

Happiness and Myopia: Evidence from a Random-Assignment Experiment

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Abstract

Myopia—time preference—has been shown to be commonplace and is believed to lead to a series of negative outcomes, such as overconsumption and addiction. Yet, little is known about the determinants of myopia. Using a random-assignment experiment, we investigate whether happiness decreases myopia. Subjects are randomly assigned to receive a happy- or neutral-affect inducement. Immediately following the inducement, we measure their myopia using a 30 question instrument. The results indicate that the happy-affect inducement significantly decreases myopia. The findings are robust to various specifications checks. Finally, our results re-confirm the ubiquity of myopia and start to explore its determinants. (JEL D01, D90, D60)

Keywords: happiness, time preference, myopia, random-assignment experiment, mood-inducement

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Introduction

Recent developments in happiness research call into question the sources of—and general trends in—happiness over time. The main dependent variable in such studies is subjective well-being. Studies have shown factors that are accepted as strong determinants of well-being by the standards of conventional wisdom do not have as strong an impact as expected—for example, per capita income. These findings are particularly relevant in the field of economics, where it is assumed that rational agents maximize utility, and that utility is increasing in income (reviews include Frey and Stutzer, 2002 & Kahneman and Krueger, 2006).

There is also a less well developed literature on how happiness affects other outcomes (Lyubomirsky et al, 2005). That is, does causation run the other way? For example, are happier individuals more successful? (Interestingly, the answer appears to be yes.) A recent review of this emerging literature indicates that being happier appears to have numerous positive effects (Lyubomirsky et al, 2005).

This paper contributes to this nascent literature by examining whether happiness affects intertemporal decision making. This is important because myopia—discounting the future at a high rate—has been shown to be commonplace and is believed to lead to a series of self-control problems—for example, overconsumption, addiction, reduced human capital accumulation, and diminished retirement saving (Ameriks et al, 2007; Benhabib et al, 2007; and Frederick et al, 2002). Further, little is known about the determinants of myopia.

In this paper, we investigate whether happiness decreases myopia. Initial empirical evidence for our hypothesis comes from the General Social Survey (GSS). Using the response to the following question as a measure of myopia, “nowadays, a person has to live pretty much for today and let tomorrow take care of itself,” we find that myopic respondents are significantly less happy than are non-myopic respondents, even after

controlling for covariates that have been shown to be related to happiness (see Appendix A for regression results).

While this empirical evidence is encouraging, it has a number of shortcomings. Most notably, the direction of causation cannot be identified; based upon this analysis, causation could run from happiness to myopia and or vice versa. Further, this measure of myopia is imperfect. It does not directly ask about one's own myopia. Rather, it asks about an anonymous *person's* myopia. While one might expect this measure to be correlated with one's own myopia, it is certainly not one and the same.

Thus, to test our hypothesis we run a random-assignment experiment in which we measure subjects' myopia after their mood has been manipulated. Specifically, subjects are randomly assigned to the treatment group—happy—or to the control group—neutral. The appropriate mood is induced using short video clips; this technique has been widely used and validated by psychologists (Gross and Levenson, 1995 & Westerman et al, 1996). To measure myopia we use an incentive-compatible procedure that was developed by behavioral economists, in which subjects choose between actual sums of money to be received now or at various points in the future (for example, Benhabib et al, 2007).

Our results indicate that subjects in the treatment group are significantly less myopic than are subject in the control group. These results are robust to various specification checks. The next section of this paper provides a brief overview of the literature; the third section discusses our methodology; and the fourth and fifth sections present and discuss the results.

Literature review

The happiness literature has grown rapidly over the past few decades. Kahneman and Kreuger (2006) note that the number of papers cited in *EconLit* that use happiness data grew twenty-fold, from five between 1991 and 1995 to over 100 between 2000 and 2005. The majority of the happiness literature has focused on determinants of happiness

(reviews include Frey and Stutzer, 2002; and Kahneman and Kreuger, 2006). Notable findings include:

- The Easterlin Paradox—that happiness increases with income within a country, but that average happiness does not increase with average per capita income for a country as a whole (Graham, 2005);
- That self-reported happiness is appropriately (negatively) affected by negative life events—for example, the death of a loved one and losing one’s job (Frey and Stutzer, 2002); and
- That self-reported happiness is stable over time—that is, happiness may be more of a personality trait than the result of life circumstances (Kahneman and Kreuger, 2006).

A smaller but growing literature reverses the question—that is, it attempts to determine the effects of being happier. In a review of this literature, Lyubomirsky et al (2005) find strong evidence for the claim that happiness leads to success across many dimensions. They report that happier individuals are more likely to “have fulfilling marriages and relationships, high incomes, superior work performance, community involvement, robust health, and a long life.” These findings are based on correlational, longitudinal, and experimental studies.

Interestingly, economists have focused more on the former inquiry—determinants of happiness—than on the latter—the effects of being happy. Consequently, the exploration of happiness’s impact on economic decision-making is in its infancy. Initial findings include that happiness affects reciprocity in “gift-exchange” games (Kirchsteiger et al, 2001); willingness to pay (Lerner et al, 2004); spending (Cryder et al, 2008), and work effort and productivity (Erez and Isen, 2005; and Oswald et al, 2008); these findings are all based on well-designed random-assignment experiments. In addition, in an innovative study, Guven (2007) uses sunshine as an instrument for happiness and demonstrates that happier people save marginally more and are more risk adverse.

This research advances the latter inquiry by examining whether happiness affects intertemporal decision making. In particular, we are interested in examining whether

happier individuals exhibit less myopia—lower time preference—than do their less happy peers. This is important since myopia is believed to lead to self-control problems and increases the likelihood of a series of “bad” outcomes¹—for example, overconsumption, obesity, addiction, reduced human capital accumulation, and diminished retirement saving (Ameriks et al, 2007; Benhabib et al, 2007; and Frederick et al, 2002). Further, Mischel et al (1989) have shown that preschoolers who exhibit *will power* (the opposite of myopia) have higher GPAs, SAT scores, educational attainment, and income over a decade later.

Myopia has also been shown to be commonplace (Frederick et al, 2002). Moreover, it has been established for some time that the rate at which we discount the future is dependent on the amount being discounted and the horizon over which discounting occurs (see Thaler, 1981); thus, discounting cannot easily be captured by one parameter, as it often is in macroeconomic models. Other factors that influence myopia, however, have not been studied by economists.

This study begins this exploration by investigating whether happiness affects myopia. An intriguing aspect of this research is that it offers a causal mechanism through which happiness leads to success. Specifically, if happier individuals are less myopic and less myopic individuals are more successful, then our findings could partially explain why happier individuals are also more successful.

Experimental Design

The effect of happiness on myopia—time preference—was examined in laboratory experiments conducted at Santa Clara University with 69 Santa Clara undergraduates as subjects. To avoid any potential disciplinary bias, subjects were recruited from courses that all Santa Clara undergraduates are required to take. In total, the experiment lasted approximately 45 minutes, and subjects received an average of \$24 for their participation.

¹ What constitutes a “bad” outcome is not being defined objectively here. Rather, we can consider “bad” outcomes to be those that follow from time-inconsistent decisions and give rise to regrets.

First, subjects were informed that they would be answering 30 questions 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?” where m and t would be specified. Further, they were told that their payment would be based on one of these questions. The payment question was determined by a random draw of a lottery ball at the end of the experimental session.

Subjects were informed that the Becker-DeGroot-Marschak (BDM) mechanism would be used to provide incentives for truthful responses (Becker et al, 1964 and Benhabib et al, 2007). Using the BDM mechanism, the amount and timing of payment would be determined as follows: m balls numbered 1 through m would be placed in a Bingo cage, and one would be chosen. If the number R on the drawn ball was less than or equal to p , then the subject would be paid $\$m$ in t days. If the number drawn exceeded p , the subject would be paid $\$R$ today (the day of the experimental session). Subjects were guided through numerous examples to ensure they understood the process. They did not, however, answer the 30 questions at this time. The order of activities will be explained further below.

Subjects were also informed that the location for picking up their payment was across campus from where the session was conducted, regardless of when they were to receive their payments. This was done to ensure that decisions were not impacted by “transportation costs” or doubt about the legitimacy of future pickups. Also, subjects were informed of the double-blind nature of the experiment: subjects would be paid in sealed envelopes, the person who put the money in the envelope knew the subject number but not the identity of the subject, while the person who gave each subject his payment-envelope knew the subject number but not the amount of money in the envelope. The payment-pickup was carefully designed (standardized, anonymous, and blind) so that subjects would not show a preference for being paid today simply because the payment-pickup was more manageable.

To study the direction of causation in the relationship between happiness and time-preference, we attempted to exogenously control happiness. Specifically, we attempted to make subjects happier by showing them a short, funny film clip. This method has been validated—and is often used—by psychologists (Gross and Levenson, 1995)². Half the subjects (35 of 69) were randomly assigned to the control group and watched a film clip intended to elicit neutral affect. The other half (34 of 69), the treatment group, watched a film clip intended to elicit positive affect. The experimental protocol was identical for the control and treatment groups except for the variant film-clip,.

The neutral-affect clip, *Denali*, was one commonly used by psychologists to elicit neutral affect and features tranquil images of landscapes and wildlife in Denali National Park, Alaska. In the positive-affect treatment, subjects watched a number of short stand-up comedy bits from the 2002 “Robin Williams – Live on Broadway.” One of the most successful positive-affect-inducing film clips reported in the psychology literature is a clip from Robin Williams’s 1986 “A Night at the Met” (Gross and Levenson, 1995). We opted for the 2002 montage primarily because it is current and puts to rest any concerns of the humor being outdated.

Following the film clips, subjects answered the 30 time-preference questions of the form described above. The 30 questions were composed of combinations of five different values of m , { \$11.34, \$18.31, \$24.28, \$32.84, \$51.71 }³, and 6 different values for t , { 1 day, 3 days, 7 days, 14 days, 28 days, 56 days }. We chose abstruse values for m to discourage the use of heuristics—for example, halving m —in the discounting task. The time-delay was not extended beyond two months, to keep all possible payouts within the current academic year.

Ideally, instructions for the time-preference questions would have immediately preceded the actual task of answering them. Given the complexity of the BDM mechanism, its

² The relationship between *being in a happy mood* and *being happy* is discussed in the discussion section.

³ The BDM mechanism utilized calls for balls numbered 1 through m to be placed in a bingo cage. Since these values of m are fractional, the number of balls placed in the cage was rounded to the next highest integer. For example, for $m = \$11.34$, balls numbered 1 through 12 were placed in the bingo cage.

explanation required a substantial amount of time, and the moods induced by the film-clips could have been seriously moderated, if not nullified, in that time. Since the objective was to study the effect of happiness on time-preference, we chose to keep the mood-inducement and time-preference exercises as close in time to one another as possible.

The time-preference questions were followed by a battery of questions about own-happiness, affect, and health. Surely, mood-inducement could have been more precisely measured had these questions immediately followed the film clips, but, for the reasons stated above, the time-preference questions were chosen to succeed the mood-inducement stage.

Finally, the payment question was determined, the BDM mechanism was implemented, and the subjects completed demographic surveys. When all surveys were complete, subjects received instructions for retrieving their payment and exited the experimental session. The payment instructions included the amount of money they would be paid, the time after which they could collect their payment, and the pick-up location. When money was picked up, subjects filled out a final questionnaire.

Econometric Specifications

In analyzing the relationship between happiness and myopia, 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 inducing treatment, M is the set of all dollar 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 singular 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 $K = \text{gender}$, $k \in \{\text{male, female}\}$, and $I_{\text{Gender}}(\text{male})$ 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. The appeal of this econometric specification is that it imposes minimal ex ante structure and does not depend in any way on the distribution of p . Thus, this parametrization does not restrict us to a specific model of discounting—for example, exponential or hyperbolic—and fits the conditional expectation function for p perfectly (Angrist and Pischke, 2009). We did estimate and test such specifications using the nested model and techniques described in Benhabib et al (2007). We find (i) only marginally more support for the hyperbolic specification than for the exponential, (ii) virtually no support for a quasi-hyperbolic component, and (iii) spotty support for fixed-cost discounting. The underwhelming support for these models directed our choice of a fully-saturated specification (see Appendix B for complete results).

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 were female. The division of students across colleges roughly mimicked the university's population. Santa Clara University has three colleges: arts and sciences, business, and engineering. Only a small number of

subjects were engineers, the rest were evenly split between arts and sciences and business. Roughly half of the subjects reported that they practice a religion. Given that Santa Clara is a Jesuit university, it is not surprising that the most heavily represented religion in the sample was Christianity, accounting for three-quarters of the subjects. Almost all other subjects consider themselves Atheists, with only two students listing a different religion. The last demographic factor we control for is race. Almost all of the subjects considered themselves white (63%), Asian (20%), or Hispanic (14%), with only two students identifying with other racial/ethnic categories. Students were asked to give their best estimate of their family income. The mean response fell in the category \$100,000 - \$150,000, while the median was \$150,000 - \$200,000. Few students reported income less than \$80,000 or greater than \$500,000.

The measure of long-term 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 range from 1 (completely unhappy) to 7 (completely happy). The 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 its sensitivity. This question is asked after mood-inducement, but because of its broad scope, is hypothesized to be unaffected by mood-inducement. Indeed, there is no statistical difference in happiness for the treatment 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 are myopic

As in Benhabib et al. (2007), 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 $D = D(m, t)$.

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), respectively, present the control and treatment groups separately.

Subjects consistently discount the distant future more heavily than they do the near future. Holding m constant, D clearly trends downward in all panels. In panels (a) and (b), the only exceptions to this occur as t changes from 14 to 28 days for the $m = \$32.84$ and as t changes from 3 to 7 days when $m = \$51.71$. The monotonicity of the negative relationship between D and t is violated more frequently in the positive affect treatment (panel (c)), but the general trend still holds. The corresponding smoothed discounting functions for each m -value are shown in Figure 1. Panel (a) corresponds to pooled data, panel (b) the control, and panel (c) the treatment.

The relationship between future payment m and the discount function does not follow so consistent a pattern. Discounting as a function of future payment is shown in Figure 2. Panels (a), (b), and (c) correspond to pooled, control, and treatment groups, respectively. For virtually no time-delay t is there monotonicity in D . Nor is there a clear non-monotonic trend: for example, for $t = 1$, D has two interior peaks, while for $t = 14$, there appears to be an inverted U-shape, and for $t = 56$ a U-shape.

Mood-inducement was successful

Mood-inducement had the hypothesized effects on affect. In the final questionnaire before leaving the experimental session, subjects were asked whether watching the film clip made them happier, sadder, or neither happier nor sadder. Controlling for payment,

watching the positive-affect clip made subjects significantly more likely to answer “happier.”⁴

Happiness reduces myopia

Preliminary support for our hypothesis—that happiness reduces time preference—can be seen in Panel (d) of Table 2. The positive-affect inducement unambiguously reduces time preference, or makes subjects less myopic. Panel (d) gives average differences between $D_{Treatment}(m, t)$ and $D_{Control}(m, t)$. For all m and t , this difference is positive; that is, $D(m, t)$ is higher in panel (c) than panel (b). Panel (d) also shows that the magnitude and statistical significance of the difference tend to increase as m and t increase.

Estimating equation (1) without demographic controls, we see further evidence that happiness reduces time preference (see column (1) of Table 3). Controlling for future-payment and time-delay, watching a positive- instead of neutral-affect film clip increases the present value of delayed payments by \$2.20 on average. This result is marginally statistically significant, with p -value = 0.054, but the magnitude is quite substantial. Even for the largest value of y we consider, \$51.71, this amounts to over four percent of y . Since we are not studying the effects of time and monetary sums on time preference, the coefficients for the y 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 now has a statistically significant effect, of increasing present value by \$2.01. 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 specifications; thus, the results appear to be robust. Finally, we estimate equation (1) conditional on $p < m$; that is, we

⁴ The question was asked after the BDM mechanism, so subjects had an idea of how much money they were going to receive. Therefore, in analyzing the effect of mood-inducement, payment amount is controlled for. The happiness and mood questions asked directly after the time preference questions (prior to the BDM mechanism) ask about general happiness and mood in a long-run sense. For example, subjects are asked to consider things “taken all together,” suggesting a long-run perspective. Mood questions explicitly ask subjects to consider the intensity of emotion they have felt “during the past few weeks.”

exclude subjects who did not discount at all. With the restricted sample, the magnitude and the significance of treatment effect increase (see Columns (5) through (8) of Table 1). Now the positive-affect inducement increases the present value of a future payment by roughly \$3.00 on average.

Discussion

The findings indicate that the happy mood inducement significantly reduces myopia. That is, the positive mood-inducement increases the present value of a delayed payment. Depending on the future payment and specification, the magnitude of the effect ranges from 4% (specification (4), $m = \$51.71$) and 27% (specification (8), $m = \$11.56$) of the future payment.

These results are robust to a number of specification checks and were derived from a random-assignment experiment. Consequently, the relationship between happiness and myopia is presumably causal with increased happiness reducing myopia. This finding is important since myopia increases the likelihood of a host of negative outcomes, for example, overconsumption, addiction, reduced human capital accumulation, and diminished saving. Further, if: (1) happiness reduces myopia, (2) reduced myopia improves outcomes, and (3) improved outcomes increases happiness, then there would appear to be a self-reinforcing cycle in which happy individuals sustain their happiness by not being myopic. Further, the opposite is presumably true as well—that is, there is a negative feedback loop in which less happy individuals act myopically, leading to negative outcomes and unhappiness, increasing myopia, ad infinitum.

Finally, one should consider the relationship between *being in a happy mood* and *being happy*. In this study, 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 are less myopic? Lyubomirsky et al (2005) explore this issue in their review and outline four possible strategies for identifying the impact of happiness. The least valid is a correlational study, which cannot demonstrate causation. The most valid is a random-assignment experiment, in which underlying happiness is

manipulated. Unfortunately, however, it is neither feasible, nor would it be ethical, to manipulate a subjects' underlying happiness. Hence, Lyubomirsky and her colleagues argue that the best feasible approach is to conduct a random-assignment experiment, in which a happy mood is induced. Such an approach is valid since happier individuals are more frequently in a happy mood (Lyubomirsky et al, 2005).

In summary, while it is well established that individuals are myopic, less is known about myopia's determinants. This study adds to the behavioral economics literature by identifying one such determinant—happiness. However, given how costly myopia can be, further research appears to be warranted.

References

- Ainslie, George and Richard J. Herrnstein. 1981. "Preference Reversal and Delayed Reinforcement." *Animal Learning and Behavior*, 9: 476-82.
- Ameriks, John, Andrew Caplin, John Leahy, and Tom Tyler. 2007. "Measuring Self-Control Problem." *American Economic Review*, 97(3): 966-972.
- Andersen, Steffen, Glenn W. Harrison, Morten I. Lau, and E. Elisabet Rutstrom. 2008. "Eliciting Risk and Time Preferences." *Econometrica*, 76(3): 583-618.
- Angrist, Joshua D. and Jorn-Steffen Pischke. 2009. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton: Princeton University Press.
- Becker, Gordon M., Morris H. DeGroot, and Jacob Marschak. 1964. "Measuring utility by a single-response sequential method." *Behavioral Science*, 9(3): 226-32.
- Benesch, Christine, Bruno S. Frey, and Alois Stutzer. 2006. "TV Channels, Self Control and Happiness." Institute for Empirical Research in Economics Working Paper No. 301.
- Benhabib, Jess and Alberto Bisin. Forthcoming. "Modelling Internal Commitment Mechanisms and Self-Control: A Neuroeconomics Approach to Consumption-Saving Decision." *Games and Economic Behavior*.
- Benhabib, Jess, Alberto Bisin, and Andrew Schotter. 2007. "Present-bias, Quasi-Hyperbolic Discounting, and Fixed Costs." Working paper.
- Benzion, Uri, Amnon Rapoport, and Joseph Yagil. 1989. "Discount Rates Inferred from Decisions: An Experimental Study." *Management Science*, 35(3): 270-84.

- Bernheim, Douglas and Antonio Rangel. 2004. "Addiction and Cue-Conditioned Decision Processes." *American Economic Review*, 94(5): 1558-90.
- Casari, Marco. 2009. "Pre-Commitment and Flexibility in a Time-Decision Experiment." *Journal of Risk and Uncertainty*, 38(2): 117-41.
- Coller, Maribeth. and Melonie B. Williams. 1999. "Eliciting Individual Discount Rates." *Experimental Economics* 2(2): 107-27.
- Coller, Maribeth, Glenn W. Harrison and E. Elisabet Rutstrom. 2003. "Are Discount Rates Constant? Reconciling Theory and Observation." Working Paper 3-31, Department of Economics, College of Business Administration, University of Central Florida.
- Cryder, Cynthia E., Jennifer S. Lerner, James J. Gross, and Ronald E. Dahl. 2008. "Misery is not Miserly: Sad and Self-Focused Individuals Spend More." *Psychological Science*, 19(6): 525-30.
- Davis, James Allen and Tom W. Smith. 2007. General Social Surveys, 1972–2006 [machine readable data file] /Principal Investigator, James A. Davis; Director and Co Principal Investigator, Tom W. Smith; Co Principal Investigator, Peter V. Marsden; Sponsored by National Science Foundation. NORC ed. Chicago: National Opinion Research Center [producer]; Storrs, CT: The Roper Center for Public Opinion Research, University of Connecticut [distributor].
- Diener, Ed and Martin E.P. Seligman. 2004. "Beyond Money: Toward an Economy of Well-Being." *Psychological Science in the Public Interest*, 5(1): 1–31.
- Di Tella, Rafael and Robert MacCulloch. 2006. "Some Uses of Happiness Data in Economics." *The Journal of Economic Perspectives*, 20(1): 25-46.

Du, Wanjiang, Leonard Green, and Joel Myerson. 2002. "Cross-Cultural Comparisons of Discounting Delayed and Probabilistic Rewards." *The Psychological Record*, 52(4): 479-92.

Erez, Amir, and Alice M. Isen. 2002. "The Influence of Positive Affect on the Components of Expectancy Motivation." *Journal of Applied Psychology*, 87(6): 1055-67.

Frederick, Shane. 2003. "Measuring Intergenerational Time Preference: Are Future Lives Valued Less?" *Journal of Risk and Uncertainty*, 26(1): 39-53.

Frederick, Shane, George Loewenstein, and Ted O'Donoghue. 2002. "Time Discounting and Time Preference: A Critical Review." *Journal of Economic Literature*, 40(2): 351-401.

Frey, Bruno S., Christine Benesch and Alois Stutzer. 2007. "Does watching TV make us happy?" *Journal of Economic Psychology*, 28(3): 283-313.

Frey, Bruno S., and Alois Stutzer. 2002. *Happiness and Economics*. Princeton: Princeton University Press.

Graham, Carol. 2005. "The Economics of Happiness: Insights on globalization from a novel approach." *World Economics*, 6(3): 41-55.

Gross, James J., and Robert W. Levenson. 1995. "Emotion Elicitation Using Films." *Cognition and Emotion*, 9(1): 87-108.

Gruber, Jonathan and Sendhil Mullainathan. 2005. "Do Cigarette Taxes Make Smokers Happier" *Advances in Economic Analysis & Policy*, Berkeley Electronic Press, 5(1): 1412.

Gul, Faruk and Wolfgang Pesendorfer. 2001. "Temptation and Self-Control." *Econometrica*, 69(6): 1403-35.

Guven, Cahit. 2007. "Reversing the Question: Does Happiness Affect Individual Economic Behavior? Evidence from Surveys from the Netherlands and Germany" Working paper.

Harrison, Glenn W. and Morten Igel Lau. 2005. "Is the Evidence for Hyperbolic Discounting in Humans Just an Experimental Artefact?" *Behavioral & Brain Sciences*, 28(5): 657.

Harrison, Glenn W. Morten I. Lau, and Melonie B. Williams. 2002. "Estimating Individual Discount Rates for Denmark: A Field Experiment." *American Economic Review*, 92(5): 1606-17.

Hermalin, Benjamin and Alice M. Isen. 2008. "A model of the effect of affect on economic decision making." *Quantitative Marketing and Economics*, 6(1): 17-40.

Isen, Alice M. and Johnmarshall Reeve. 2005. "The Influence of Positive Affect on Components of Expectancy Motivation." *Motivation and Emotion*, 29(4): 295-323.

Kahneman, Daniel and Alan B. Krueger. 2006. "Developments in the Measurement of Subjective Well-Being." *Journal of Economic Perspectives*, 20(1): 3-24.

Kirby, Kris N. 1997. "Bidding on the Future: Evidence Against Normative Discounting of Delayed Rewards." *Journal of Experimental Psychology: General*, 126(1): 54-70.

Kirby, Kris N. and Richard J. Herrnstein. 1995. "Preference Reversals Due to Myopic Discounting of Delayed Reward." *Psychological Science*, 6(2): 83-9.

Kirby, Kris N. and Nino Marakovic. 1995. "Modeling Myopic Decisions: Evidence for Hyperbolic Delay-Discounting with Subjects and Amounts." *Organization Behavior and Human Decision Processes*, 64(1): 22-30.

Kirby, Kris N. and Nino Marakovic. 1996. "Delay-Discounting Probabilistic Rewards: Rates Decrease as Amounts Increase." *Psychonomic Bulletin & Review*, 3(1): 100-4.

Kirby, K.N., Nancy M. Petry, and Warren K. Bickel. 1999. "Heroin Addicts Have Higher Discount Rates for Delayed Rewards Than Non-Drug-Using Controls." *Journal of Experimental Psychology: General*, 128(1): 78-87.

Kirchsteiger, Georg, Luca Rigotti and Aldo Rustichini. 2001. "Your morals are your moods." Institute of Business and Economic Research Department of Economics, UCB, Paper E01-294.

Lerner, Jennifer S., Deborah A. Small, and George Loewenstein. 2004. "Heart Strings and Purse Strings." *Psychological Bulletin*, 15(5): 337-341.

Loewenstein, George, Daniel Read, and Roy F. Baumeister. 2003. *Time and decision: economic and psychological perspectives on intertemporal choice*. New York: Russell Sage Foundation.

Loewenstein, George and Drazen Prelec. 1992. "Anomalies in Intertemporal Choice: Evidence and Interpretation." *Quarterly Journal of Economics*, 107(2): 573-97.

Lyubomirsky, Sonja, Laura King, and Ed Diener. 2005. "The Benefits of Frequent Positive Affect: Does Happiness Lead to Success?" *Psychological Bulletin*, 131(6): 803-55.

Mischel, Walter, Yuichi Shoda, and Monica L. Rodriguez. 1989. "Delay of Gratification in Children." *Science*, 244: 933-8.

Myerson, Joel and Leonard Green. 1995. "Discounting of Delayed Rewards: Models of Individual Choice." *Journal of Experimental Analysis of Behavior*, 64(3): 263-76.

O'Donoghue, Ted and Matthew Rabin. 1999. "Doing It Now or Later." *American Economic Review*, 89: 103-24.

Oswald, Andrew, Eugenio Proto and Daniel Sgroi. 2008. "Happiness and Productivity." Working paper.

Prelec, Drazen. 2004. "Decreasing Impatience: A Criterion for Non-Stationary Time Preference and "Hyperbolic" Discounting." *Scandinavian Journal of Economics*, 106(3): 511-32.

Rachlin, Howard, Andres Raineri, and David Cross. 1991. "Subjective Probability and Delay." *Journal of Experimental Analysis of Behavior*, 55(2): 233-44.

Read, Daniel. 2001. "Is Time-Discounting Hyperbolic or Subadditive?" *Journal of Risk and Uncertainty*, 23(1): 5-32.

Rubinstein, Ariel. 2003. "Economics and Psychology? The Case of Hyperbolic Discounting." *International Economic Review*, 44(4):1207-16.

Shapiro, Jesse M. 2005. "Is There a Daily Discount Rate? Evidence from the Food Stamp Nutrition Cycle." *Journal of Public Economics*, 89: 303-25.

Stevenson, Betsey and Justin Wolfers. 2008. "Happiness Inequality in the United States." *The Journal of Legal Studies*, 37(52).

Strotz, R.H. "Myopia and Inconsistency in Dynamic Utility Maximization." *Review of Economic Studies* 23 (1956): 166-80.

Stutzer, Alois. 2006. "When Temptation Overwhelms Will Power: Obesity and Happiness." For: Conference on New Directions in the Study of Happiness, University of Notre Dame.

Stutzer, Alois and Bruno S. Frey. 2006. "What Happiness Research Can Tell Us About Self-Control Problems and Utility Misprediction." IZA Discussion Paper No. 1952
Institute for Empirical Research in Economics Working Paper No. 267.

Thaler, Richard H. 1981. "Some Empirical Evidence on Dynamic Inconsistency." *Economics Letters*, 8: 201-7.

Thaler, Richard H. and Hersch M. Shefrin. 1981. "An Economic Theory of Self Control." *Journal of Political Economy*, 89(2): 392-406.

Warner, John T. and Saul Pleeter. 2001. "The Personal Discount Rate: Evidence from Military Downsizing Programs." *American Economic Review*, 91(1): 33-53.

Westerman, Rainer, Kordelia Spies, Gunter Stahl, and Friedrich W. Hesse. 1996. "Relative Effectiveness and Validity of Mood Induction Procedures." *European Journal of Social Psychology*, 26: 557-80.

Whiteside, Stephen P. and Donald R. Lynam. 2001. "The Five Factor Model and impulsivity: using a structural model of personality to understand impulsivity." *Personality and Individual Differences*, 30(4): 669-89.

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

<i>Family Income</i> < \$100,000	0.24+ (0.07)	0.15 (0.06)	0.19+ (0.05)
<i>Family Income</i> <i>between</i> \$100,000 <i>and</i> \$200,000	0.35+ (0.08)	0.38 (0.08)	0.37+ (0.06)
<i>Family Income</i> > \$200,000	0.41+ (0.09)	0.47 (0.09)	0.44+ (0.06)
<i>Happiness</i>	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								
		<i>t</i> (Days)						
		1	3	7	14	28	56	<i>Mean</i>
<i>m</i> (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)

Table 2.b. $D(m, t)$, control group—neutral affect								
		<i>t (Days)</i>						
		1	3	7	14	28	56	<i>Mean</i>
<i>m (Dollars)</i>	\$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)
	<i>Mean</i>	.886 (.244)	.865 (.207)	.814 (.237)	.800 (.204)	.769 (.210)	.721 (.234)	.805 (.193)
Table 2.c. $D(m, t)$, treatment group—positive affect								
		<i>t (Days)</i>						
		1	3	7	14	28	56	<i>Mean</i>
<i>m (Dollars)</i>	\$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)
	<i>Mean</i>	.951 (.114)	.917 (.133)	.906 (.122)	.876 (.128)	.843 (.169)	.821 (.197)	.885 (.116)

Table 2.d. { $D_{Treatment}(m, t) - D_{Control}(m, t)$ }								
		<i>t</i> (Days)						
		1	3	7	14	28	56	<i>Mean</i>
<i>m</i> (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)
	<i>Mean</i>	.065 (.046)	.051 (.042)	.092 ** (.046)	.076* (.041)	.073 (.046)	.099* (.052)	.081** (.039)

* significant at <0.1, **significant at <0.5, ***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)
<i>Treatment</i>	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)
<i>Only discounter included</i>	-	-	-	-	Yes	Yes	Yes	Yes
<i>College</i>	-	Yes	-	Yes	-	Yes	-	Yes
<i>Gender</i>	-	Yes	-	Yes	-	Yes	-	Yes
<i>Race</i>	-	Yes	-	Yes	-	Yes	-	Yes
<i>Religion</i>	-	Yes	-	Yes	-	Yes	-	Yes
<i>Practicing</i>	-	Yes	-	Yes	-	Yes	-	Yes
<i>Income</i>	-	Yes	-	Yes	-	Yes	-	Yes
<i>Self-Reported Happiness</i>	-	-	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
<i>Clusters</i>	69	68	69	68	58	57	58	57
* significant at <0.1 **significant at <0.5 robust standard errors reported in parentheses								

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

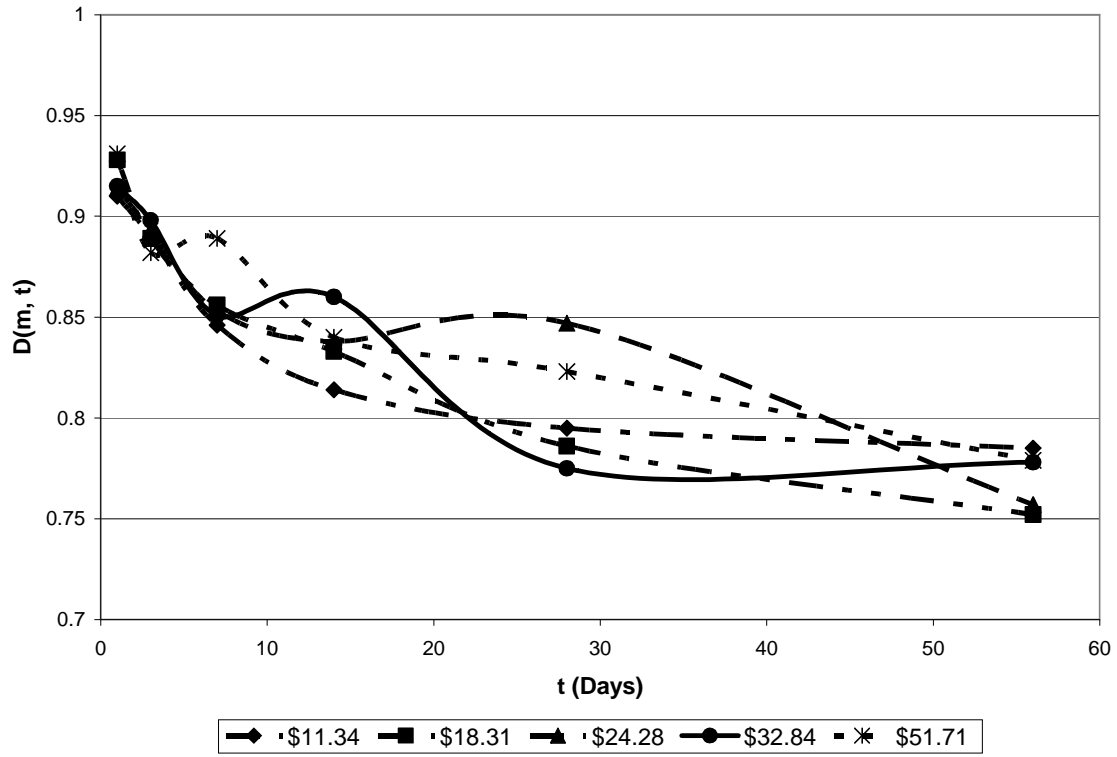


Figure 1.b. $D(m, t)$, holding m constant, control group—neutral affect

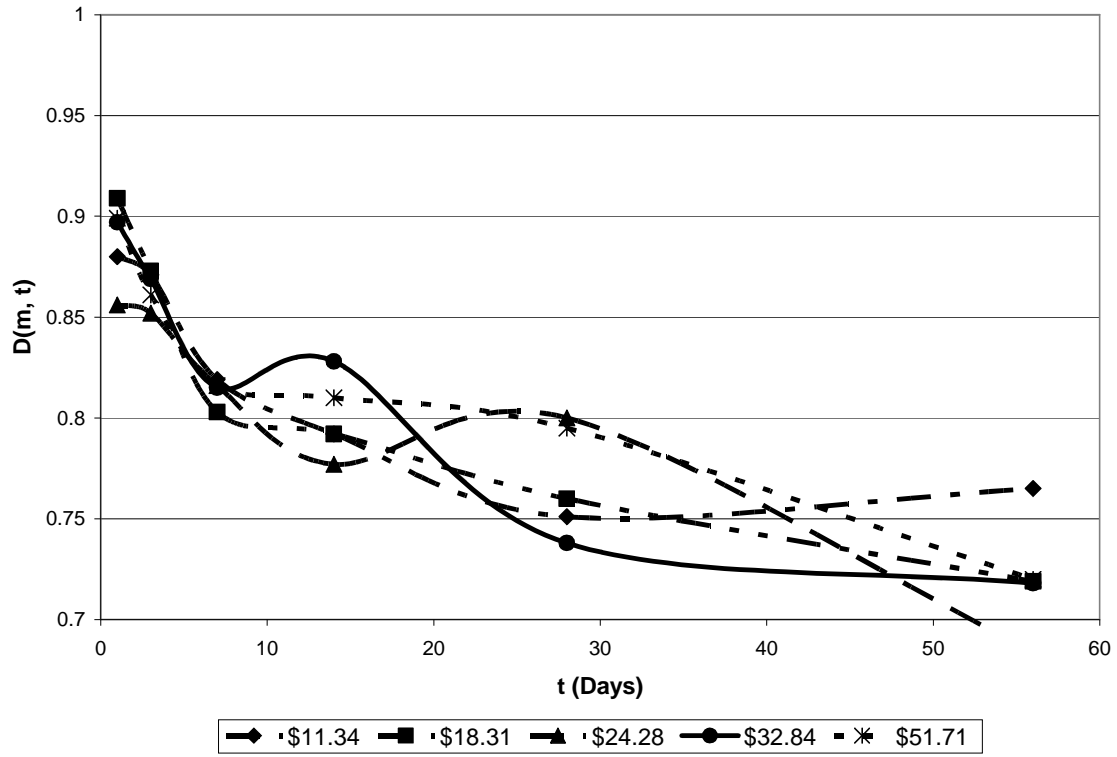


Figure 1.c. $D(m, t)$, holding m constant, treatment group—positive affect

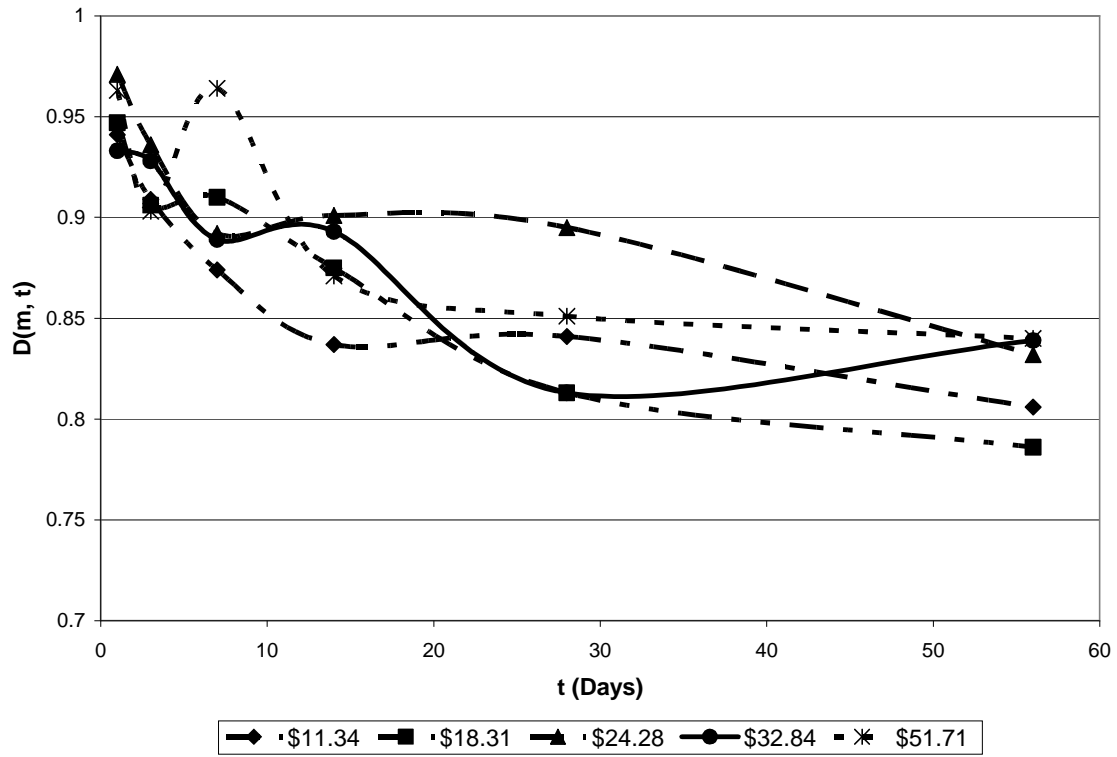


Figure 2.a. $D(m, t)$, holding t constant, pooled data

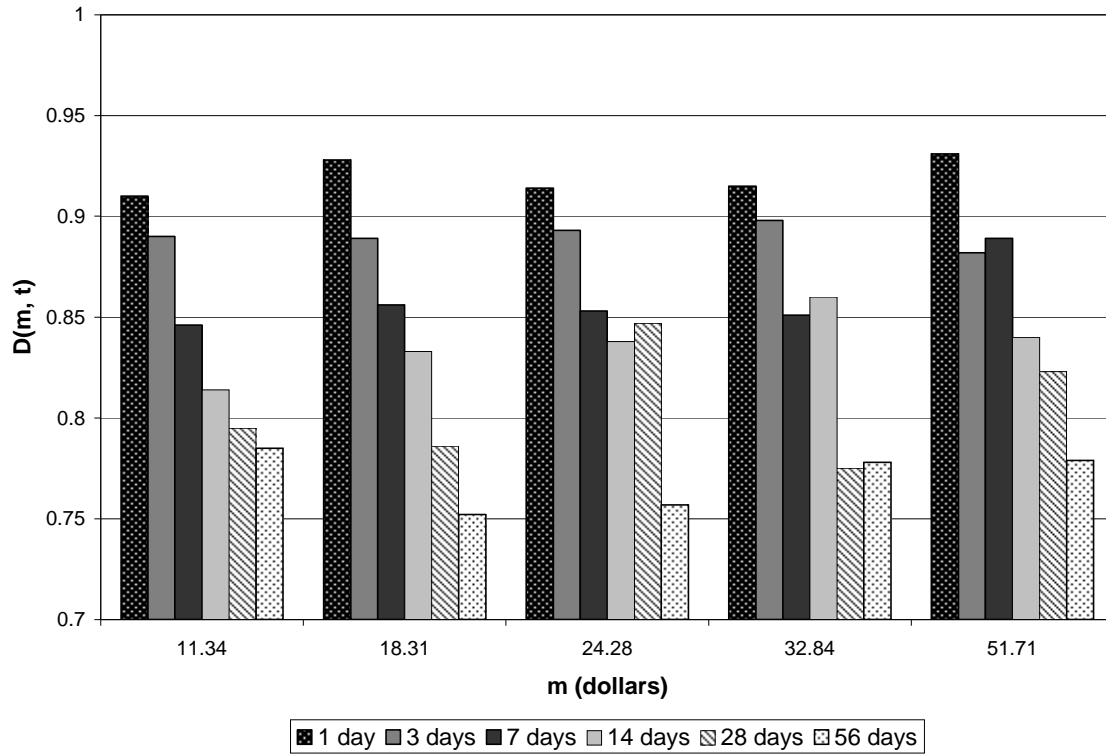


Figure 2.b. $D(m, t)$, holding t constant, control group—neutral affect

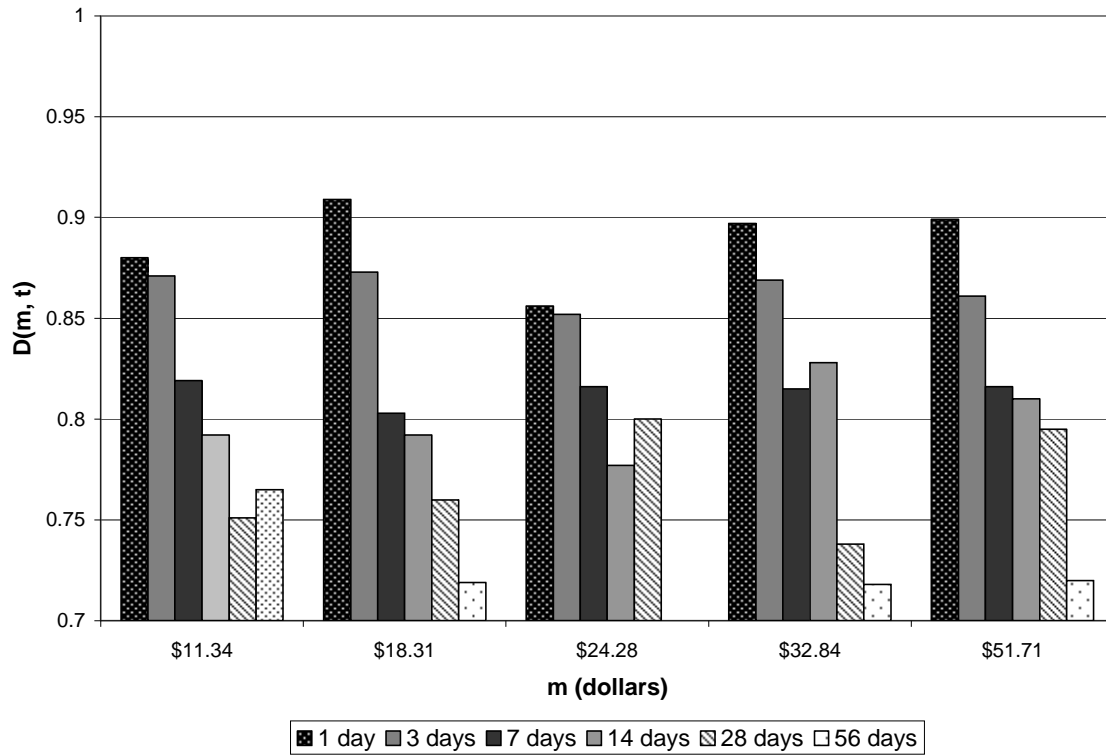
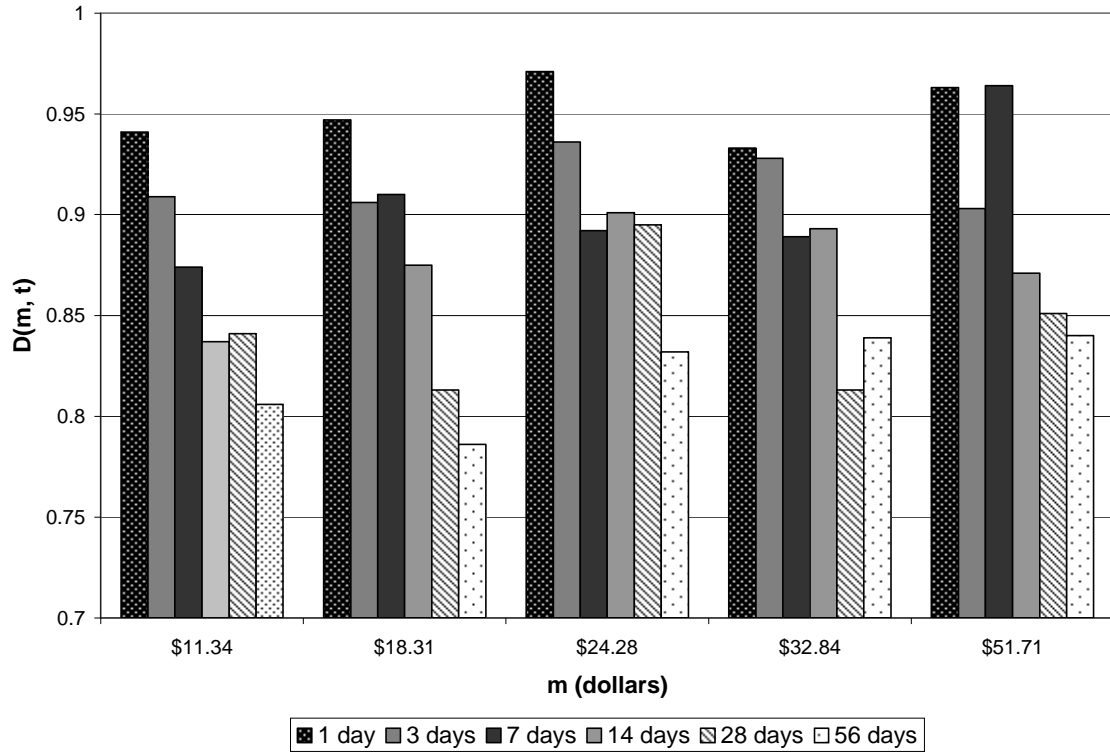


Figure 2.c. $D(m, t)$, holding t constant, treatment group—positive affect



Appendix A. Results from regressing ‘happiness’ on ‘live for today’ and covariates using data from the GSS

<i>Dependent variable: Happy from GSS</i>	
<i>Live for today</i>	0.205* (.111)
<i>Attend religious services</i>	0.066*** (.021)
<i>Age</i>	0.0211 (0.0239)
<i>Age squared</i>	0.000 (0.000)
<i>Low income</i>	0.044 (0.220)
<i>Low education</i>	0.045 (0.141)
<i>Female</i>	0.329** (0.112)
<i>Nonwhite</i>	-0.509** (0.207)
<i>Poor health</i>	-1.629*** (0.364)
<i>Fair health</i>	-0.842*** (0.169)
<i>Excellent health</i>	0.597 (0.116)
<i>N</i>	1636

* significant at <0.1, **significant at <0.5, ***significant at <0.01
standard errors reported in parentheses

Appendix B. Estimates and tests of various discount functions

The discount rates and discount factors exhibited by our subjects are compatible with those from earlier studies. Using a model of exponential (hyperbolic) discounting, our pooled data suggests an annual r of 2.25 (2.70). Disaggregating by future value m and time delay t , our data supports the existence, as in earlier studies, of time-preference, with r decreasing in t , and a magnitude effect, with r decreasing in m .

Because r is a function of m and t , disaggregation allows for more appropriate comparisons with earlier studies whose m and t values differed substantially from ours. For example in Thaler (1980), which uses hypothetical rather than real-money questions, m ranges from \$15 to \$3,000, and t from 1 month to 10 years. We can thus compare our discount rates to his (\$15, 1 month)-combination by restricting our data to m -values of \$11.34 and \$18.31 and the t -value to 28 days. The implied annual discount rate in Thaler (1980), using the (\$15, 1 month) data and assuming exponential discounting, is 345%; the corresponding figures from our restricted data are 309% (assuming exponential discounting) and 350% (assuming hyperbolic discounting). Benhabib et al. (2007), whose experimental protocol we closely matched, report an annual $r = 2.21$ (assuming exponential discounting), which is very close to our estimate. Those authors also re-estimate the hyperbolic function using data from Kirby and Marakovic (1996) restricted to more comparable m and t values and derive an average annual r of 1.83.

Further, one can test which model of time-discounting best fits the data. Benhabib et al. (2007) provides the following specification which nests four different time-discounting models: exponential, hyperbolic, quasi-hyperbolic, and fixed-cost:

$$D(m, t; \theta, r, \alpha, b) = \begin{cases} 1 & \text{if } t = 0 \\ \alpha d(t; \theta, r) - \frac{b}{m} & \text{if } t > 0 \end{cases}$$

$$\text{where } d(t; \theta, r) = (1 - (1 - \theta)rt)^{\frac{1}{1-\theta}}.$$

As in Benhabib et al. (2007) we conduct the following three tests:

Test (1): Assuming $\alpha = 1$ and $b = 0$, we test for an exponential versus hyperbolic specification. Specifically if θ , the measure of curvature, equals 1 then there is exponential discounting; if θ equals two then there is hyperbolic discounting.

Test (2): Relaxing the restriction on b above, we test for fixed-cost discounting. Specifically, if b is different from 0 then there is fixed-cost discounting.

Test (3): Relaxing the final assumption, we test for quasi-hyperbolic discounting. Specifically, if α is less than one, then there is quasi-hyperbolic discounting.

For all three tests, non-linear least squares are used to estimate parameters of the function $x = mD(m, t; \theta, r, \alpha, b)$ for each subject. Results are presented separately for each test. In all tables, estimates that did not converge have been omitted, and entries have been rounded to three decimal places.

Test (1) Results

Table B.1. presents estimates of θ and r , assuming $\alpha = 1$ and $b = 0$. Estimates were derived for 46 of 69 subjects. Below is a discussion of the estimates.

r : Values of r range from 0.0007 to 4.897, with a mean value of 0.266 and median of 0.021.

θ : Of the 46 sets of estimates, the exponential model ($\theta = 1$) and the hyperbolic model ($\theta = 2$) are rejected in 20 and 18 cases, respectively. Of the 20 cases (18 cases) in which the exponential (hyperbolic) model is rejected, the hyperbolic (exponential) model is also rejected in all but four cases (two cases). In other words, while the exponential model is rejected in favor of the hyperbolic model for four of twenty subjects, the hyperbolic model is rejected in favor of the exponential model for only two of twenty subjects. Thus there is slightly more evidence of hyperbolic than exponential discounting.

Test (2) Results

Table B.2. presents estimates of θ , r , and b , assuming $\alpha = 1$. Estimates were derived for 47 of 69 subjects. Below is a discussion of the estimates.

r: Values of r are roughly consistent with those from Test (1) and range from 0.0003 to 2.639, with a mean value of 0.252 and median value of 0.015.

\theta: Again, tests of the parameter θ suggest slightly more support for hyperbolic than exponential discounting. For 17 subjects, the hypothesis of exponential discounting is rejected; for five of these subjects hyperbolic discounting is not rejected. The hyperbolic hypothesis is rejected for only 12 subjects, and only for two of these subjects is the exponential model not also rejected.

b: For 16 subjects, b was significantly different from 0; in all but two cases, b was significantly greater than 0 and thus consistent with fixed-cost discounting. So there is support for fixed-cost discounting in roughly 30% of subjects. The magnitude of the fixed-cost of delayed gratification is given by the point-estimate of b . Values of b range from -105.918 to 50.918, with a mean value of 6.552 and median value of 5.745.

Test (3) Results

Table B.3. presents unrestricted estimates of θ , r , b , and α . Estimates were derived for 46 of 69 subjects. Below is a discussion of the estimates.

r: Values of r are close to, but slightly lower, than those from Tests (1) and (2), ranging from 0.0001 to 3.424. The mean and median values of r are 0.177 and 0.014, respectively.

\theta: In this test, both the exponential and hyperbolic models are rejected for fewer subjects than in Tests (1) and (2). Further, the exponential model is rejected for fewer subjects than the hyperbolic. The exponential model is rejected for five subjects, and the hyperbolic model is rejected for seven subjects. Of the five subjects for whom the exponential model is rejected, the hyperbolic model is not rejected for only one. Of the seven subjects for whom the hyperbolic model is

rejected, the exponential model is not rejected for three. Hence, Test (3) provides support for the exponential model over the hyperbolic model.

b: The estimates of *b* closely mimic those in Test (2): 17 subjects exhibited *b* significantly different from 0. For all but one of these 17 subjects *b* was significantly greater than zero. The estimates of *b* range from -106.666 to 64.997, with a mean of 6.357 and median of 7.98.

α: Of the 46 subjects for whom there are parameter estimates, 19 correspond to *α* greater than 1. However, *α* is in no cases less than (or even different from) one; thus, there is no evidence of quasi-hyperbolic discounting.

In summary, both Tests (1) and (2) support hyperbolic discounting over exponential discounting: (i) exponential discounting is rejected for more subjects than is hyperbolic discounting; and (ii) exponential discounting is rejected in favor of hyperbolic discounting more often than vice versa. By these same criteria, Test (3) supports exponential discounting over hyperbolic discounting. Both Tests (2) and (3) suggest that roughly 35% of subjects exhibit fixed-cost discounting. Finally, Test (3) offers no support for quasi-hyperbolic discounting.

Results of these same tests in Benhabib et al (2007) suggest marginally more support for hyperbolic versus exponential discounting, a lack of support for quasi-hyperbolic discounting, and significant support for fixed-cost discounting. With respect to hyperbolic versus exponential discounting, the results of Tests (1) and (2) are congruent with Benhabib. Our Test (3), however, suggests the opposite of Benhabib's result. Our lack of support for quasi-hyperbolic discounting fully supports Benhabib's similar finding. The greatest deviation of our results from Benhabib's is with respect to fixed-cost discounting, for which they find significantly greater support.

Table B.1. Parameter estimates for Test (1)				
Subject	θ	se(θ)	r	se(r)
1	2.984	1.333	0.015	0.004
2	497.747	169.141	0.037	0.055
3	12.607	4.122	0.328	0.333
4	40.032	22.857	0.020	0.024
5	20.229	11.065	2.377	6.890
8	17.412	7.823	0.018	0.012
9	7.889	1.831	0.050	0.018
10	38.956	13.835	0.291	0.410
14	2.662	1.184	0.015	0.004
16	9.522	18.895	0.002	0.001
18	410.457	564.493	0.090	0.622
19	301.268	153.756	0.007	0.010
20	34.264	26.612	0.007	0.007
21	0.178	0.749	0.008	0.002
23	8.266	6.513	0.007	0.004
24	-1.792	1.337	0.005	0.001
28	-0.473	4.937	0.002	0.001
29	3.412	0.710	0.054	0.014
30	172.333	223.352	4.897	51.348
32	27.293	6.178	0.045	0.023
33	0.000	14.521	0.001	0.000
34	23.721	17.867	0.199	0.485
35	-9.870	3.519	0.002	0.000
36	16.014	3.751	0.084	0.046
39	4.025	1.407	0.024	0.008
40	6.748	2.569	0.163	0.134
42	5.941	1.937	0.051	0.024

43	-4.695	2.818	0.003	0.001
47	4.851	2.284	0.733	0.973
48	13.306	5.172	0.015	0.008
49	9.645	2.577	0.207	0.142
51	-21.051	29.800	0.001	0.001
52	0.000	8.632	0.002	0.001
53	111.019	75.988	0.116	0.323
54	-1.322	3.935	0.003	0.001
55	150.153	113.691	0.027	0.065
57	1.723	1.073	0.028	0.012
58	38.853	119.447	0.001	0.001
59	9.758	2.293	1.750	1.767
60	-0.978	2.761	0.004	0.002
61	13.358	1.906	0.302	0.133
63	3.509	1.142	0.021	0.006
64	340.501	200.125	0.015	0.029
65	3.684	1.222	0.189	0.114
67	0.745	0.374	0.021	0.004
68	3.733	6.357	0.004	0.002

Table B.2. Parameter estimates for Test (2)						
Subject	θ	se(θ)	r	se(r)	b	se(b)
1	2.970	1.393	0.015	0.005	0.336	10.241
2	492.337	168.244	0.021	0.028	1.008	0.619
3	12.954	4.453	0.260	0.276	17.695	17.715
4	33.017	26.911	0.007	0.008	15.899	6.250
5	20.328	11.366	2.254	6.694	2.867	22.096
8	16.344	8.207	0.015	0.011	4.719	8.038
9	7.745	1.921	0.039	0.015	18.146	9.132
10	38.947	14.223	0.201	0.276	8.155	7.714

12	0.000	2.728	0.000	0.000	4.948	1.184
14	2.623	1.245	0.015	0.004	1.666	10.098
16	8.285	21.068	0.002	0.001	1.610	4.139
18	0.000	8.340	0.000	0.000	4.851	2.842
19	302.699	169.752	0.006	0.008	0.905	1.176
20	19.597	32.140	0.002	0.002	14.013	4.973
21	-0.190	0.832	0.007	0.001	11.761	7.714
23	-3.271	6.583	0.002	0.001	30.446	6.032
24	-2.373	1.639	0.004	0.001	10.128	9.598
28	-4.577	5.835	0.002	0.001	5.745	3.281
29	3.404	0.737	0.052	0.014	5.525	12.417
30	176.489	235.474	2.098	20.507	5.496	7.172
32	25.067	5.888	0.025	0.012	12.874	3.993
33	0.000	12.927	0.001	0.000	3.815	3.204
34	24.446	20.199	0.136	0.348	16.161	24.034
35	-12.500	4.948	0.001	0.000	5.571	3.833
36	15.997	3.844	0.082	0.049	0.949	8.300
39	4.079	1.446	0.025	0.009	-2.113	11.891
40	6.886	2.901	0.112	0.099	38.028	25.895
42	5.737	2.094	0.038	0.019	25.810	14.841
43	-8.477	6.553	0.002	0.001	27.604	12.491
47	3.941	1.678	1.146	1.373	-105.918	44.790
48	8.334	4.858	0.007	0.003	15.172	6.266
49	9.648	2.547	0.236	0.173	-8.932	16.295
50	4.676	1.434	2.639	3.019	-64.168	30.098
51	0.000	24.249	0.002	0.002	7.978	9.138
52	-7.911	14.941	0.001	0.001	13.504	6.938
53	106.824	76.996	0.052	0.130	5.518	5.512
54	-4.655	4.993	0.002	0.001	12.477	5.091
55	84.480	105.182	0.003	0.004	8.300	3.620

57	1.507	1.228	0.020	0.009	50.918	24.285
59	9.701	2.326	1.821	1.901	-4.007	16.479
60	-3.753	3.930	0.003	0.001	24.016	9.936
61	13.314	1.818	0.218	0.089	17.188	6.711
63	2.492	1.075	0.014	0.004	27.125	8.876
64	340.431	201.436	0.016	0.034	-0.208	1.438
65	3.674	1.233	0.195	0.126	-4.710	31.598
67	0.660	0.401	0.019	0.004	21.992	13.775
68	4.444	6.509	0.004	0.002	-2.931	7.025

Table B.3. Parameter estimates for Test (3)

Subject	α	se(α)	b	se(b)	θ	se(θ)	r	se(r)
1	0.996	0.076	0.492	11.027	3.054	1.763	0.015	0.007
2	5.124	5.923	1.005	0.629	374.202	315.643	0.001	0.004
3	0.715	126.754	18.868	16.955	26.359	31.040	1.291	179.681
4	0.007	4.295	17.106	6.393	74.045	129.708	1.089	337.706
5	0.974	30.964	3.042	22.723	0.906	113.216	0.002	0.009
7	0.763	1.207	-87.333	48.363	0.413	3.215	0.030	0.048
8	1.222	0.376	3.816	8.337	12.887	11.721	0.008	0.011
9	0.160	0.511	22.134	8.635	10.159	2.091	0.424	1.511
10	0.725	357.196	7.953	7.183	-1.752	4201.796	0.000	0.002
14	0.873	0.133	6.687	10.481	3.726	1.393	0.023	0.011
16	0.848	0.333	3.359	4.450	15.122	20.532	0.003	0.003
19	0.197	33.594	0.907	1.169	547.773	783.517	0.053	8.012
20	0.577	0.731	15.343	5.295	35.095	32.691	0.007	0.014
21	1.012	0.026	16.784	8.230	0.633	0.885	0.010	0.002
23	1.013	0.047	31.558	6.732	-0.689	7.364	0.003	0.002
24	1.037	0.064	12.474	10.778	-1.814	1.835	0.005	0.002
28	0.969	0.093	5.146	3.665	-7.059	8.322	0.001	0.001
29	0.744	0.215	10.547	12.396	4.091	0.868	0.095	0.056

30	4.424	78.498	5.534	7.318	40.114	480.942	0.001	0.004
32	1.083	0.697	12.839	4.106	24.224	8.626	0.021	0.027
34	2.328	1367.008	17.018	24.074	62.256	226.674	0.601	295.819
35	0.708	0.274	2.649	4.175	-21.521	13.791	0.001	0.000
36	0.781	1.933	1.064	8.481	16.524	6.205	0.116	0.400
39	0.874	0.228	-0.302	12.512	4.946	1.819	0.036	0.025
40	0.042	2.760	41.624	25.397	9.647	5.555	3.424	227.218
42	0.894	0.407	27.155	15.458	6.070	2.694	0.047	0.051
43	1.281	0.171	37.410	13.608	-4.035	2.937	0.003	0.002
47	1.957	3.329	-106.666	45.673	3.431	3.133	0.340	1.549
48	1.029	0.154	13.077	6.538	2.185	6.681	0.004	0.002
49	1.818	1.659	-9.376	16.564	8.376	4.394	0.082	0.180
50	0.931	4.919	-62.106	33.396	0.927	5.712	0.013	0.028
51	1.298	0.503	10.302	10.281	-15.768	30.349	0.001	0.001
52	0.957	0.262	12.788	7.807	-10.300	21.787	0.001	0.001
53	1.469	3.357	5.434	5.546	17.795	106.579	0.001	0.002
54	1.025	0.092	16.364	5.440	-0.112	4.345	0.003	0.001
55	1.333	0.966	7.875	3.768	54.366	166.764	0.001	0.003
57	0.865	0.194	64.997	25.196	2.275	1.278	0.034	0.022
58	0.528	0.877	8.007	2.732	56.643	112.869	0.001	0.002
59	5.176	11.422	-4.048	16.780	8.730	4.770	0.201	0.895
60	1.050	0.075	26.667	11.147	-2.281	4.105	0.004	0.002
61	2.323	0.579	16.788	6.533	8.872	2.921	0.027	0.020
63	0.964	0.081	28.247	9.561	3.164	1.355	0.018	0.007
64	0.230	30.022	-0.180	1.440	386.281	461.932	0.074	9.403
65	0.810	0.294	-3.547	32.905	0.278	1.059	0.017	0.011
67	0.994	0.038	35.118	13.633	1.068	0.411	0.025	0.006
68	0.972	0.137	-2.190	7.656	5.662	7.889	0.005	0.004