amount now. Also, what it comes down to is that you get less money! Why

would you settle for less today if you could simply wait a while and have much more? For example, if I were to receive $15 today rather than $30 in a month, I could spend the $15 on dinner for myself. But if I were to wait, I could take a friend to dinner or put it towards something I've been saving for. You get more, and all you have to do is wait. Waiting isn't so bad.

Impatient, financial reasoning

The stock market on average grows about 10% annually. Therefore, most of the choices there beat the average expectation of the market. However, some, like $34 now or $35 173 days later, do not even compare with what you could do if you invested in the market. While 10% in finance may be a lot, in daily activities, we experience mark ups easily exceed 10%. Thus, from an entrepreneurial or pricing standpoint, waiting more than a month for small return (eg $20 now, or $24 in 40 days) would also seem excessive. Time is money, and you could easily take the $20 and generate more than $24 in 40 days if you, for example, were able to make a cheap product and sell to your friends (like personal birthday cards), then you would obviously want the money now. For larger differences, say $10 now or $15 in 10 days, the wait is not substantial and the increase is dramatic. In situation, it would be better to wait the 10 days to get $15. Lastly, anything with a ridiculously long wait time just isn't worth it. Who would want to wait half a year to receive money that's only marginally more than what they would receive today?

Impatient, prospective thought

Imagine that you are worried about paying your electric bill, the baby sitter, the dentist for your child. The economy is tanking, half your peers have lost their jobs this month. You may be next. You're still there because your hours were reduced. Someone is offering you money. You can take an amount today or you can take somewhat more money in a few weeks. If the payment is much larger at a much later date, the odds of being given the money are reduced. Your need for the money will also be increased. Money now can be used to pay immediate needs to prevent interest charges. It can be put in an emergency fund, something money "later" (that may never arrive or be devalued by inflation) may not provide. A smaller amount of money given today or in the next few days also provides a financial cushion and a margin of security. That cash reserve can be used to pay sudden costs (kid to ER, car repair) that might have caused overdraft charges on a checking account. That $20 extra today suddenly saves $25 in overdraft charges or late fees. $35 in six months cannot equal that value.