Happiness and Time Preference: The Effect of Positive Affect in a Random-Assignment Experiment

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Abstract

We conduct a random-assignment experiment to investigate whether positive affect impacts time preference, where time preference denotes a preference for present over future utility. Our result indicates that, compared to neutral affect, mild positive affect significantly reduces time preference; affects were induced using short film clips. This result is robust to various specification checks; and alternative interpretations of the result are considered and rejected. Our result has implications for the effect of happiness on time preference and the role of emotions in economic decision-making, in general. Finally, we reconfirm the ubiquity of time preference and start to explore its determinants.

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Initially ignored—and subsequently thought to be disruptive—emotions have historically received a bum rap from decision researchers (Isen 2008; and Loewenstein and Lerner 2003). A great deal of recent research, however, has shown that emotions—and in particular mild positive affect—can have important, and often salutary, effects (Isen 2008). For example, positive affect has been shown to increase cognitive flexibility (Isen 2008); reciprocity in "gift-exchange" games (Kirchsteiger et al 2006); work effort and productivity (Erez and Isen 2005; and Oswald et al 2008); loss aversion (Isen et al 1988); and risk aversion when the stakes are high (Isen and Geva 1987); and to decrease spending and willingness to pay (Cryder et al 2008; and Lerner et al 2004); and risk aversion when the stakes are low (Isen and Geva 1987). We conduct a random-assignment experiment to investigate whether positive affect impacts time preference, where time preference denotes a preference for present over future utility (Frederick et al 2002). Our results indicate that mild positive affect significantly reduces subjects' time preference.

Because an individual's rate of time preference affects his or her decisions, economists have shown tremendous interest in modeling and estimating time preference (Andersen et al 2008; Benhabib and Bisin 2005; Coller and Williams 1999; Coller et al 2003; Gul and Pesendorfer 2001; Harrison and Lau 2005; Harrison et al 2002; Laibson 1997; Loewenstein and Prelec 1992; O'Donoghue and Rabin 1999; Rubinstein 2003; Shapiro 2005; Thaler and Shefrin 1981; and Warner and Pleeter 2001). Time preference has been shown to be commonplace, is believed to lead to self-control problems, and may increase the likelihood of negative outcomes—for example, overconsumption, obesity, addiction, reduced human capital accumulation, and diminished retirement saving (Ameriks et al 2007; Benhabib et al 2010; Bernheim and Rangel 2004; Frederick et al 2002; and Kirby et al 1999). Further, Mischel et al (1989) found that preschoolers' ability to delay gratification was a strong predictor of SAT scores over a decade later.

Initial empirical evidence for our hypothesis comes from the General Social Survey (GSS), which in three waves (1973, 1974, and 1976) includes both a measure of self-reported happiness ("Taken all together, how would you say things are these days—

would you say that you are very happy, pretty happy, or not too happy?") and time preference (agreement or disagreement with the statement, "Nowadays, a person has to live pretty much for today and let tomorrow take care of itself."). We find that happier respondents are less likely to agree with the "live for today" statement than are less happy respondents. This holds even after controlling for covariates that have been shown to be related to happiness (see Appendix A for regression results). While this empirical evidence provides loose support for our result, it has a number of shortcomings. Most notably, the direction of causation cannot be identified. Further, this measure of time preference is imperfect at best. While in this paper we will study the impact of mild positive affect—rather than happiness—on time preference, our methodology will address both of these shortcomings.[1]

To explore the relationship between mild positive affect and time preference, we run a random-assignment experiment in which subjects' time preference is measured after their mood has been manipulated. Specifically, subjects are randomly assigned to the treatment group—positive affect—or the control group—neutral affect. The appropriate affect is induced using short video clips. Time preference is measured using a standard matching procedure, in which subjects report the present value of a future payment and truthful responses are incentivized.

Our results indicate that subjects in the treatment group exhibit significantly lower time preference than do subjects in the control group. This result is robust to various specification checks. The next section of this paper provides a brief overview of the literature; the third and fourth sections describe the experimental design and the econometric specifications, respectively; the fifth section presents the results; the sixth section presents two alternative interpretations of the result and explains why our interpretation of the result—that positive affect decreases time preference—is supported; finally, in the discussion section, potential mechanisms are discussed, along with implications of the result.

[1] The degree to which one can generalize from our result to the impact of happiness on time preference is explored in the discussion section.

Literature Review

The impact of mild positive affect on decision-making has been extensively studied over the past 20 years. Researchers, most notably Alice Isen, have conducted random-assignment experiments which demonstrate that mild positive affect can have beneficial effects on decision-making, increasing cognitive flexibility, work effort, helpfulness, and creativity (recent reviews include Isen 2008; and Lyubomirsky et al 2005). Moreover, mild positive affect does not appear to impede decision-making as many would expect it to. For example, there is no experimental evidence that mild positive affect causes individuals to be impulsive, thoughtless, or overly optimistic (Isen 2007).

Research that explores the impact of positive affect on self-control is most relevant to our study, since the psychological concept of a lack of self-control overlaps with the economic concept of time preference. For example, Tice and Bratslavsky (2000) reported that psychologists generally understand a lack of self-control to be distinguished by a proclivity toward short-term gains, even in the face of long-term costs. Three recent psychological studies are of particular interest: First, Baumeister et al (1998) found that mild positive (negative) affect increases (decreases) the proportion of time subjects spent studying for a non-incentivized test in the laboratory; second, Isen and Reeve (2005) demonstrated that mild positive affect increases intrinsic motivation for interesting tasks; and third, Isen (2007) reported that mild positive affect replenishes will power.[2] These results are taken to indicate that mild positive affect increases forward-looking thinking, the ability to stay on task, and self-control. In summary, this line of research is far smaller and less well corroborated than other research regarding the impact of mild positive affect on decision-making, leading Isen and Reeve (2005) to conclude that, "the topic of the role of positive affect in development of self-control seems a promising one for investigation."

[2] Six more studies considering the effect of affect on self-control have been conducted exclusively with young children (Fry 1975; Mischel et al 1968; Mischel et al 1973; Schwarz and Pollack 1977; Seeman and Schwarz 1974; and Underwood et al 1973). For developmental reasons, the results of these papers cannot be generalized to adults (Bucciol et al 2009).

A related strand of economic literature considers the effect of self-control on subjective well-being. This research attempts to identify the impact of poor self-control by comparing the happiness of individuals who make decisions that are thought to result from a lack of self-control to those who do not make such decisions. For example, Frey et al (2007) found that heavy TV watchers report being less happy; and Stutzer (2007) found that obesity reduces the subjective well-being of individuals who report having limited self-control. Further, Gruber and Mullainathan (2005) found that cigarette taxes increase happiness among individuals prone to smoke. The authors interpreted the tax as a self-control device, which suggests that a lack of self-control may cause unhappiness. These studies appear to indicate that a lack of self-control reduces happiness. By extension this suggests that time preference may affect positive affect. While this direction of causation—the opposite of the one tested in this study—may hold, it is outside of the scope of the current paper to explore this possibility.[3]

Finally, this research also adds to a small literature regarding the determinants of time preference. Two well-established results in this literature are that (a) the magnitude of the future payment, and (b) the length of time over which discounting occurs, are important determinants of time preference (Kirby and Marakovic 1996; and Thaler 1981). More recently, it has been shown (a) that high cognitive load increases time preference (Benjamin et al 2006; and Hinson et al 2003); and (b) that individuals with greater cognitive skills, as measured by IQ tests, exhibit lower time preference (Burks et al 2009). This study adds to the literature by identifying a new determinant of time preference.

Experimental Design

We examined the effect of positive affect on time preference in a laboratory experiment conducted at Santa Clara University. In brief the experimental procedure was as follows (additional details are provided below): First, subjects read and signed an informed

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[3] An additional paper, Wertheim and Schwarz (1983), found that self-reported depression was correlated with a preference for immediate (delayed) benefits (costs). This study is correlational and does not provide any evidence regarding a causal relationship in either direction.

consent form. Second, subjects were instructed (a) that they would be answering 30 time-preference questions, (b) that their payment would be based on one of these questions, (c) that the payment question would be determined randomly at the end of the session, (d) that a mechanism would be used to provide an incentive for truthful responses, and (e) that they would receive certificates of guarantee for their payments that could be redeemed off-site after the experiment for cash. Third, the mood inducement procedure was administered. Fourth, subjects answered the 30 time-preference questions. Fifth, subjects answered questions regarding their subjective well-being and mood. Sixth, payments were determined. Seventh, subjects answered questions regarding their demographic and psychological characteristics. Finally, subjects received their certificates of guarantee, which indicated the payment amount, and the time and location after which the certificate could be redeemed for cash. In total, the experiment lasted approximately 45 minutes, and subjects received an average of $24 for their participation.

Participants

Sixty-nine undergraduate students were recruited from introductory English courses that all Santa Clara students are required to take; these courses were chosen in an attempt to avoid potential disciplinary bias.

Participant instructions

After completing the informed consent form, subjects received detailed written instructions, which were also read aloud by the experimenter. The instructions introduced the time-preference questions and informed the subjects that the experimental procedure had been designed to encourage truthful responses. Specifically, subjects were told that the 30 time-preference questions would be of the following form: “What amount of money, \$$p$, if paid to you today would make you indifferent to \$$m$ paid to you in t days?” Five values of m, {\$11.34, \$18.31, \$24.28, \$32.84, \$51.71}, and six values of t, {1 day, 3 days, 7 days, 14 days, 28 days, 56 days}, were used. We chose abstruse values for m to discourage the use of heuristics, such as answering one-half of m for each p. The questions were randomized so that there was no pattern in the order of the values of m or t; this was done to avoid anchoring. The time-delay, t, was not extended beyond two months so that all possible payouts would occur within the academic term. Also, values of t were chosen to avoid weekends and school holidays, and with the exception of the 1- and 3-day delays, to fall on the same day of the week as the experimental session.

Subjects were informed that their payment would be based on one of the 30 time-preference questions, that the payment-question would be determined randomly at the end of the session, and thus, that they should answer each question as if their payment depended on it. Subjects were then introduced to the Becker-DeGroot-Marschak (BDM) mechanism and informed that it would be used to provide an incentive for truthfully answering the 30 time-preference questions (Becker et al 1964; and Benhabib et al 2010). Specifically, the amount and timing of the payment were determined as follows (using the BDM mechanism): m balls numbered 1 through m were placed in a spinner, and one was chosen. If the number R on the drawn ball was less than or equal to p, then the subject was paid \$$m$ in t days. If the number drawn exceeded p, the subject was paid \$$R$ on the day of the experimental session. Finally, note that since the values of m were fractional, the number of balls placed in the spinner was rounded to the next highest integer. For example, if m = \$11.34, then balls numbered 1 through 12 were placed in the spinner. Finally, subjects were guided through numerous examples in an attempt to ensure that they understood the process.[4]

Subjects were also informed of the payment-pickup process, which was designed carefully in an attempt to equalize the transaction costs and uncertainty associated with experimental payments—challenging design issues in all time preference experiments. For example, consider a design wherein present payments are distributed on-site at the end of the experimental session, and future payments are distributed off-site. Then the transaction costs associated with future payments are higher than those associated with present payments (since future payments require subjects to make an additional trip to retrieve their payment). Consequently, subjects' preference for present versus future

[4] Subjects did not answer the 30 time-preference questions at this time. Rather, they answered them immediately following the mood inducement procedure. This order of events eliminated the possibility that the induced mood could have been moderated, if not nullified, by reading the participant instructions.

payments could be affected by this cost differential, confounding any measure of time preference.

In our experiment, subjects were issued certificates of guarantee at the end of the experimental session for all payments. These certificates were redeemable for cash at an administrative office (which was in a different building than the one in which the experimental session was conducted). The certificate also included the location, date, and time, after which it was redeemable. Even subjects receiving present (same-day) payments were required to wait one hour to redeem their certificates. Further, the certificate included contact information for the experimenters—professors at Santa Clara University—and instructed subjects to contact the experimenters if there were any problems redeeming their certificates.[5]

Subjects were also informed of the anonymous and blind nature of the payment-process. They were told (a) that one person would prepare the payment-envelopes, (b) that a second person would distribute the sealed payment-envelopes, (c) that neither would know their identity, only their subject identification number, and (d) that the envelope-distributor would not know the payment amount. This procedure was implemented in an attempt to minimize the potentially confounding role of subject-experimenter reciprocity.

[5] The challenges discussed above have been addressed in numerous ways in the literature. For example, Benhabib et al (2009) attempt to address the issue by distributing personal checks on-site for present payments and mailing checks for future payments. However, this resolution is not wholly satisfactory, since there is uncertainty associated with mail delivery, and this uncertainty only affects future payments. In a recent series of working papers, Andreoni and Sprenger (**2010a; 2010b) improve upon this design by restricting subjects to intertemporal decisions that include front-end delays and mail personal checks to subjects for all experimental payments. Further, they attempt to reduce uncertainty about mail-delivery by restricting their subjects to dorm-residents and partnering with campus mail administrators to attempt to ensure timely payment delivery. Our design most closely resembles that used by Coller and Williams (1999) and by Harrison et al (2002). In these papers, subjects are given certificates of guarantee for all payments that are redeemable for personal checks at an administrative office. Our design is identical in that no experimental payments were made on-site. One substantive difference between our methodology and those cited above is that we paid our subjects with cash and not checks. We think this improves upon the use of personal checks because it removes any uncertainty and/or heterogeneity regarding banking practices, timing of fund availability, and branch-accessibility. Further, our design obviates the use of mail and any uncertainty inherent with mail-delivery. Finally, providing contact information for the experimenters on the certificate of guarantee is similar to the tactic used in Andreoni and Sprenger (2010a; 2010b), in which the experimenters distributed Professor Andreoni's business card and told subjects to contact Professor Andreoni if they didn't receive their payments in the mail.

Mood-inducement procedure

We attempted to manipulate subjects' mood by showing them a short film clip. The use of film clips to induce moods is common in psychological and, increasingly, economic experiments (Gross and Levenson 1995; Kirchsteiger et al 2006; Oswald et al 2008; and Rottenberg et al 2007). Westerman et al (1996) evaluated eleven mood-inducement procedures. They found that the use of film or story was the most effective means of inducing positive affect.

In our experiment, half of the subjects (34 of 69) were randomly assigned to the treatment group and watched a film clip intended to induce positive affect. The other half of the subjects (35 of 69) were assigned to the control group and watched a film clip intended to induce neutral affect. Except for the variant film clip, the experimental protocol was identical for the control and treatment groups.

Our choice of film clips followed Gross and Levenson (1995). There, over 200 film clips were evaluated for their efficacy in inducing each of seven different affects. Nearly 500 subjects were asked to rate on a scale from 0 to 8 the greatest intensity of each affect they felt during the course of the film clip. The strongest affect felt during the clip was dubbed the target affect for that film. The authors then reported the two most effective clips for inducing each of the affects.

In our experiment, the positive-affect film clip was a short montage of stand-up comedy bits from the 2002 "Robin Williams – Live on Broadway." This choice followed directly from Gross and Levenson (1995), in which one of the two most successful positive-affect-inducing film clips was Robin Williams's 1986 "A Night at the Met." We opted for the 2002 montage primarily because it was more current and reduced concerns of the humor being out-dated. The neutral-affect film clip was also one commonly used by psychologists and featured tranquil images of landscapes and wildlife in Denali National Park, Alaska (for example, Rottenberg et al 2007).

The success of the mood-inducement procedure was measured using the Positive Affect Negative Affect Schedule (PANAS), which was administered immediately after the time preference questions. The PANAS asks subjects to rate on a scale from 1 to 10 how much of each of 7 positive and 9 negative affects they feel. The positive affects are amusement, arousal, contentment, happiness, interest, relief, and surprise; the negative affects are anger, confusion, contempt, disgust, embarrassment, fear, pain, sadness, and tension. In addition, subjects were asked whether the film clip made them happier, sadder, or neither; and whether the film clip put them in a better mood, worse mood, or neither.

Time-preference questions and completing the session

Immediately following the mood-inducement procedure, subjects answered the 30 time-preference questions. Then, subjects answered questions about their subjective well-being. Next, the payment question was determined, and the BDM mechanism was implemented. Finally, subjects answered questions regarding their demographic and psychological characteristics, including happiness and personality traits.

The measure of happiness comes from the question, "Taken all together, how would you say things are these days—would you say that you are…," where possible responses ranged from 1 (completely unhappy) to 7 (completely happy). This measure is similar to the ones used in the GSS and the World Values Survey (WVS), each of which has been used extensively in the happiness-economics literature as a measure of long-term happiness. The GSS, however, uses a 3-point scale and the WVS a 4-point scale. We expanded the scale to 7 points to increase sensitivity. This question was asked after mood-inducement and the time-preference questions, but because of its broad scope, it should not be affected by mood-perturbation (Kahneman et al 1999). The personality-traits questions were a subset of the Five Factor Personality Test that were intended to measure impulsivity and self-control (Hendricks et al 1999). Subjects strongly agreed with, agreed with, were neutral about, disagreed with, or strongly disagreed with each of 23 statements. These statements are listed in Appendix B. We included these questions to determine whether they were related to time preferences over money as well as to control for any pre-existing differences across subjects.

When all surveys were completed, subjects received certificates of guarantee for their payments and exited the experimental session.

Econometric Specifications

In analyzing the relationship between positive affect and time preference, we consider a model of the form:

$$p = \beta H + \sum_m \delta_m I_M(m) + \sum_t \alpha_t I_T(t) + \sum_m \sum_t \phi_{mt} I_M(m) \times I_T(t) + \sum_K \sum_k \lambda_{Kk} I_K(k) + \varepsilon \quad (1)$$

where H is a dummy for the positive-affect treatment, M is the set of all future payment amounts m, T is the set of all time delays t (in days), and p is the subjective present value of \$$m$ in t days. The indicator functions $I_M(m)$ and $I_T(t)$ take the value of one for a given m and t, respectively, and zero otherwise; this specification allows for all possible linear and interacted effects of time-delay and future payments on discounting. The model also includes demographic controls. K denotes the set of controls, and for a given control, k is the set of possible values. For example, for $K = gender$, $k \in \{male, female\}$, and $I_{Gender}(male)$ equals one if the subject is male, and zero otherwise.

In this specification, the amount \$$p$ necessary today to be indifferent to \$$m$ in t days is considered to be a function of m, t, and $m*t$; that is, the regression is fully saturated with respect to the effect of time and future payments on present value. The appeal of this econometric specification is that it imposes minimal ex ante structure and does not depend on the distribution of p. Thus, this parametrization does not restrict us to a specific model of discounting and fits the conditional expectation function for p perfectly (Angrist and Pischke 2009).

Our choice of the fully-saturated model follows from the underwhelming support we found for the exponential, fixed-cost, and hyperbolic models of discounting, which we estimated and tested using the techniques described in Benhabib et al (2010).[6] Those authors also rejected the exponential and hyperbolic models, though they found support for fixed-cost discounting.

Finally, OLS is used to estimate equation (1). Corrected standard errors are calculated by clustering observations by subject; this is necessary since subjects answered 30 questions and their responses are unlikely to be independent.

Results

Demographic characteristics of subjects

There is no significant difference between the values of any of the demographic characteristics for the treatment and control groups, so random assignment is valid ex post (see Table 1). Roughly half of the subjects are female. The division of students across colleges roughly mimics the university's population. Santa Clara University has three colleges: arts and sciences, business, and engineering. Only a small number of subjects are in the engineering college, the rest are evenly split between arts and sciences and business. Roughly half of the subjects report that they practice a religion. Given that Santa Clara is a Jesuit university, it is not surprising that the most heavily represented religion is Christianity, accounting for three-quarters of the subjects. Almost all other subjects consider themselves Atheists, with only two students identifying a different religion. The next demographic factor we control for is race. Almost all of the subjects consider themselves white (63%), Asian (20%), or Hispanic (14%), with only two subjects identifying with other racial/ethnic categories. Finally, subjects were asked to give their best estimate of their family income. The mean response falls in the $100,000 - $150,000 category, while the median is in $150,000 - $200,000 category. Few students report family income of less than $80,000 or greater than $500,000.

As noted above, the measure of long-term happiness is hypothesized to be unaffected by mood-inducement. Indeed, there is no statistical difference in happiness for the treatment

[6] Please contact the authors for complete results.

and control groups. Mean responses, reported with other descriptive statistics in Table 1, are indistinguishable (*t-test p-value* = 0.923), as is the response-distribution (*chi-square p-value* = 0.353). Thus, it appears that long-term happiness is independent of short-term affective shocks.

Subjects exhibit time preference

As in Benhabib et al (2010), discounting will be represented by D, the factor that when multiplied by m yields the dollar amount p necessary today to make one indifferent to \$$m$ in t days: $D = p/m$. Discounting may itself depend on the levels of m and t, so $D = D(m, t)$. Without this structure, comparisons of p across different values of m would be meaningless, since p's domain is defined by m. This structure will be relinquished in the regression analysis, where equation (1) will be estimated using the absolute level of p as the dependent variable. Table 2 presents observed values of D for all (m, t)-combinations; panel (a) pools all subjects, and panels (b) and (c) present the treatment and control groups, respectively.

Subjects consistently discount the distant future more heavily than they do the near future. Holding m constant, D clearly trends downward in all panels; this is visualized in Figure 1(a) for the pooled data. In panels (a) and (c) of Table 2, there are few exceptions to the downward trend. The monotonicity of the negative relationship between D and t is violated more frequently in the positive-affect treatment (see panel (b) of Table 2), but in general the relationship holds.

The relationship between future payment m and the discount factor D, holding t constant, does not follow so consistent a pattern. For virtually no time-delay t is there monotonicity in D with respect to m. Nor is there a clear non-monotonic trend (for example, in panel (a), for $t = 1$, D has two interior peaks, for $t = 14$, there appears to be an inverted U-shape, and for $t = 56$, a U-shape).

Mood-inducement is successful

Mood-inducement had the intended effect on affect. The net positive affect—the sum of the positive affects minus the sum of negative affects from the PANAS—of subjects in the positive-affect treatment was significantly higher than that of subjects in the neutral-affect treatment (7.364 vs. 0.531, *p-value* = 0.048 for *one-sided t-test*). Further, controlling for payment, watching the positive-affect clip made subjects significantly more likely to state that the film clip made them happier (*p-value* = 0.048) and put them in a better mood (*p-value* = 0.076).[7]

Positive affect reduces time preference

Preliminary support for positive affect reducing time preference can be seen in panel (d) of Table 2, which reports the difference between $D_{Treatment}(m, t)$ and $D_{Control}(m, t)$. This difference is positive for each (m, t)-combination; the positive-affect inducement unambiguously reduces time preference. This is visualized in panel (b) of Figure 1, which separately illustrates the discount factors for the control and treatment groups over time-delay t; the average discount factor for each group is emphasized.

Estimating equation (1) without demographic controls, we see further evidence that positive affect reduces time preference. Controlling for future-payment and time-delay, watching a positive- instead of neutral-affect film clip increases the present value of future payments by $2.20 on average (see column (1) of Table 3). This result is marginally statistically significant, with a *p-value* = 0.054. Further, the magnitude is quite substantial. Even for the largest value of m, $51.71, the increase in the present value of the future payment is over four percent. Since we are not studying the effects of time and monetary sums on time preference, the coefficients of the m and t dummies and their interactions are not presented.

In column (2), controls are added for gender, race, family income, religion, regular religious service attendance, and college. Treatment is now statistically significant,

[7] The last two affect checks are in the final questionnaire, which was administered after the payments were determined; hence the efficacy of mood inducement is tested, not with simple t-tests, but with regressions controlling for payment.

increasing present value by \$2.01 on average. In columns (3) and (4), the analyses of columns (1) and (2), respectively, are repeated controlling for self-reported, long-term happiness. The main effect is stable regardless of the specification; thus, the results appear to be robust.[8] Finally, we estimate equation (1) conditional on $p < m$; that is, we exclude observations in which subjects did not discount. With the restricted sample, the magnitude and the significance of the treatment effect increase (see Columns (5) through (8) of Table 1). The positive-affect inducement now increases the present value of a future payment by an average of \$3.00 in each of the four restricted specifications.

In summary, our experiment demonstrates that mild positive affect significantly increases the present value of a future payment, a result that is robust to a number of econometric specification-checks. The magnitude of the increase depends on the value of the future payment and the specification, ranging from 4% of the future payment (specification (4), m = \$51.71) to 27% (specification (8), m = \$11.56).

Robustness

We interpret the increase in the present value of a future payment for subjects in the positive-affect treatment—relative to those in the neutral-affect treatment—to indicate that positive affect reduces time preference. In this section we examine—and demonstrate the invalidity—of two alternative interpretations of the result: (1) that positive affect increases the subjective probability weights or decreases the risk aversion associated with receiving future payments; and (2) that positive affect acts as a substitute for money.

First Alternative Interpretation

The first alternative interpretation would imply that the present value of a future payment increases for subjects in the positive-affect treatment, not because of any impact on time preference, but because of increased subjective probability weights or decreased risk

[8] These results are robust to inclusion of the summed responses to the statements regarding personality traits, for which there was no statistically significant difference by treatment.

aversion associated with future payments; both of which would increase the expected utility of future payments, positively biasing the treatment effect and confounding our interpretation of the result.

Before continuing let's fix notation. The indifference condition is: $\pi_1 u(x) = \delta\pi_2 u(y)$, where π_1 is the subjective probability associated with receiving payment today, δ is time preference, and π_2 is the subjective probability associated with receiving payment in the future. The first alternative explanation assumes that positive affect only impacts subjects' subjective probability weights or risk preferences associated with *future* payments (i.e., the right hand side of the indifference condition). However, positive affect clearly impacts subjects' subjective probability weights or risk preferences associated with present payments as well; most, if not all, research that examines these relationships does so for present outcomes, and not for future outcomes. Thus, one needs to consider the *relative* impact of positive affect on subjects' risk preferences or subjective probability weights associated with future versus present payments.

To our knowledge, there is no research that considers the impact of positive affect on intertemporal subjective probability weights—for example, the *differential* impact of positive affect on subjects' assessment of the probability of present versus future payments, π_1 versus π_2, respectively. Similarly, to our knowledge, there is no research that considers the impact of positive affect on intertemporal risk preferences—for example, the *differential* impact of positive affect on subjects' risk preferences for present versus future payments. There is research on temporal proximity and risk (i.e., risk preferences for present versus future outcomes) and positive affect and risk, but not on the interaction between temporal proximity, positive affect, and risk preferences. The research on temporal proximity and risk finds that risk aversion tends to increase with temporal proximity (Noussair and Wu 2006). That is, people are more risk neutral over future outcomes than they are over present outcomes. In our analysis below, we will assume this is true. The research on positive affect and risk (discussed previously) finds that positive affect decreases risk aversion when stakes are low and increases it when stakes are high (Isen and Geva 1987).

Following the natural assumptions of the first alternative interpretation, let's assume that the probability of future payment, π_2, is assessed to be higher by subjects in the positive-affect treatment than by subjects in the neutral-affect treatment, i.e., $\pi_{2,\text{ positive}} > \pi_{2,\text{ neutral}}$. Further, it seems natural to assume that positive affect influences subjects' assessment of the probability of present payments in a similar manner, i.e., $\pi_{1,\text{ positive}} > \pi_{1,\text{ neutral}}$. To fully examine the impact of positive affect on our interpretation of the results, one needs to consider the following three cases: (SP1) $[\pi_{2,\text{ positive}}/\pi_{1,\text{ positive}}] < [\pi_{2,\text{ neutral}}/\pi_{1,\text{ neutral}}]$; (SP2) $[\pi_{2,\text{ positive}}/\pi_{1,\text{ positive}}] = [\pi_{2,\text{ neutral}}/\pi_{1,\text{ neutral}}]$; and (SP3) $[\pi_{2,\text{ positive}}/\pi_{1,\text{ positive}}] > [\pi_{2,\text{ neutral}}/\pi_{1,\text{ neutral}}]$.

Before analyzing the implications of these three conditions, we will set up analogous conditions to examine the impact of positive affect on intertemporal risk preferences. Let r_t denote risk aversion over an outcome to be realized in time period t. The assumption that risk aversion increases with temporal proximity can be denoted as $r_1 > r_2$. Again, following the natural assumptions of the first alternative interpretation, let's assume that positive affect decreases risk aversion, i.e., $r_{2,\text{ positive}} < r_{2,\text{ neutral}}$ and $r_{1,\text{ positive}} < r_{1,\text{ neutral}}$. There are three possible cases: (RP1) $[r_{2,\text{ positive}}/r_{1,\text{ positive}}] > [r_{2,\text{ neutral}}/r_{1,\text{ neutral}}]$; (RP2) $[r_{2,\text{ positive}}/r_{1,\text{ positive}}] = [r_{2,\text{ neutral}}/r_{1,\text{ neutral}}]$; and (RP3) $[r_{2,\text{ positive}}/r_{1,\text{ positive}}] > [r_{2,\text{ neutral}}/r_{1,\text{ neutral}}]$.

In Appendix C, it is shown that (SP1) and (RP1) each negatively bias our interpretation of the result; neither (SP2) nor (RP2) biases our interpretation of the result; and (SP3) and (RP3) each positively bias our interpretation of the result.

While (SP3) and (RP3) cannot be ruled out entirely, they are highly unlikely to hold, as each requires that the impact of a positive affective shock in the present period be magnified for future outcomes in comparison to the present. In order to consider the likelihood of this, we need to consider a model outside of standard economic theory, one that allows current affective states to impact decisions about the future. One such model is that of projection bias.[9] In the context of our experiment, projections bias would suggest that: (a) subjects project their current mood into the future, and (b) the magnitude of the impact of their current affective state will be smaller on their assessment of future subjective probability weights or risk preferences than on their assessment of current subjective probability weights or risk preferences. So, if anything, it would be more natural to expect that subjects in the positive-affect treatment—relative to subjects in the neutral-affect treatment—would increase π_1 more than π_2, and decrease r_1 more than r_2, ruling out (SP3) and (RP3).

Further evidence that (RP3) is unlikely to hold can be seen in our results. As discussed previously, Isen and Geva (1987) have shown that positive affect decreases (increases) risk aversion when stakes are low (high). If (RP3) holds, then Isen and Geva's findings would suggest that as stakes (future payments) increase subjects in the positive- relative to neutral-affect treatment would experience increasing risk neutrality for future outcomes compared to present outcomes. However, we do not observe this pattern. That is, the *difference* between discount factors for subjects in the positive- and neutral-affect treatment is not increasing with the future payments. These differentials are reported Table 2(d). Reading the table down each column for any time delay—and for the average across all time delays in the last column—there is no observable upward trend.

To end the discussion of (SP3) and (RP3), it should be noted that the likelihood that (SP3) and (RP3) hold increases with the certainty of present payments. In the extreme, if present payments were completely certain, and future payments were not, then π_1 could not change (since it already equals one) and r_1 would be irrelevant. Then (SP3) and (RP3) could hold. However, as noted in our experimental design, we attempted to equalize, as much as possible, the uncertainty associated with present and future payments. In particular, the certificates of guarantee were only redeemable off-site at an administrative office and were not redeemable until one hour after the experimental session ended. This procedure is clearly less certain than a procedure in which present

[9] This well-established model asserts that when assessing the future, individuals have a tendency to assume they will be under the influence of their current affective/visceral state more than they actually will be (Loewenstein et al 2003).

payments are made on-site immediately following the completion of the experimental session. Hence we believe $\pi_1 < 1$.

Finally, we have two additional pieces of evidence that our experiment is capturing the impact of positive affect on time preferences, and not the impact of positive affect on risk preferences or subjective probability weights. First, five of the questions regarding personality traits—those bolded in Appendix B—include explicit reference to intertemporal decision-making. After correcting for the direction of the scale, we sum the responses to these five questions and regress the present value of the future payment on this sum.[10] The results indicate that increased self-reported impulsivity in intertemporal decision-making significantly reduces the present value of the future payment (*t-test p-value* = 0.049). This finding is consistent with our interpretation of the result: that positive affect decreases time preference. Further, since these questions have nothing to do with risk preferences or subjective probability weights this result would not be expected if either were driving subjects' responses to the time-preference instrument.

Second, gender—which has been shown to be a significant determinant of risk preferences (see Croson and Gneezy 2009)—is not a statistically significant determinant of the present value of a future payment. Specifically, if our result were due to risk preferences, and our subjects exhibit standard risk preferences (i.e., women are more risk averse than men), then in regressions of the present value of a future payment on a female dummy, the coefficient on female should be negative and significantly different than zero. In none of our specifications in Table 3 do we find support for the present value of a future payment being different for female subjects than for male subjects: the t-statistic on the female dummies ranges from -0.16 to 0.00, depending on the specification. Thus, it seems unlikely that our result can be explained by risk.

[10] The impact of positive affect on the present value of the future payment is robust to inclusion of this sum as a regressor in all of the specifications reported in Table 3 in the paper.

Second Alternative Interpretation

We will now consider the second alternative interpretation, namely that positive affect acts as a substitute for money today, making subjects in the positive-affect treatment more willing to postpone income to a state in which they may be in a less good mood. The intuition is that if a happy mood today decreases the marginal utility of money today without directly increasing instantaneous utility, then one unambiguously needs more money today in a happy mood than in a neutral mood.

This alternative interpretation is supported by two assertions: (A1) that a happy mood today substitutes for money today (i.e., a happy mood and money are both arguments of the instantaneous utility function), and (A2) that a happy mood today decreases the marginal utility of money today (i.e., the cross-derivative is negative). Before assessing the validity of this alternative interpretation, we will set up an appropriate model to examine it carefully. In it, we assume instantaneous utility in period t is given by $u(x_t, a_t)$, where x_t is money in period t and a_t is the affective state in period t. In our experiment, subjects were asked 30 questions of the following form: "What amount of money if paid to you today (*p*) would make you indifferent to *m* dollars paid to you in *t* days." In other words, given affective state a_1 in period 1, a_2 in period 2, and total wealth level x_2 in period 2 (equal to expected personal wealth in period 2, plus *m* dollars), they were asked to choose the value *p* in period 1 (where x_1 equals personal wealth in period 1, plus *p* dollars) to solve $u(x_1, a_1) = \delta u(x_2, a_2)$.[11] For subjects in the positive-affect treatment, this means choosing x_1 to equalize $u(x_1, \text{positive}_1) = \delta u(x_2, a_2)$. Similarly, for subjects in the neutral-affect treatment, this means choosing x_1 to equalize $u(x_1, \text{neutral}_1) = \delta u(x_2, a_2)$. Assuming that a_2 is the same for subjects in each treatment, the right-hand sides are the same for subjects in each treatment. Thus, the following condition (C1) must hold:

$$u(x_{1,\text{ neutral}}, \text{neutral}_1) = u(x_{1,\text{ positive}}, \text{positive}_1) = \delta u(x_2, a_2)$$

The validity of the second alternative interpretation—and invalidity of our interpretation that positive affect decreases time preference—hinges on both (A1) and (A2) holding. To

[11] We will consider the validity of the second alternative interpretation, ceteris paribus. Hence we ignore subjective probability weights and leave consideration of them in the first alternative interpretation.

see this, note that (A2) implies that $\frac{\partial^2 u}{\partial x \partial a} < 0$; further assume that u(·, positive$_t$) = u(·, neutral$_t$). Under these conditions, for C1 to hold, it must be that $x_{1,\,positive} > x_{1,\,neutral}$. This is exactly our result—that the positive-affect treatment increases x_1. Thus, if (A1) and (A2) hold, then our interpretation of the result may be confounded, i.e., our measurement of the treatment effect is potentially positively biased.[12]

However, (A2) is unlikely to hold since under conventional utility functions, including CES, linear, and Leontief, cross-derivatives are non-negative.[13] Specifically, linear utility functions are characterized by a cross-derivative of zero, and all other conventional utility functions are characterized by positive cross-derivatives. Further, if only (A1)—and not (A2)—holds, then the second alternative interpretation cannot confound our result. That is, if the utility functions in question are conventional, i.e., their cross-derivatives are non-negative, then a happy mood would decrease the amount of money necessary today to equalize utility with a future payment. To see this, assume $\frac{\partial^2 u}{\partial x \partial a} \geq 0$ and u(·, positive$_t$) ≥ u$_t$(·, neutral$_t$). Under these conditions, for C1 to hold, it must be that $x_{1,\,positive} \leq x_{1,\,neutral}$. This weakly negatively biases our interpretation of the result, and hence does not confound it. Moreover, $x_{1,\,positive} = x_{1,\,neutral}$ only if $\frac{\partial^2 u}{\partial x \partial a} = 0$ and u(·, positive$_t$) = u(·, neutral$_t$). Otherwise, it is must be that $x_{1,\,positive} < x_{1,\,neutral}$, i.e., our interpretation of the result is strongly negatively biased. The intuition here is that if a happy mood increases the marginal utility of money today and/or increases instantaneous utility, then one needs less money today in a happy mood than in a neutral mood to satisfy C1.

[12] It is important to note that it is presumably more natural to assume that u(·, positive$_t$) > u(·, neutral$_t$). Under this assumption, the impact of (A1) and (A2) on our interpretation of the result is ambiguous, since the positive impact of being in a happy mood on instantaneous utility offsets the negative impact on the marginal utility of money today; and the magnitude of each effect is unknown.
[13] In the Appendix D, we provide additional evidence using our experimental data that even if (A2) holds our interpretation of the result is not confounded.

Discussion

Our research indicates that mild positive affect significantly reduces time preference. Since this result is derived from a random-assignment experiment, the relationship between positive affect and time preference is presumably causal with positive affect reducing time preference. Below, we discuss, in turn, mechanisms that may explain our result and its implications.

Potential mechanisms

The psychological literature, where the bulk of affect-research has been reported, discusses two potential mechanisms that may explain why mild positive affect decreases time preference. First, Isen (2008) states that mild positive affect increases cognitive flexibility by broadening focus and attention, promoting openness to information, and enabling improved integration of information. Thus, the observed reduction in time preference may result from a more thorough consideration of broader (including future) net benefits. In addition, support for this mechanism comes from what the psychological literature dubs the "dopamine hypothesis:" that the release of dopamine (the neurotransmitter linked to rewards) in areas of the brain responsible for cognitive flexibility is the mediating factor in the effect of positive affect on behavior (Ashby et al 1999; and Isen 2008). Second, the replenishment of will power may help explain our result. As mentioned in the literature review, mild positive affect has been shown to replenish will power (Isen 2007). Consequently, post-inducement, subjects in the positive-affect treatment should have their will power replenished, and thus, exhibit greater patience for a future payment.

Implications

In this section, we discuss what can and cannot be extrapolated from our result and then turn to policy implications. To understand what can be extrapolated, it is important to recognize that the effects of affect do not lie on a continuum from intense positive affect to intense negative affect. In particular, the "continuum" is violated in three significant ways. First, the effect of intense positive affect is not necessarily an amplification of the effect of mild positive affect (Isen 2007). Thus, we cannot assume that intense positive affect would result in a further reduction of time preference. Second, negative affect does not necessarily have the opposite effect of positive affect. The independence of positive and negative affect is well-established in psychology (Bradburn 1969; Diener and Emmons 1984; Isen 2007; Lyubomirsky et al 2005; and Watson et al 1988). Moreover, neural research suggests the two are unrelated. Each is associated with a distinct neurotransmitter: dopamine with positive affect and serotonin with negative affect. In other words, it should not be inferred from our result that negative affect would necessarily increase time preference. Third, two affects may have variant effects, even if both are positive or negative. For example, anger and sadness, while both negative affects, may have different effects on decision-making. In general, negative affects are more likely to have variant effects and positive affects are less likely to have variant effects (Isen 2007).[14] Thus, our result may not be specific to the particular positive affect induced—amusement—and may apply to a wide range of positive affects.

We now turn to the relationship between positive affect and happiness, that is, the relationship between *being in a happy mood* and *being happy*. In our experiment, we successfully improved subjects' mood, but were unable—not surprisingly—to change subjects' underlying, long-term happiness. Thus, can we validly claim that *happier* individuals should exhibit lower time preference?

The distinction between positive affect and happiness, and what this distinction means for studying the impact of happiness, have been considered by Konow and Earley (2008) and Lyubomirsky et al (2005). In the latter, four possible strategies for identifying the impact of happiness are discussed. The least valid is a correlational study due to the inherent difficulty of demonstrating causation. Conversely, the ideal would be a random-assignment experiment, in which underlying happiness is manipulated. Such an experiment, however, is neither feasible nor ethical. Hence, Lyubomirsky and her colleagues argue that the best feasible approach is a random-assignment experiment in

[14] We are considering the effect of negative affects on time preference in a separate paper, specifically focusing on the effects of sadness, anger, and fear. Of these treatments, we have already conducted the sadness-inducement and are now turning to the others.

which positive affect is induced. They argue that such an approach is a valid way to identify the impact of *being happy* since happier individuals experience more frequent positive affect (Diener and Seligman 2004; and Lyubomirsky et al 2005). In fact, Diener, Sandvik, and Pavot (1991) state that, "frequent positive affect is both necessary and sufficient to produce the state we call happiness, whereas intense positive experience is not." Thus, our result suggests that happier individuals should exhibit less time preference.

Regardless of how affect and happiness are related, our result on the impact of affect *alone* has important implications. Affective shocks are ubiquitous; it is easy to forget how much we are subject to them. For example, quotidian experiences—a kind word from a loved one or the tedium of traffic—are often enough to perturb one's affective state. While research on laboratory mood-inducement procedures suggests that the moods induced in our experiment would likely last approximately 15 minutes, affective shocks outside of the lab may last longer—for hours or even days.[15] Indeed, outside of the lab, mood generated by weather has been shown to influence stock returns (Hirshleifer and Shumway 2003; and Saunders 1993); and affective changes due to sports outcomes have been linked to changes in political views, self-confidence, optimism, health, stock returns, and crime and suicide rates (see Edmans et al 2007). That the behavioral differentials observed in our experiment were the result of a mild and short-lived affective shock underscores—and does not detract from—the potency of mood's effect on behavior.

Mood is not the first domain in which seemingly trivial perturbations significantly affect behavior. Madrian and Shea (2001) famously showed that if 401(k) has to be opted out of instead of into, both participation and savings rates dramatically increase. That research suggests that important decisions are not necessarily insulated from seemingly inconsequential perturbations of the decision-making context. Further, it has been shown that once employees make their 401(k) decisions, they generally do not change them. An

[15] Isen et al (1976) and Isen and Gorgoglione (1983) estimate that the positive affect induced by a free gift, or by reading statements with a positive valence, lasts between 10 and 20 minutes. Further, Isen and Gorgoglione (1983) state that positive affect induced by film may last longer.

important implication discussed in that research is that defaults are critical and should be designed optimally; in other words, policy makers should strive to "get the default right" (Madrian and Shea 2001). Analogously, policy makers may be able to increase well-being by accounting for mood in the design of decision-making environments. As noted above, sports outcomes have been shown to affect political views; hence scheduling elections closely following major national sports events may be distortionary. Our result would suggest that a benevolent employer could help employees increase their pension plan contributions by having them complete the requisite paperwork after an enjoyable orientation session or other mood-elevating activity. This momentary decision, influenced by positive affect would have long-lasting and important consequences. One can easily imagine other important decisions that could be similarly influenced.

Another practical implication of our result is that individuals may benefit from awareness that their mood affects their behavior. For example, a new employee may want to postpone pension plan contribution decisions until he or she is in a happy mood. The new employee may even want to proactively put him- or herself into a good mood. Indeed, evidence from the positive psychology literature suggests that people can manipulate their own affect (Snyder and Lopez 2005). It should be noted that these implications are speculative, as further research is required to determine whether: (i) awareness of the effect of mood interacts in any way with the direct effect itself, or (ii) self-induced positive affect has the same influence on time preference as a positive affective shock. For example, Loewenstein (1996) identifies a "hot-cold empathy gap," namely that people tend to mis-predict the impact of emotions on their behavior, especially when trying to assess the effect of an emotion other than the one they are currently experiencing. Awareness of how to objectively understand the consequences of one's own emotions can hence benefit decision-makers. In summary, the practical implications of our research are similar to those called upon in Laibson (2001) in reference to the effect of cues on consumption: "…when consumers understand these mechanisms, consumers try to influence the sequence of cues they experience (e.g., recovering alcoholics avoid the smell or sight of alcohol). Cues serve as an important endogenous variable, which firms, consumers, and governments try to control."

Our research also has important theoretical implications. A host of process-oriented economic models speak directly to the impact of affective shocks on intertemporal decisions (Fudenberg and Levine 2006; Loewenstein 1996; Loewenstein et al 2003; and Loewenstein and O'Donoghue 2004). In particular, our result reveals a gap in the way that economists have modeled the role of affect. The common theme of many relevant theoretical models is the conflict between the desire for immediate and delayed gratification (Benhabib and Bisin 2005; Bernheim and Rangel 2004; Dekel et al 2001; Fudenberg and Levine 2006; Gul and Pesendorfer 2001 and 2004); Loewenstein and O'Donoghue 2004; Smith 1759; and Thaler and Shefrin 1981). These models often include "dual selves," and behavior results from a struggle between the immediate (emotional and visceral) components of the self and the purposeful, long-term, goal-oriented components of the self. More specifically, these models predict that the immediate self, and the factors that motivate it, disrupt the more reasoned and deliberate goals of the long-term self. So, while dual selves models may effectively capture the phenomenon of "blind rage," or how anger might influence behavior, how positive affect fits into these models is less clear.[16] The need for a more nuanced view of affect—one that, like the psychological explanations discussed above, captures the salutary effect of some affects—is supported by our research. Relatedly, our research indicates that positive affect may change fundamental preferences. Thus, it is important to incorporate the impact of positive affect into economic models.

Lastly, an important implication for other experimental researchers is that affect should be neutralized at the beginning of time preference experiments. Indeed, uncontrolled affect may be partially responsible for the highly variant estimates of discount rates reported in the time preference literature (Frederick et al 2002).

In summary, our experiment adds to the mounting evidence that positive affect influences behavior in economically important ways. However, we can only speculate upon how

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[16] The same can be said for relevant economic models that do not rely on dual selves, for example, Laibson's (2001) cue theory of consumption.

this effect comes to be. In addition, this study adds to the behavioral economics literature by identifying a determinant of time preference.

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Table 1. Demographic Characteristics			
	Control (*Neutral-Affect Inducement*)	*Treatment* (*Positive-Affect Inducement*)	*All subjects*
N	35	34	69
Female	0.51 (0.09)	0.47 (0.09)	0.49 (0.06)
College: Arts & Sciences	0.49 (0.09)	0.41 (0.09)	0.45 (0.06)
Business	0.43 (0.08)	0.41 (0.09)	0.42 (0.06)
Engineering	0.09 (0.05)	0.18 (0.07)	0.13 (0.04)
Practicing a Religion	0.49 (0.09)	0.44 (0.09)	0.46 (0.06)
Religion: Atheist	0.26 (0.07)	0.18 (0.07)	0.22 (0.05)
Christian	0.71 (0.08)	0.74 (0.08)	0.73 (0.05)
Other Religions	0.03 (0.03)	0.09 (0.05)	0.06 0.03)
Race: White	0.57 (0.08)	0.68 (0.08)	0.63 (0.06)
Hispanic	0.17 (0.06)	0.12 (0.06)	0.14 (0.04)
Asian	0.23 (0.07)	0.18 (0.07)	0.20 (0.05)
Other	0.03 (0.03)	0.03 (0.03)	0.03 (0.02)

Family Income < $100,000	0.24+ (0.07)	0.15 (0.06)	0.19+ (0.05)
Family Income between $100,000 *and* $200,000	0.35+ (0.08)	0.38 (0.08)	0.37+ (0.06)
Family Income > $200,000	0.41+ (0.09)	0.47 (0.09)	0.44+ (0.06)
Happiness	5 (0.21)	4.97 (0.22)	4.99 (0.15)

Standard errors reported in parentheses

+One missing observation

Note: difference of means test reveals that none of the means are significantly different

Table 2.a. *D*(*m*, *t*), pooled data, 69 subjects, 30 questions (n = 2,065)								
		t (*Days*)						
		1	3	7	14	28	56	*Mean*
m (*Dollars*)	$11.34	.910 (.215)	.890 (.171)	.846 (.203)	.814 (.210)	.795 (.238)	.785 (.305)	.840 (.153)
	$18.31	.928 (.200)	.889 (.195)	.856 (.217)	.833 (.207)	.786 (.235)	.752 (.272)	.841 (.172)
	$24.28	.914 (.219)	.893 (.201)	.853 (.227)	.838 (.209)	.847 (.169)	.757 (.253)	.849 (.171)
	$32.84	.915 (.211)	.898 (.177)	.851 (.219)	.860 (.161)	.775 (.252)	.778 (.244)	.846 (.169)
	$51.71	.931 (.212)	.882 (.241)	.889 (.248)	.840 (.258)	.823 (.246)	.779 (.265)	.857 (.209)
	Avg	.919 (.191)	.890 (.175)	.859 (.193)	.837 (.174)	.805 (.193)	.770 (.220)	.845 (.163)

* significant at <0.1, **significant at <0.05, ***significant at <0.01

standard errors reported in parentheses

Table 2.b. *D*(*m*, *t*), treatment group, 34 subjects, 30 questions (n = 1,017)								
		t (*Days*)						
		1	3	7	14	28	56	*Mean*
m (*Dollars*)	$11.34	.941 (.167)	.909 (.123)	.874 (.159)	.837 (.214)	.841 (.198)	.806 (.247)	.868 (.125)
	$18.31	.947 (.157)	.906 (.184)	.910 (.131)	.875 (.149)	.813 (.232)	.786 (.258)	.873 (.133)
	$24.28	.971 (.071)	.936 (.115)	.892 (.160)	.901 (.114)	.895 (.131)	.832 (.203)	.904 (.100)
	$32.84	.933 (.173)	.928 (.107)	.889 (.159)	.893 (.130)	.813 (.224)	.839 (.213)	.883 (.125)
	$51.71	.963 (.171)	.903 (.211)	.964 (.053)	.871 (.209)	.851 (.231)	.840 (.222)	.899 (.144)
	Mean	.951 (.114)	.917 (.133)	.906 (.122)	.876 (.128)	.843 (.169)	.821 (.197)	.885 (.116)

* significant at <0.1, **significant at <0.05, ***significant at <0.01
standard errors reported in parentheses

Table 2.c. *D*(*m*, *t*), control group, 35 subjects, 30 questions (n = 1,048)								
		t (*Days*)						
		1	3	7	14	28	56	*Mean*
m (*Dollars*)	$11.34	.880 (.252)	.871 (.208)	.819 (.237	.792 (.208)	.751 (.268)	.765 (.356)	.813 (.175)
	$18.31	.909 (.235)	.873 (.206)	.803 (.268)	.792 (.246)	.760 (0.239)	.719 (.284)	.809 (.200)
	$24.28	.856 (.292)	.852 (.253)	.816 (.274)	.777 (.258)	.800 (.190)	.684 (.277)	.793 (.207)
	$32.84	.897 (.243)	.869 (.223)	.815 (.261)	.828 (.182)	.738 (.274)	.718 (.259)	.811 (.198)
	$51.71	.899 (.244)	.861 (.268)	.816 (.330)	.810 (.299)	.795 (.260)	.720 (.293)	.817 (.253)
	Mean	.886 (.244)	.865 (.207)	.814 (.237)	.800 (.204)	.769 (.210)	.721 (.234)	.805 (.193)

* significant at <0.1, **significant at <0.05, ***significant at <0.01

standard errors reported in parentheses

Table 2.d. { $D_{Treatment}(m, t) - D_{Control}(m, t)$}, n = 2,065								
		t (*Days*)						
		1	3	7	14	28	56	*Mean*
m (*Dollars*)	$11.34	.061 (.052)	.039 (.041)	.055 (.049)	.045 (.051)	.091 (.057)	.041 (.074)	.055 (.037)
	$18.31	.038 (.048)	.034 (.047)	.107** (.051)	.082* (.049)	.053 (.057)	.067 (.065)	.063 (.041)
	$24.28	.115** (.051)	.083* (.047)	.076 (.054)	.125** (.048)	.094** (.039)	.149** (.059)	.111*** (.039)
	$32.84	.036 (.050)	.059 (.042)	.066* (.038)	.061 (.062)	.074 (.060)	.122** (.057)	.072* (.040)
	$51.71	.064 (.051)	.043 (.058)	.074 (.053)	.149** (.057)	.055 (.059)	.120* (.063)	.082 (.050)
	Mean	.065 (.046)	.051 (.042)	.092 ** (.046)	.076* (.041)	.073 (.046)	.099* (.052)	.081** (.039)

* significant at <0.1, **significant at <0.05, ***significant at <0.01

standard errors reported in parentheses

Table 3. Results of estimating equation (1), dependent variable is present value, *p*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Treatment	2.202* (1.124)	2.012** (0.958)	2.216** (1.112)	2.078** (0.958)	2.997** (1.353)	3.027** (1.159)	3.002** (1.332)	3.133*** (1.160)
Only discounter included	-	-	-	-	*Yes*	*Yes*	*Yes*	*Yes*
College	-	*Yes*	-	*Yes*	-	*Yes*	-	*Yes*
Gender	-	*Yes*	-	*Yes*	-	*Yes*	-	*Yes*
Race	-	*Yes*	-	*Yes*	-	*Yes*	-	*Yes*
Religion	-	*Yes*	-	*Yes*	-	*Yes*	-	*Yes*
Practicing	-	*Yes*	-	*Yes*	-	*Yes*	-	*Yes*
Income	-	*Yes*	-	*Yes*	-	*Yes*	-	*Yes*
Self-Reported Happiness	-	-	*Yes*	*Yes*	-	-	*Yes*	*Yes*
Excludes observations where $p = m$	-	-	-	-	*Yes*	*Yes*	*Yes*	*Yes*
R^2	0.748	0.794	0.751	0.795	0.680	0.744	0.683	0.745
N	2065	2035	2065	2035	1471	1447	1471	1447
Clusters	69	68	69	68	58	57	58	57

* significant at <0.1, **significant at <0.05, ***significant at <0.01. Robust standard errors reported in parentheses. For 5 observations, the reported value of p was unintelligible and thus excluded from all specifications. Columns (2), (4), (6), and (8) have one fewer cluster, and up to 30 fewer observations, than columns (1), (3), (5), and (7), respectively, because one subject had unreported demographic characteristics. Columns (5)-(8) exclude observations where $p=m$; ten subjects had $p=m$ for all observations, thus there are ten fewer clusters in (5)-(8) than in (1)-(4).

Figure 1.a. *D*(*m*, *t*), holding *m* constant, pooled data

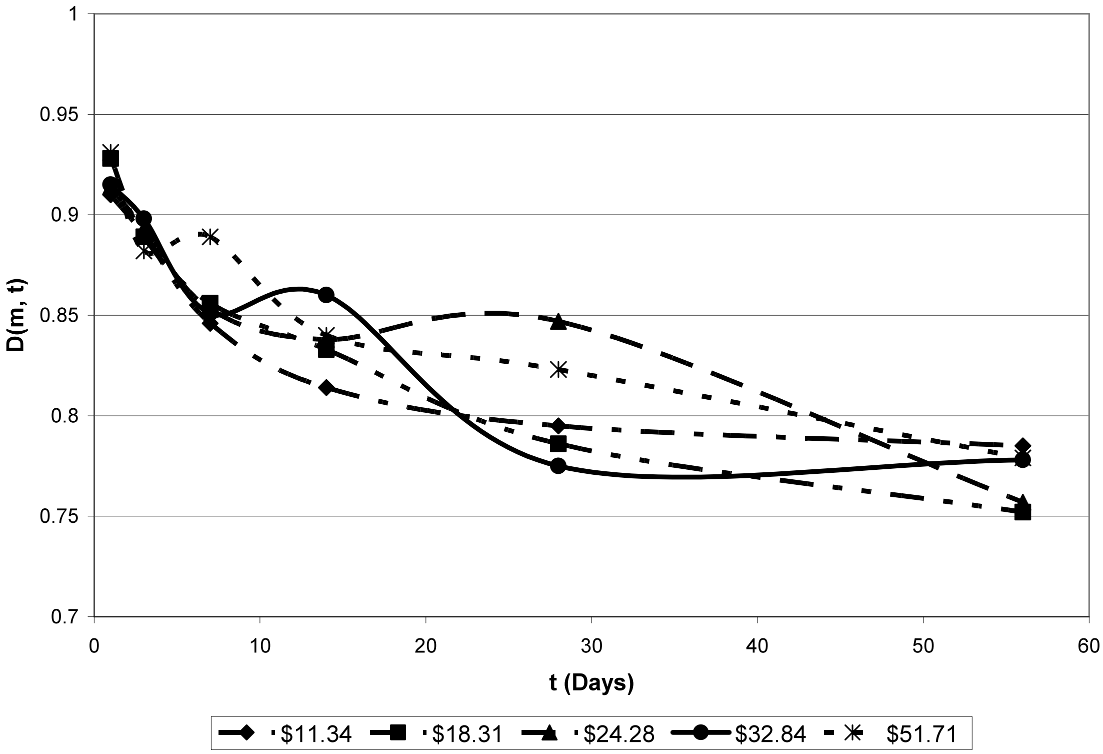
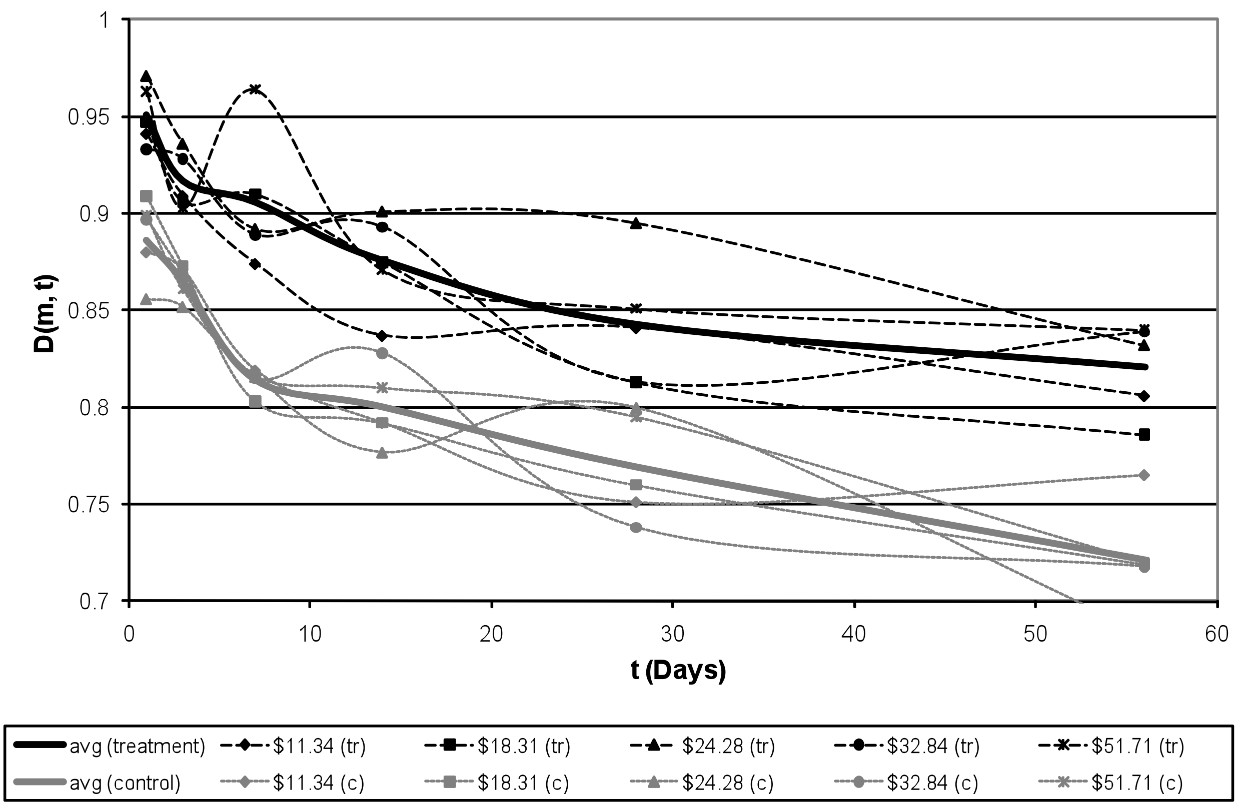


Figure 1.b. *D*(*m*, *t*), averaging over *m*, by treatment



where avg = average, tr = treatment, and c = control

Appendix A. Results from regressing 'live for today' on self-reported happiness

Dependent variable: Live for today (1 = *'agree' and* 0 = *'disagree'*)		
	(1)	(2)
Happiness (3 = 'very happy,' 2 = 'pretty happy', and 1 = 'not too happy')	-0.048*** (0.012)	-0.042** (0.021)
Age	-	-0.006 (0.006)
Age squared	-	0.000 (0.000)
Attend religious services at least once per month	-	0.010 (0.026)
Female	-	0.062** (0.028)
Income below median (<$15,000)	-	0.073** (0.035)
Low education (<11 years)	-	0.216*** (0.032)
Nonwhite	-	0.123*** (0.045)
Poor or fair health	-	0.073** (0.036)
N	1636	1636

* significant at <0.1, **significant at <0.05, ***significant at <0.01

standard errors reported in parentheses

Appendix B. Personality-trait statements, intertemporal decision-making items bolded

1) I have trouble resisting my cravings
2) **Sometimes I do things on impulse that I later regret**
3) I often do things on the spur of the moment
4) I pay my debt promptly and in full
5) I am known as hot-blooded and quick-tempered
6) I often get angry at the way people treat me
7) I rarely use words like "fantastic!" or "sensational!" to describe my experiences
8) It takes a lot to get me mad
9) **I'm pretty good about pacing myself so as to get things done on time**
10) **I would rather keep my options open than plan everything in advance**
11) I rarely overindulge in anything
12) I never seem to be able to get organized
13) I try to perform all the tasks assigned to me conscientiously
14) Once I find the right way to do something, I stick with it
15) I'm pretty set in my ways
16) I have a clear set of goals and work toward them in an orderly fashion
17) I'm known for my prudence and common sense
18) **Nowadays, a person has to live pretty much for today and let tomorrow take care of itself**
19) I hesitate to express my anger even when it is justified
20) **Occasionally I act first and think later**
21) I am not compulsive about cleaning
22) I seldom give in to my impulses
23) I control my behavior

Appendix C. Analysis of conditions of subjective probability weights and risk preferences

Under (SP1), the expected utility of a future payment increases by less than the expected utility of a present payment for subjects in the positive-affect treatment in comparison to subjects in the neutral-affect treatment. Thus, in our experiment the interaction between positive affect and subjective probability weights would reduce the present value of the future payment for subjects in the positive-affect treatment more than for subjects in the neutral-affect treatment. This negatively biases our interpretation of the result.

Under (SP2), the expected utility of a future payment increases in proportion to the expected utility of a present payment for subjects in the positive- and neutral-affect treatments. Thus, in our experiment the interaction between positive affect and subjective probability weights would have no effect on the present value of the future payment for subjects in the positive- and neutral-affect treatments. This does not bias our interpretation of the result.

Under (SP3), the expected utility of a future payment increase by more than the expected utility of a present payment for subjects in the positive-affect treatment in comparison to subjects in the neutral-affect treatment. [17] Thus, in our experiment the interaction between positive affect and subjective probability weights would increase the present value of the future payment for subjects in the positive-affect treatment more than for subjects in the neutral-affect treatment. This positively biases our interpretation of the result.

Under (RP1), subjects in the positive-affect treatment—relative to subjects in the neutral-affect treatment—experience increased risk aversion over future outcomes in comparison to outcomes today. In our experiment, this would lower the net present value of the future payment more for subjects in the positive-affect treatment than for subjects in the neutral-affect treatment. This would negatively bias our interpretation of the result.

Under (RP2), subjects in the positive- and neutral-affect treatments experience the same relative change in risk aversion over future versus present outcomes. In our experiment, this would have the same effect on the net present value of the future payment for subjects in the positive- and neutral-affect treatments. This would not bias our interpretation of the result.

Under (RP3), subjects in the positive-affect treatment—relative to subjects in the neutral-affect treatment—experience decreased risk aversion over future outcomes in comparison to outcomes today. In our experiment, this would increase the net present value of the future payment more for subjects in the positive-affect treatment than for subjects in the neutral-affect treatment. This would positively bias our interpretation of the result.

[17] Assuming that $p_{1,\text{ positive}} = p_{1,\text{ neutral}}$—that subjective probability weights for present payments are unaffected by positive affect—is simply a special case of (SP3).

Appendix D. Direct evidence that, even if condition (A2) holds, our interpretation of the result is not confounded

We may also have direct evidence that the cross-derivative is not negative. Immediately following the administration of the time preference instrument, subjects were asked the following questions:

(Q1) "Taken all together, how would you say things are these days—would you say that you are," where answers ranged on a seven-point scale from completely unhappy to completely happy.

(Q2) "Please indicate the number on the scale directly below that best describes the greatest amount of each emotion below that you felt <u>during the past few weeks</u>," where 1 corresponds to "You did not feel even the slightest bit of the emotion," and 10 corresponds to, "You felt the most of the emotion you have ever felt in your life." This set of questions is referred to as the PANAS (Positive Affect Negative Affect Schedule) and includes 16 affects, 7 of which are positive and 9 of which are negative.

The net positive affect—the sum of the positive affects minus the sum of negative affects from the PANAS—of subjects in the positive-affect treatment was significantly higher than that of subjects in the neutral-affect treatment. This indicates that when asked the general happiness question mood-inducement was still in effect. Yet, there is no economic or statistical difference between subjects in the positive- and neutral-affect treatments in response to (Q1)—4.97 versus 5, respectively ($p = 0.9226$ for the two tailed test).

This is important because (A2) implies that total utility from all consumables other than mood would be lower for subjects in the positive-affect treatment than for subjects in the neutral-affect treatment (assuming that the cross-derivatives of mood and all other consumables are also negative). That the average general happiness is constant across treatment groups implies that the impact of positive affect on instantaneous utility must fully offset the impact of (A2). If this is the case, then our interpretation of the result is not confounded by (A2). The intuition is that if positive affect decreases the marginal utility of all non-mood consumables today it must also be directly and equally increasing instantaneously utility today.