Social discounting: Social distance and altruistic choice

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Abstract of the Dissertation

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Social discounting measures the amount of money an individual is willing to forgo in order to give money to another person. Seven experiments were conducted to explore the relationship between social discounting and altruistic decision making. In the first two experiments, the amount of money forgone was determined by a hyperbolic function of the social distance between giver and receiver. In the third experiment individual rates of social discounting were compared to individual rates of delay and probability discounting. In Experiment 4 participants gave psychophysical measures of social distance. In Experiment 5 the percentage of cooperation in a single-shot prisoner's dilemma game was correlated with rates of social discounting. In Experiment 6 the amount of money participants gave to individuals at a given social distance in an ultimatum or dictator game was reduced as social distance increased. In Experiment 7, the participants were more forgiving as the as social distance increased when acting as the receiver in an ultimatum game. The role of social discounting and altruistic behavior is discussed with implications for future applications of the measure.

Table of Contents

List of Figures

List of Tables

Preface

Note 1: Theory

The current series of studies examine the role of social discounting as primarily an economic theory. That is, the value of social relationships can be predicted by a function of social distance, and that value is useful for estimating decision making preferences under a variety of situations. The purpose of this study is to establish the predictive value of social discounting measures in a variety of economic games.

The rate of social discounting has been linked to self-control in a variety of studies (Myerson et al., 2003; Harris & Madden, 2002; Madden, et al., 2003). Steep delay discounters, those who systematically prefer immediate rewards over delayed rewards, are likely to have problems with making impulsive decisions such as the decision to use illegal/harmful substances. Just as delay discounting measures self-control, social discounting measures altruism. An altruistic choice benefits another individual at a cost to the self. Steep social discounters, those who are likely to take more money for themselves systematically across social distances, behave more selfishly in economic games than shallow social discounters behave.

Preliminary studies have suggested that social and delay discounting share more than hyperbolic form; overlapping rates of discounting relate directly to the relationship between self control and altruism (Rachlin & Jones, in press). It is easy to think of examples of how self-control can be related to selfishness. For example, taking the last piece of cake may be impulsive, selfish, or both. This study examined the link between discounting and altruism by exploring relationships between types of discounting, self control, and altruism.

Note 2: Mass Testing

At Stony Brook, one class session per semester is devoted to “mass testing.” The advantage of this procedure is the large number of available participants. For studies where procedures involve some risk to participants, their number is properly limited to the minimum for expected significance. However, in this study there was minimal risk. We therefore tested as many participants as possible. The very good fits to theoretical curves obtained with the larger number of participants and the convergence of these results with Jones & Rachlin’s (2006) results (see Figure 2) justifies the procedure.

A disadvantage of experimentation in this setting is that some participants, in the anonymity of a large class, do not complete the experiment or pay attention to the instructions. However, the present experiments contain a built-in check on consistency; as the “selfish” alternative decreases from high amounts, participants should have crossed over only once between selfish and generous choices at each social distance. Data from participants who chose inconsistently at any social distance were not used in the analysis. However, the number of participants who make inconsistent choices is small; the primary reason for removing participants is failure to complete an entire packet. Unlike laboratory experiments where unmotivated participants feel obligated to continue the experiment in order to please the experimenter, anonymous mass testing participants merely stop writing. Thus the mass testing provides a check to eliminate apathetic participants.

Note 3: Hypothetical Rewards

One apparent weakness of this procedure is its use of hypothetical rewards. Participants might honestly imagine that they would be generous in a certain situation with hypothetical rewards yet choose selfishly when real rewards are offered. This is a serious disadvantage of the present procedures. But the use of real monetary rewards does not solve the problem. Amounts of money offered in real-reward experiments are typically much lower than those in real-life situations; results with real rewards may not be any more indicative of what people will do in real-life situations, where motives and incentives are strong, than are results with larger, hypothetical rewards. Moreover, where they have been compared, discount functions for real (but small) and hypothetical (but large) rewards have been similar (Madden et al., 2003).

Social discounting: Social distance and altruistic choice

Social relationships are often described by referring to distance between individuals. By definition, our strongest social relationships are with those who are 'closest' to us; individuals with lesser relationships are more 'distant.' We allocate more resources toward those to whom we share the closest relationships. As social distance increases, the utility of the relationship decreases. Economists such as Julian Simon (1995) have claimed that altruism can be explained in terms of utility. Simon proposed that a person's decision to allocate resources can be determined on a 3-coordinate system: a) current consumption by the person herself, b) consumption by the same person at later times [delay discounting], and c) consumption by other people [social discounting]. He said: "Instead of a one-dimensional maximizing entity, or even the two-dimensional individual who allocates intertemporally, this model envisages a three-dimensional surface with an interpersonal 'distance' dimension replacing the concept of altruism" (p. 367). Thus, benefits to others are viewable as a valuable commodity that can be quantified by social distance.

In this study, social discounting was found to underlie a variety of decisions made every day by individuals. Steep social discounters, individuals who systematically prefer the selfish choice for all but their closest relationships, are less sensitive than shallow discounters to the influence of social relationships. The rate of social discounting, therefore, should predict altruistic behavior in a variety of settings.

The following experiments explored the link between social discounting, selfishness, altruism, and self control. In each experiment, the individual rate of social discounting impacted altruistic and self controlled behaviors.

The plan of the experiments is as follows: First, I establish a procedure for determining rate of social discounting that is similar to the procedure for determining the rate of delay discounting. Experiments 1 (Jones & Rachlin, 2006) and 2 (Rachlin & Jones, in press) are designed to show that reward exhibits similar reduction in value over social distance as it does over delay and to determine which function fits social discounting best. Experiment 3 compares delay, probability, and social discounting directly. Experiment 4 is designed to show that individuals evaluate social distance systematically.

Next, I show that social discounting underlies altruistic and selfish decisions. For example, in a prisoner's dilemma game (PDG), a game commonly used to study altruistic decision making, the decision to cooperate or defect may be correlated with the participant's social discount rate. Under conditions of anonymity participants defect significantly more often than they do when their choice is exhibited to the other player(s) (Fox & Guyer, 1978); anonymity provides the maximum social distance between individuals. Thus, when social distance is maximized, individuals should defect most often; this should be influenced by the individuals' sensitivity to social relationships. Those who exhibit steep discounting curves should therefore be more likely to defect in a prisoner's dilemma game. Experiment 5 investigated this prediction.

Degree of social discounting should predict the likelihood that a person will share resources. For example, the decision to give money to another person without their input can be studied using a dictator game. In an ultimatum game, the giver decides what portion of an initial endowment to allocate between himself and a receiver; the receiver determines whether or not the allocation was fair, similar to a business contract. In dictator games the receiver has no say in the terms of the offer; in an ultimatum game the receiver may reject the offer, ensuring that no party receives any portion of the available resource. Previously, these games have been conducted under conditions of anonymity (Handgraaf, Van Dijk, & De Cremer, 2003) and have not included a measurable social distance component.

In ultimatum games, participants' choices to give money or to reject money offered may be influenced by the social distance between themselves and the receiver. In both dictator and ultimatum games, participants offer substantially less money as social distance increases. In ultimatum games participants, acting as receivers for similar offers, may expect less money from more distal participants. Thus, the discounted value of the social relationship may predict behavior. Experiments 6 and 7 explored the relationship between social discounting and ultimatum/dictator bargaining games.

Third, I predict that social discounting will relate directly to self control. Social discounting shares some of the same properties as delay discounting (Rachlin, & Jones, in press). Steep delay discounters are unable to delay gratification, much like the example of a child who is unable to hold back from eating a treat offered to them immediately (Mischel & Mischel, 1983); they are shortsighted about their future decisions. Steep social discounters are shortsighted about social decisions; they are likely to make choices benefiting themselves, rather than others without concern for future interactions with the other person. These behavioral patterns suggest that a common process may underlie both forms of discounting. For example, cigarette smokers are more likely to be steep delay discounters (Baker, Johnson, & Bickel, 2003). Smoking has been labeled an impulsive habit; where the immediate reward of nicotine outweighs future reward of prolonged good health. However, smoking may also have a direct social component; a smokers' decision to continue smoking may adversely affect those around them and the long term health consequences of exposure to smoke may have a detrimental effect on those in proximity of the smoker. Thus, the decision to smoke is also a selfish choice. Experiment 3 replicated Bickel et al.'s (2003) work with smokers in delay discounting using social discounting measures.

To achieve the understanding that social discounting relates to decision making, the following seven experiments examined these predictions:

1) Social discounting follows the same hyperbolic form as delay and probability discounting.
2) Social discounting occurs even when there is no direct benefit for being altruistic
3) Social discounting is related to other forms of discounting and self control
    a. Social discount rates will correlate with delay and probability discount rates.
    b. Social discount rates will correlate with a measure of nicotine dependency.
4) Social distance is perceived systematically; changes in social rank are estimated by a power function.
5) Social discount rates determine the percentage of cooperative choices made in a prisoner's dilemma game.
6) Social discount rates determine the amount of money offered in dictator and ultimatum games.
7) Social discounting determines the likelihood of a participant rejecting money as the receiver in an ultimatum game.

First, we must address the issues of social distance, delay, and probability discounting, discuss the hyperbolic form of discounting equations, and understand ultimatum, dictator, and prisoner's dilemma games.

Social Distance

Previous attempts to define social distance relied on qualitative measures of closeness. An early attempt (Bogardus, 1938) focused on a person's perceived distance from groups of individuals. Bogardus provided an ordinal scale by which participants used ethnicity to make simple decisions, such as who they would marry or who they would hire. Further work expanded on Bogardus's (1938) scale by including factors such as social class, political affiliation, etc (for a discussion see Triandis & Triandis, 1960). However, there was no attempt to account for the difference between individuals quantitatively. It is left to the field of behavioral economics to provide a quantitative framework for social distance.

Simon (1995) proposed that a component of individual utility is the consumption of available goods by another person and that the closeness of Person B to Person A determines the degree to which Person B's consumption adds to Person A's utility. But Simon did not provide a mechanism by which the distance may be measured.

Social relationships can impact a broad range of human behaviors. One important influence of social reinforcement is on addictive behaviors. The decision to smoke one's first cigarette, for example, is often attributed to a family member or friend's influence (Kobus, 2003). One theory of the impact of social relationships on addiction is that an addict's need for addictive substances can sometimes be replaced by social reinforcement (Green & Fisher 2000). Group therapy can be a substitute for drug use for some addicts. However, the success of such substitution remains contingent upon the individual addict's reliance on their social network. A measure of how an individual values their social network might be integral for predicting how successful social substitution may be in treating addiction. Thus, a test for determining how an individual perceives their social network could provide insight to maximize the efficacy of therapeutic intervention. Essential to the process of using social discounting as a tool for treatment is exploring the relationship between social distance and behavioral choice in an experimental setting.

These experiments take a behavioral economic approach to understand the mechanisms behind social distance by providing a framework based on a model of altruistic choice. Participants were asked to make a choice or series of choices based on their preference for sharing or giving money to a person at a given social distance [*N*]. Central to these experiments is the theory of social discounting: the more distal your relationship with another person, the less altruistic you will be toward that person (Jones & Rachlin, 2006).

In the current studies the specific qualities of a social relationship were left unmeasured; rather than ask participants to describe specific relationships, I relied upon the participants to base their decisions on how social relationships are ranked. In each experiment the rate of social discounting measured relied on the concept of social distance as defined by Jones and Rachlin (2006). Experiment 4 explored how individuals perceive social distance directly.

Hyperbolic Social Discounting

In the first study of social discounting (Experiment 1), a method for ascribing social distance in terms of both physical space and altruistic choice was established (Jones & Rachlin, 2006). Participants were asked to imagine a list of their social relationships and rank them in an ascending order from 1 to 100 (without actually making the list). The first person (#1) was someone with whom they shared the closest personal relationship; #100 would be someone who the participant might know in passing, and have only a tenuous relationship with. See Appendix A for the social distance example. Participants were then asked to make a series of decisions between keeping money for themselves and splitting an amount of money with an individual at a given social distance. Participants chose to forgo more money for the benefit of their closest relationships and less money for the benefit of those at the furthest social distances. The data are best fit by Mazur's hyperbolic discounting equation (Equation 1; Mazur, 1987) (R^2 = .997). Thus, individuals are more altruistic towards those closest to themselves and more selfish toward those further away in a predictable pattern.

$$v = \frac{V}{1 + kN^{s}} \qquad \text{Equation 1}$$

In this hyperbolic function the discounted value *v* is determined by the original value offered *V*, social distance *N*, and an individual discount rate *k*. Given several indifference points and an original *V*, the individual *k* can be found. High *k* values characterize individuals who choose to keep more money for themselves, and thus exhibit steep discount curves; low *k* values characterize individuals who forgo larger portions of money to give to others, even at larger social distances. Jones and Rachlin (2006) found that fitting their average data with three parameters, V, k, and s, did not significantly improve the (already excellent) fit of Equation to the data over fits varying only two parameters, V and k. It was therefore assumed that $s = 1$.

Social Discounting and Delay Discounting

Simon (1995) proposed that a component of altruistic decision making is related directly to the consumption by the individual at a later time. Thus, an individual's rate of delay discounting may have an impact on their decision to choose an altruistic behavior. Because of this, social discounting should share similar properties with delay discounting. Equation 2 shows the hyperbolic delay discounting equation commonly found in human discounting studies (Rachlin, 2006).

$$v = \frac{V}{1 + kD^{s}} \qquad \text{Equation 2}$$

In a pilot study seventy-seven participants completed measures of social and delay discounting online. Each received one questionnaire via email, and received the second questionnaire 48 hours after completing the first. Both social and delay measures were fit well by the hyperbolic discount equation (R^2 = .999 and R^2 = .995 respectively). There was no significant difference between the discounting rates produced by the online and paper versions of the social discounting measures. The delay discounting procedure asked participants to choose between varied immediate amounts of hypothetical money over $1,000 delayed by [*D*] duration. Rates of discounting were computed for individuals and converted to logarithmic bases in order to compare across tests. Over half of the participants failed to complete both studies, accounting for a large loss of data. Regardless of data loss, the results show a small but significant correlation between social discounting and delay discounting ($r(33) = .351$; $p = .045$). Experiment 3 completed a better controlled version of the social and delay discounting comparison.

Social Discounting and Probability Discounting

Probability is discounted in a similar fashion to delay (Rachlin, Brown, & Cross, 2000; Rachlin, Logue, Gibbon, & Frankel, 1986). The greater the odds against earning a reward, the more it is discounted. As the likelihood of winning shrinks, participants are more likely to prefer a sure bet to a gamble. Previous work has found only weak correlations between probability and delay discount rates (Myerson et al., 2003). In a preliminary study, two hundred twenty-six participants completed pen and paper measures of social and probability discounting. The hyperbolic equation fit both social (R^2 = .981) and probability discounting (R^2 = .982) quite well, but the measures were not significantly correlated ($p > .05$). It may be that perceptions of probability and social distance are completely unrelated; however there has yet to be a study directly comparing social, delay, and probability discounting. Experiment 3 examined this issue in detail.

Delay Discounting and Prisoner's Dilemma

One widely studied economic game is known as the Prisoner's Dilemma Game (PDG). In a PDG the player is asked to choose between cooperation and defection. The reward for each round in the game is based on all players' choices. For example, in a 2-player PDG the payoff for each player's choice is shown by Figure 1.

Insert Figure 1 here. (Refer to page 58).

On an individual trial in a PDG, defection pays more than cooperation does. For player 1 in the 2-player example the defection column (6 and 2 points) pays higher than the cooperation column (5 and 1 points). However if both players cooperate they both make more (5 points) than if both players defect (2 points).

Similarly, in a multiple-person PDG the more players that defect the less money is made overall. A single defection often leads to mutual defections among the entire group. Cooperation pays more in the long run by avoiding defection (for a review see Rachlin, 2000).

The optimal strategy in a multiple-round PDG is called Tit-For-Tat (TFT) (Komorita, Parks, & Hulbert, 1992; Sheldon, 1999). A player playing TFT initially cooperates but then mimics the choices of the opponent. If the opponent defects on the initial round, the strategy calls for the player to match the defection on a subsequent round. A player facing opponents using the TFT strategy is, on each round, playing against his or her own previous-round choice.

A PDG can be considered a self control paradigm when the game is played over multiple rounds. Defection is initially a larger reward than cooperation, however defection is short-sighted. Defection is similar to an impulsive behavior; the initial benefit for choosing defection is quickly lost when other players begin to defect in return and payoffs drop dramatically.

Against an opponent playing with a tit-for-tat strategy, where cooperation and defection choices are reciprocated, the PDG becomes a game where an individual is competing against his or her own choice on the previous round. In delay discounting, a self-controlled choice is the preference for delayed rewards over immediate ones. In this manner, self-control is similar to cooperation in a repeated Prisoner's Dilemma Game (PDG) (Rachlin, 2000; Ainslie, 1992). Cooperation sacrifices a lesser reward on the present choice for a pair of still larger alternatives on the following choice.

Thus, the proportion of cooperative responses in a PDG against a computer opponent has been found to correlate with an individual's delay discount rate (Harris & Madden, 2002; & Yi, Johnson, & Bickel, 2006). Steep delay discounters are significantly more likely to choose the short term (defection) option over the self controlled (cooperative) option.

The decision to cooperate in a PDG is also influenced by socially driven factors. For example, adding more players or making player's choices anonymous decreases levels of cooperation (Fox & Guyer, 1978; & Jorgenson & Papciak, 1981; Komorita, Parks, & Hulbert, 1992). Changes to the structure of the game may increase defection rates by reducing expectancy of cooperation from the other players.

The likelihood of a participant cooperating in a PDG may be directly tied to the social expectancies involved in competing against human opponents. In a single-shot game, where players make only one choice, it is always the best strategy to defect (Komorita, Parks, & Hulbert, 1992). Cooperation levels are much lower in a single-shot game compared to a multiple-round PDG (Nauta & Hoekstra, 1995). Nevertheless, there are individuals who cooperate despite it being the less optimal strategy. I predicted that social discounting rates will be related to the decision to cooperate in a one-shot game. Individuals who discount social relationships less steeply would be expected to cooperate more than steep social discounters.

In Experiment 5 a single-shot public goods game (PGG) was chosen to test the individual level of cooperation. In a PGG participants choose between contributing a portion of their endowment to the group or to keep the endowment for themselves. Contributions to the group are doubled and then divided equally among all participants, even to those who keep their endowments (Kollock, 1997).

The decision to keep money for oneself in a PGG is similar to a defection in a PDG; to contribute to the group is in a PGG is similar to cooperation in a PDG. A PGG differs only slightly from a PDG in that the payoff to each player is not a fixed amount. That is, the total number of players determines how much money is awarded, rather than being determined *a priori* by the experimenter..

Experiment 5 shows that a person's individual's social discount rate is directly related to that person's level of cooperation in an economic game. People with steep social discount rates are less sensitive to the impact of social relationships and therefore less likely to cooperate in a PGG.

Ultimatum Games and Social Discounting

An ultimatum game is a bargaining scenario in which one person ("the giver") is put in charge of an endowment provided by the experimenter, and offers a split to the other party ("the receiver"). The receiver has the option of accepting the terms or rejecting them; if the receiver rejects the offer neither party receives anything. The receiver may choose to punish the giver by rejecting the offer. The giver must determine a fair split to appease the receiver.

Economic theory proposes that a receiver should not reject any offer greater than zero (Güth, 1995); after all, the alternative *is* zero. However, individuals often reject much larger offers in order to punish the giver failing to offer a 'fair' split (Fëhr & Gachter, 2002). Givers, realizing this, usually offer amounts significantly greater than zero. Thus, behavior in ultimatum games may be strongly influenced by the social relationship between giver and receiver.

A dictator game is similar to an ultimatum game except that the receiver has no option to reject the giver's offer (Güth, 1995). The giver is free to offer nothing to the receiver and cannot be punished for lack of generosity. Offers from givers in a dictator game are significantly lower than offers from givers in ultimatum games. However, many givers in a dictator game offer the receiver more than $0. An offer greater than zero is purely altruistic; Experiment 6 tested our prediction that social relationships directly impact the amount of the offers in both ultimatum and dictator games.

Prior work on ultimatum games fails to account for the social relationship between the giver and the receiver. In an ultimatum game, the reward offered to the receiver is larger than it is in a dictator game (Forsythe et al., 1994): the offer is made knowing that it could be rejected. In a dictator game the offer is lower: the giving party merely decides how much to offer without fear of the giver being able to punish. Regardless of the type of game, the social distance between giver and receiver should impact the fraction of the initial endowment offered by the giver; the more distal the receiver, the less should be offered.

Previously, ultimatum/dictator type games have been studied under conditions of anonymity or with strangers (Handgraaf, Van Dijk, & De Cremer, 2003), and have not included a social component. In ultimatum games, participants' choice to give money or to reject money offers may have been affected by the social distance between themselves and the other players, but social distance was left unmeasured. Experiments 6 and 7 were designed to explore the impact of social distance on ultimatum and dictator games.

<u>Experiment 1 (Jones & Rachlin, 2006)</u>

Experiment 1 was designed to provide a scale for social distance. Participants chose between hypothetical amounts of money for themselves, or split with another person at a given social distance [N]. The amount of money they chose to forgo in order to share money with another person was used to calculate social discount rates.

Experiment 1 Method

Participants

Three hundred ten undergraduates (153 male, 157 female, *m* age = 19.57, *sd* = 2.36) in an introductory psychology class were given a pen and paper measure of social discounting as part of a mass testing session (see Note 1) for partial course credit.

Materials and procedure

Participants completed an eight-page questionnaire. The first page asked for gender, age, and contained the Social Distance Example (see Appendix A), followed by the following instructions:

> Next you will be asked to make a series of judgments based on your preferences. On each line you will be asked if you would prefer to receive an amount of money for yourself versus an amount of money for yourself and the person listed. Please circle A or B for each line.

The following seven pages all had the same form (see Appendix B), with N replaced by one of seven social distances (#1, #2, #5, #10, #20, #50, and #100). Pages were presented in a random order in each packet. Column A contained nine values of money ranging from $155 down to $75 for half of the participants; the other half received Column A values of money ranging from $75 up to $155. Column B was identical on all lines, offering participants $75 for themselves and $75 for person #N.

Experiment 1 Results

In almost all cases, participants preferred greater amounts of money for themselves as social distance [N] increased. Crossover points were determined at which each participant was indifferent between an amount of money for himself alone (the "selfish" option) and $75 for himself plus $75 for person N (the "altruistic" option). For example, if a participant preferred the selfish option at $155 and the altruistic option at $145, the crossover point was calculated to be $150. Data of 17 participants, who crossed over more than once on a given page or who failed to complete a page, were not used in the analysis. The median crossover point for each social distance was obtained across all remaining participants. These points were fit by hyperbolic and exponential functions. Equation 1 (R^2 = .997) was a better fit than an exponential function (R^2 = .970) and did not deviate systematically from the points as did the exponential function (see Figure 2).

Insert Figure 2 here. (Refer to page 59).

The best fitting *V* was $83. The median participant preferred to give $75 to the person at *N* = 1 than to obtain $75 for herself. Thus, the amount of money for the self ([*N*] = 0) predicted by the intercept *V* is greater than the highest amount offered. Additionally, the exponent *s* was not statistically different than 1.0, which puts the variance required to fit the curve to only two variables: *V* and *k*.

In addition, hyperbolic functions were fitted to the data of each subject. The median of the individual k values (*k* = .052) was virtually identical to the *k* of the median indifference points (*k* = .051). This is evidence that the latter is not an artifact of averaging. Figure 3 shows the distribution of individual k values. The distribution of individual k values is positively skewed; a log transformation (Figure 4) reverses and greatly reduces the skew. Log transformations of k will therefore be used in subsequent analyses unless specifically stated to the contrary.

Insert Figure 3 here. (Refer to page 60).

Insert Figure 4 here. (Refer to page 61).

Experiment 1 Discussion

Participants systematically discounted the value to themselves of money given to another person; they chose altruistically when social distances were close and, as social distance increased, began to prefer the more selfish option. However, at social distance [*N*] = #100, participants still gave up more than $10 in order to split money with a near stranger.

At N = 1 and N = 2 many participants chose to give $75 rather than take the selfish option of $155; this choice seems irrational. If a participant had chosen the $155 they could have still given $75 to the other person and had $80 for themselves. Participants asked to share money are typically generous (Fëhr & Schmidt, 1999). In Experiment 1 the altruistic option included a significant reward for the participant. Experiment 2 (Rachlin & Jones, in press) was designed to examine the amount of money participants would give to another person at a given social distance when they would receive no monetary reward for being altruistic.

Experiment 2

Experiment 2 was designed to extend the original Rachlin and Jones (2006) findings by eliminating any reward for participants who chose the altruistic option. Participants were asked to choose between differing amounts of money to keep for themselves or to give to another person at a given social distance [*N*].

Experiment 2 Method

Participants

Two-hundred-forty-two Stony Brook University undergraduates (111 male, 131 female, *m* age = 18.66, *sd* = 1.96) were given a series of written questions. Participants, students in an introductory psychology class, were given the questionnaire as a part of a mass testing session for partial course credit.

Materials and Procedure

The packets presented in Experiment 2 were identical to those of Experiment 1, with the following exceptions: the amount of money offered in column A was reduced to the $85 decrementing downwards to $5; the amount of money offered in column B was $75 given only to person #N (see Appendix C for a complete example). The seven pages in the questionnaire were presented in random order.

Additionally, each packet included a brief demographics page that asked participants to indicate the frequency of smoking, drinking alcohol, and eating unhealthy meals. For smoking, the alternatives were: a) never smoked, b) quit smoking, c) 1 pack a month or less, d) 2-3 packs a month, e) 1 pack a week, f) 2-3 packs a week, g) 1 pack a day, h) more than one pack a day. For alcoholic drinking the alternatives were: a) never drank, b) quit drinking, c) 1-2 drinks a month, d) 3-4 drinks a month, e) 1 drink a week, f) 2-3 drinks a week, g) 1 drink a day, h) more than 1 drink a day. For unhealthy eating the alternatives were: a) never eat unhealthy, b) dieting, c) 1-2 meals a month, d) 3-4 meals a month, e) 1 meal a week, f) 2-3 meals a week, g) 1 meal a day, h) more than 1 meal a day.

Experiment 2 Results

The results of Experiment 2 were analyzed in an identical manner to those of Experiment 1. Twenty-three participants were removed for double crossover points. The median obtained values of the parameters were: V = \$90; k = 0.055, s = 1.03 (R^2 = .969). As in Experiment 1, the best fitting exponential equation was a worse fit (R^2 = .927) and deviated systematically from the points. As in Experiment 1 (Jones and Rachlin, 2006) the median best-fitting exponent s was essentially equal to unity (1.0) and was taken as unity in subsequent fits of Equation 1 to social discounting data. Figure 5 shows the hyperbolic and exponential fits. Parameters of the hyperbolic function did not differ significantly from those of Experiment 1. Figure 6 shows the distribution of individual log k_{social} values. Figure 7 shows functions from Experiment 1 and Experiment 2 together.

Insert Figure 5 here. (Refer to page 62).

Insert Figure 6 here. (Refer to page 63).

Insert Figure 7 here. (Refer to page 64).

Preliminary comparison between social discount rates (k_{social}) of non-smokers (those indicating 0 cigarettes smoked) and heavier smokers (1 pack a week and up) indicate that smokers are more likely to be steep social discounters than non-smokers, but too few individuals reported smoking status greater than 0 to reach statistical significance ($r(220) = .09$, $p = .185$).

Experiment 2 Discussion

The main purpose of this experiment was to determine whether sharing (Experiment 1) was significantly different from giving (Experiment 2). Despite differences in procedure between Experiment 1 and Experiment 2, nearly identical results were reported. Parameters of the hyperbolic function did not differ significantly from those of Experiment 1. Figure 5 shows that the function from Experiment 1 overlaps that of Experiment 2. This shows that, surprisingly, there is no difference in altruism between situations where money is shared and situations where it is given outright. This implies that social discounting effects are robust when presented in alternative ways.

Experiment 2 is a form of game commonly studied by decision theorists called a “dictator game” (Güth, 1995). In a dictator game a participant decides how much of an initial money endowment to give to another person without the receiver having any input in the decision. The giver in a dictator game must forgo an amount of money for herself if she chooses to give it to the other person; the supposed rational choice would be to keep the money rather than to give it. However, just as in the case of social discounting, some participants allocate large portions of the endowment to the receiver. Social discount rates may be useful for determining what factors play a role in the decision to give at at one’s own expense. Experiment 6 will explore this matter in more detail using both a dictator and ultimatum game.

The prediction that smokers are more likely to be selfish is consistent with previous findings that smokers are more likely to be steep delay discounters (Baker, Johnson, & Bickel, 2003). However, the smoking results of Experiment 2 constitute only a brief attempt at relating discount rates to smoking status. The inclusion of the smoking scale was only a secondary purpose of the study and was designed to pilot data for future exploration. Problems with the small number of heavy smokers, lack of adequate validation of the smoking measure, and the attrition rate all hindered our ability to measure the relation between smoking status and social discounting.

In order to better understand the difference between different forms of discounting, such as delay and probability, and confirm the link between selfishness and smoking Experiment 3 was designed to include a more rigorous measure of nicotine dependence and incorporates measures of delay and probability discounting.

Experiment 3

Pilot studies have found that delay and social discounting significantly correlate. Additionally, preliminary attempts have failed to show a link between probability and social discounting. The main purpose of this experiment is to test the relationship between types of discounting in a systematic fashion. In addition, the relation between discount rates and smoking status was measured.

Experiment 3 was designed to supplement the previous findings by testing each participant in a single session and to equate delay, social, and probability discounting on the same monetary scale ($75). As a secondary purpose, participants' smoking status measured by the Fägerstrom Test of Nicotine Dependence (FTND) (Heatherton et al., 1991) was used to compare the discount rates of smokers and non-smokers.

Experiment 3 Method

Participants

One hundred ninety seven undergraduate (99 male, 87 female, 11 unreported, *m* age = 21.96, *sd* = 4.84) students from Stony Brook University completed pen and paper measures of discounting as a part of mass testing session for partial course credit. One hundred and seven participants received packets containing two measures of discounting: social and delay, social and probability, or probability and delay. Ninety participants completed a modified single-shot PDG whose data is presented in Experiment 5 followed by a packet containing all 3 discount measures (social, delay, and probability discounting).

Materials and Procedure

Participants received either two (*n* = 107) or three (*n* = 90) discounting questionnaires in an 11 or 16 page packet as part of a mass testing session. Each discount measure consisted of 1 page of instructions and 4 pages of judgments; the 11th or 16th page (respectively) included instructions and a short demographic questionnaire. Included in the demographic questionnaire was the Fägerstrom Test for Nicotine Dependence (FTND), a six question assessment of dependence on nicotine (Heatherton et al., 1991). The FTND asks questions like "How soon after you wake up do you smoke your first cigarette?" and has been validated by a number of studies for use in assessing smoking status without being invasive (Etter, Vu Duc, & Perneger, 1999).

Each participant received one of three packets containing social and delay, delay and probability, or social and probability discounting questionnaires. One of five social distances (#1, #5, #10, #50, & #100), five probabilities (90%, 70%, 50%, 30% 10%), or five delays (1 day, 1 week, 1 month, 1 year, and 5 years) were presented on each page of the discount questionnaires. Within each packet, the order of each discount measure was counterbalanced, as well as the order of the 5 points within each measure. Social and delay discount instructions were identical to those of previous experiments (see Appendices 2 and 3).

The delay discounting measure was similar to the following with five delays (1 day, 1 week, 1 month, 1 year, and 5 years) substituted for [*D*] on each page:

Please choose which amount of money you would rather have for each line

A. $75 for you right now. B. $75 for you **after [D]**.
A. $65 for you right now. B. $75 for you **after [D]**.
A. $55 for you right now. B. $75 for you **after [D]**.
-----------Down To----------
A. $5 for you right now. B. $75 for you **after [D]**.

The probability discount measure was similar to the following with probability values substituted for [*P*] on each page:

Please choose which amount of money you would rather have for each line

A. $75 guaranteed or B. A **[P]%** chance of winning $75.
A. $70 guaranteed or B. A **[P]%** chance of winning $75.
-----------Down To----------
A. $5 guaranteed or B. A **[P]%** chance of winning $75.

Experiment 3 Results

Hyperbolic discount functions were fit to the indifference points for delay (Equation 2), social (Equation 1), and probability discounting measures. In probability discounting the value used to discount offers was odds against ((1-[*P*])/[*P*]), which is shown in the hyperbolic probability discounting equation as [θ] (see Equation 3). The median values of each point were used to calculate functions that fit each group. Table 1 shows the best fitting values for the median indifference points for each discounting measure.

$$v = \frac{V}{1+\Theta^{s}} \qquad \text{Equation 3}$$

Insert Table 1 here. (Refer to page 82).

Discount rates for individuals were calculated to determine whether the rates of each measure correlate with each other. The relations between social, delay, and probability discount rates were tested using Pearson correlations. The data of eight individuals were removed from overall analysis due to double crossover choices on one or more measure. The highly skewed individual rates of discounting (k_{social}, k_{delay}, and $k_{probability}$) were brought closer to normal by log transformations (see Figure 8, 9, and 10). Significant correlations were found between individual rates of log k_{social} and log $k_{probability}$ ($r(135) = .250$, $p = .003$).

Figure 11 shows the relation between log k_{social} and log $k_{probability}$. The log $k_{probability}$ and log k_{delay} correlation was marginal ($r(119) = .165$, $p = .073$). However, unlike preliminary results, no correlation was found between log k_{delay} and log k_{social} discounting rates ($r(101) = .064$, $p > .05$). The correlations are reported in Table 2.

Insert Figure 8 here. (Refer to page 65).

Insert Figure 9 here. (Refer to page 66).

Insert Figure 10 here. (Refer to page 67).

Insert Figure 11 here. (Refer to page 68).

Insert Table 2 here. (Refer to page 83).

Finally Fägerstrom Test for Nicotine Dependence results were correlated with discount rates in order to investigate the effect of smoking status and discount rates. As in Experiment 2, the number of smokers in the current study (FTND > 0; n =31) was relatively small; and even fewer were heavily dependent upon nicotine (FTND > 4; n = 11). The results of this experiment were combined with previously unreported pilot data comparing probability and social discounting in order to reach the number of smokers required to have enough statistical power for a significant comparison between non-smokers and smokers. In all, we examined rates of social and probability discounting of 362 participants, 69 of whom indicated a smoking status of greater than FTND = 0.

The correlation between FTND and social discounting (log k_{social}) was not significant ($r(318) = .065$, $p = .251$). The correlation between FTND and delay discounting (log k_{delay}) was not significant ($r(135) = .06$, $p = .489$). Finally, the correlation between FTND and probability discounting (log $k_{probability}$) was also not significant ($r(345) = .041$, $p = .451$). Participants were then divided into two groups, smokers (FTND = 0) and non smokers (FTND = 1). A T-test for independent samples was used to compare discounting measures. The comparison between the log k_{social} values of smokers and non-smokers was marginal ($t(316) = 1.81$, $p = .07$). Smokers had a greater k_{social} than non-smokers but not significantly so.*

Experiment 3 Discussion

A direct comparison was conducted among three measures of discounting: social, probability, and delay. All three measures offered similar amounts of money to individuals Participants completed either 2 or 3 measures, allowing for within subject comparisons of discounting rates. No significant relations were found between social discounting and smoking status, between probability discounting and smoking status, and between delay and smoking status. Additionally, social discounting and probability discounting correlated with each other, but not with delay discounting.

A number of explanations can account for the relation between social and probability discounting but not between social and delay discounting. One commonality between the social and probability discounting is the effect of magnitude: in previous work, social discounting (Rachlin & Jones, in press) exhibited reverse magnitude effects similar to those

*Untransformed social discounting rates (*social k*) were significantly higher among smokers ($M = 2.28$) than non-smokers ($M = .42$) ($t(316) = 2.60$, $p = .01$).*

found with probability measures (Rachlin, Brown, & Cross, 2000). As magnitude increases, discount rates become steeper. Delay discounting, on the other hand, shows a standard magnitude effect; large magnitudes are discounted with more shallow curves.

The dissimilarity between the current results and that of the pilot may be impacted by the magnitude of the delay discounting measure. Earlier delay discounting studies (including the pilot study) typically offer around $1,000 (Rachlin, Raineri, & Cross, 1991). However, in the current study we chose a maximum value of $75 for each discounting measure in order to keep the magnitude of rewards offered across all three discounting measures the same. Although each discount measure fit the Mazur (1987) hyperbolic function well (see Table 1), it may be that amount of money offered for delay discounting measures was too small in magnitude to accurately capture individual differences in rate. Additionally, fewer participants overall completed delay discounting measures, compared to the number of participants who completed social and probability measures, reducing the statistical power of the delay discounting comparisons.

Another similarity between probability and social discounting might be in the way the participants framed their choices. Probability discounting is considered to be akin to risk aversion, in much the same way delay discounting has become synonymous with impulsivity measurement (Reynolds, 2006, Rachlin et al., 1986). Steep probability discounters are risk averse: they prefer more probable rewards over less probable rewards of equal expected value. In social discounting, there are risks associated with generosity. Judgments of common interest with others may be faulty. Or, others who have reliably reciprocated generosity in the past may not do so in the future. Therefore, people who are averse to risks as measured by steep probability discount functions may also be ungenerous as measured by steep social discount functions. Future work on social discounting might measure risk perception directly or change the framing of the scenario to examine the influence on giving of knowledge by the receivers of the conditions under which the gift was made.

The relation between smoking (FTND) and discounting rates in this study was weak, but in the direction predicted by previous work. That is, the discount rates of smokers were greater than the discount rates of non-smokers in all three (social, delay, and probability) discounting measures. Social discount rates, but not delay discount rates, were marginally different when participants were split into smokers and non-smokers. The failure to replicate the delay discounting relation between smokers and non-smokers is in part influenced by the relatively small number of smokers that completed delay discounting measures.

One reason for the failure to replicate large effects of smoking status may be that previous work recruited smokers directly (Baker, Johnson, & Bickel, 2003). The participants in previous work had much higher ratings on the FTND scale than in the current study. Among the current participants a clear majority of those who smoked at all ($n = 51$) would be classified as light smokers (FTND < 5).

Studies of smoking status of populations of college students conclude that college students smoke less than the overall population (Patterson et al., 2004). College attending smokers discount delays less steeply than a matched sample of their non-college attending peers (Jaroni et al., 2004). The next step for understanding the role of nicotine dependence and social discounting rates would be to recruit heavy smokers directly and compare their rates of discounting with individuals who successfully abstain from smoking.

Experiment 4

A follow up study to the Jones and Rachlin (2006) social discounting study was conducted to estimate how individuals perceive social ranks in terms of social distance. Similar in method to magnitude estimation studies by Stevens (1965), participants were asked to make subjective judgments of the physical distance between themselves and individuals at a given social distance *[N]*.

Experiment 4 Method

Participants

Forty-four undergraduates from Stony Brook University were asked to complete a pen and paper estimate of social distance as part of a mass testing session for partial course credit.

Materials and Procedure

Participants received an eight page packet. On the first page participants were given instructions including the social distance example (see Appendix A). Participants were asked to imagine all 100 people standing on a field; for each of the seven *[N]* values (#1, #2, #5, #10, #20, #50, and #100), participants were asked to give a number and unit of distance estimated between themselves and that person. The following instructions were presented:

> Now try to imagine yourself standing on a vast field with those 100 people. The actual closeness between you and each other person is proportional to how close you feel to that person. For example, if a given person were 10 feet away from you then another person to whom you felt twice as close would be 5 feet away from you and one to whom you felt half as close would be 20 feet away. We are going to ask you for distances corresponding to some selected individuals of the 100 on your hypothetical list.
>
> Remember that there are no limits to distance – either close or far; even a billionth of an inch is infinitely divisible and even a million miles can be infinitely exceeded. Therefore, do not say that a person is zero distance away (no matter how close) but instead put that person at a very small fraction of

> the distance of one who is further away; and do not say that a person is infinitely far away (no matter how far) but instead put that person at a very great distance compared to one who is closer.
>
> Of course there are no right or wrong answers. We just want you to express your closeness to and distance from these other people in terms of actual distance; the closer you feel to a person, the closer you should put them on the field; the further you feel from a person, the further they should be from you on the field. Just judge your own feelings of closeness and distance.

Each of the following 7 pages differed in *N*-value, randomly ordered, and stated the following question:

> How far away from you on the field is the [*N*th] person on your list?
> Feel free to use any units you wish (inches, feet, miles, football fields, etc. Just indicate what the unit is).
> Please write a number and units of measurement for the [*N*th] person on your list: ______________________________

Experiment 4 Results

The many distance units used by the participants were converted into feet, and a power function was derived based on the median distance at each ordinal value. The results indicate that participants had little trouble ordering and assigning a physical distance to the range of social relationships in a consistent manor. As rank order increases, distance in feet changes as described by Equation 4. Change in social rank, represented by [*N*], increases the perceived social distance *d* by a multiple of the constant 1.9 and the power 2.2. Figure 12 shows the power function graphed on a log scale.

$$\log d = 2.2(\log N) - .72$$
$$d = .19N^{2.2}$$
Equation 4

Insert Figure 12 here. (Refer to page 69).

Experiment 4 Discussion

The results of Experiment 4 provide evidence that participants perceive the distance between social ranks in a systematic fashion. The greater-than-unity exponent of the power function emphasizes the closeness of people close to the participants and the distance of those distant from them. As N increased, the physical distance between N and N+1 increased dramatically.

Social distance can be a reliable tool for evaluating social rank and establishing criteria for individuals to base altruistic or selfish decisions upon in behavioral economic experiments. Economic games that involve participation with other individuals can now be redesigned to include a measure of social distance in order to estimate the influence of the continuum between close relationship and stranger.

Experiment 5

Experiment 5 examined social, delay, and probability discounting measures with the decision to cooperate or defect in a single-shot PGG. Previous work has shown that rates of delay discounting correlate with cooperation in multiple-round PDG's (Harris & Madden, 2002; Yi, Johnson, & Bickel, 2006). In a multiple-round PDG individuals who steeply discounted delay were more likely to defect. A multiple-round game is similar to one where the opponent is employing a TFT strategy, specifically in that over time individual choices are reciprocated on future rounds. Because of this, cooperation is similar to a self-controlled behavior in a PDG.

These results indicate that there is a link between self-control and delay discounting rates. Social discounting measures the level of altruism in individuals. Experiment 5 was designed to test the relation between social discounting and selfishness, in the same way delay discounting is linked to self control. A single-shot PGG was chosen for Experiment 5 for its similarity to a single-shot PDG and because it asks participants to choose between money for the self or the group. Instead of a matrix of individual payoffs, the total amount earned in a PGG is the sum of the amount kept for oneself and an equal split among all participants of the total amount given to the group multiplied by a constant value. Thus, participants in a PGG can cooperate by donating money to the group, or defect by keeping the money for themselves.

The optimal strategy in a single-shot game is to defect (Komorita, Parks, & Hulbert, 1992); in a single-shot game opponents have no opportunity to retaliate in future rounds. Thus, any cooperative choice made by a participant is an altruistic choice. Choice on each round in a single-shot game is not confounded by the choices made by participants in previous rounds influencing the current round. Thus, unlike in a multiple round PDG, a single-shot game is free from a comparison to a self control paradigm (Brown & Rachlin, 1999).

Social discounting, delay discounting, and probability discounting measures were used to determine individual rates of discounting. Each was compared directly to the amount of the endowment the individual contributed to the group in the PGG. How sensitive an individual is to social interactions (i.e. social discount rate) was related to the amount of money contributed to the group.

Experiment 5 Method

Participants

Ninety four students (47 male, 43 female, 4 unreported, *m* age = 24.01, sd = 5.52) enrolled in Stony Brook University business classes completed pen and paper measures of social, delay, and probability discounting. Additionally, a 1 page, single-shot PGG was presented to them.

Materials and Procedures

A single page one-shot PGG was present to each participant. Immediately after completing the PGG participants each received the social, delay, and probability discounting measures reported in Experiment 3 in a random order. The PGG game was identical to the following example:

> Imagine the following situation (purely hypothetical we regret to say):
>
> 1. The experimenter gives you $100.
> 2. A box is passed around to each person in this room.
> 3. Each person may put all or any part or none of the $100 into the box. *No one else will know how much money anyone puts into the box.*
> 4. After the box goes around the room, the experimenter *doubles* whatever is in the box and distributes it equally to each person in the room regardless of how much money they put into the box.

Each person will then go home with whatever they kept plus what they received from the box.
Note that you will maximize the money you receive by not putting *any* money in the box. Then you will take home the original $100 you kept plus what the experimenter distributes after doubling whatever money was in the box.
HOWEVER: If everybody kept all $100, nothing would be in the box and each person would take home $100.
Whereas, if everybody put all $100 in the box, each person would take home $200 after the money in the box was doubled and distributed.
Please indicate below how much of the $100, if any, you would put into the box.
Please try to answer the question as if the money were real:
I would put the following amount into the box: $______
I would keep the following amount: $______
Sum must equal $100

Experiment 5 Results

Individual delay and social discounting rates were calculated by fitting indifference points to Equation 1 and 2. Four participants were removed from analysis for crossing over more than once on one or more page in a single measure. Individual rates of social, probability, and delay discounting were compared directly to each other; participants in Experiment 5 were included in the results from Experiment 3. The amount of money given to the group (cooperation) (M = 31.77, sd = 32.23) was significantly correlated with the log of social discounting rates (log k_{social}) ($r(90) = -.242$, $p = .021$). The log of probability discounting rates (log $k_{probability}$) also correlated significantly with cooperation ($r(90) = -.305$, $p = .003$). However, delay discounting rates did not correlate with cooperation ($p > .05$). Figure 13 shows the log k_{social} versus the amount given in the PGG. Figure 14 shows the log $k_{probability}$ versus the amount given in the PGG.

Insert Figure 13 here. (Refer to page 70).

Insert Figure 14 here. (Refer to page 71).

Experiment 5 Discussion

Cooperative choice in a single-shot PGG correlates directly with individual social and probability discount rates, but not delay discount rates The more steep the individual's social discount rate is, the less likely she will be to cooperate in a single shot game. Additionally, cooperative choice varies directly with probability discounting; the more risk averse a person is, the more money the person is likely to keep for herself in a single-shot PGG.

Unlike previous work, which examined delay discounting and cooperation in a multiple round PDG, there was no correlation between delay discounting rates and cooperation in this experiment. This result is not surprising. A single-shot game is independent of prior or future interaction with the other players in the game; participants are making a decision based solely on the immediate round.

Participants in a multiple-round PGG often adopt a strategy of play: either a cooperative or competitive strategy based on interaction with their opponents. In a single-shot PGG the decision to cooperate is based more on altruism. In a sense, a player chooses to cooperate for two reasons, A) that by doing so they help the group (explained by social discount rates) or B) that the risk of their cooperative choice will not be reciprocated is low (explained by probability discount rates) (Baker & Rachlin, 2001).

I conclude from the relations between the social discounting measure and cooperative choice in a PGG that social discount rates impact altruistic behavior directly. The single-shot PGG used in this experiment asked participants to contribute to the entire group playing: in this case, members of a university class. It is unlikely that while completing the measure participants paused to evaluate their relationship with every individual in the class. It is also unlikely that an individual who gave all or a portion of their money to the group had a number of close social relationships with the rest of the class. Rather they relied on a general heuristic for how to behave in a group setting. The social discounting measure, therefore, was able to gauge the likelihood that a participant would cooperate.

Additionally, the relationship between social and probability discount rates found in Experiment 3 was replicated by Experiment 5. The link between risk aversion and altruism extends beyond discounting measures. The failure to find relations with delay discount rates has the same caveats as well; primarily that the magnitude of money offered in the delay discounting measure was much smaller than that used by previous work comparing delay discounting and PDGs (Yi, Johnson, & Bickel, 2006; Baker, Johnson, & Bickel, 2003). Future work might examine the relation between social and probability discount rates in other areas of choice.

Similarly there is no connection between decision to give or keep in a PGG and amount received. In both decisions, the amount added by the other players giving to the group (cooperation) is independent of your own decisions. So you should choose to keep the money (defect).

But people behave as if they are betting that other players will give (cooperate), as shown by the similarity to probability discounting. Perhaps it is because in real life they are often betting in situations where reciprocation is more probable the more you give (cooperate). If you are willing to gamble on a possible return (probability discounting), you are willing to gamble on your classmates giving money to the group.

Experiment 6

Further exploration the impact of social discounting on altruistic behavior is possible by implementing economic games that include choices or judgments about allocating hypothetical amounts of money to other individuals. One such example is that of an ultimatum game. In an ultimatum game, participants act as either a giver or receiver. The giver determines how much money to offer the receiver; the receiver then decides to reject the offer or to accept it. Rejection earns both parties $0, acceptance earns both parties the offered split.

The control procedure for an ultimatum game, the dictator game, removes the option for the receiver to reject the offer. Without the rejection clause the giver is free to offer any amount he wishes, even that of nothing to the receiver. The amount of money offered to a receiver in a dictator game has been found to be significantly less than the amount offered in an ultimatum game (Forsythe et al., 1994).

Prior work on ultimatum games has included direct comparisons between anonymous and known receivers (Handgraaf, Van Dijk, & De Cremer, 2003). However, no work has included a component that measures the relationship between individuals. Complex designs like blind or double blind conditions have been implemented to alter 'social distance' (Hoffman, Mccabe, & Smith, 1998), yet the studies do not quantify social distance. Instead the concept of social distance is implied and the resulting differences in offers between groups are attributed to various mental states.

Experiment 6 was designed investigate the effect of social distance on offers in an ultimatum and dictator game.. The Jones and Rachlin (2006) social distance scale (see Appendix A) used to describe the relationship with the receiver in an ultimatum or dictator game allowed the participants to make decisions about how much to allocate based on the nature of the relationship with the receiver. Three magnitudes ($10, $1,000, and $100,000) of the endowment were offered to givers in order to understand the effects of varying amounts of money offered. Previous work has found only small differences between offers with endowments of differing magnitudes (Slonim & Roth, 1998).

Experiment 6 Method

Participants

Three-hundred-seventy-eight undergraduate students completed pen and paper ultimatum experiments. Participants completed the packet as a part of a series of mass testing questionnaires for partial course credit.

Materials and Procedures

Each packet contained a four page ultimatum experiment in which the participant served as the giver. Half the participants received the standard ultimatum game with the instructions including the clause that the person receiving the offer could choose to reject the split and thereby insure neither party would get any of the endowment. The other half of the participants were given the same instructions but without the rejection clause. Without the rejection clause the game becomes a dictator rather than ultimatum game.

Participants chose how much money to share with a series of receivers at four social distances #[N]: 1, 10, 50, and 100. Three hypothetical amounts of money (C) were used as endowments: $10, $1,000, and $100,000; participants randomly received one amount across their entire packet. Each page looked similar to the following with the #[N] replaced with a different social distance on each page, C remained the same across all pages:

The Game Show

Imagine that you are a contestant on a Game Show. With you is person **#N** from your list of 100 people closest to you.
The Game Show Host gives you a $**[C]** prize.
You can keep the entire amount of the money, or give any amount of it to person **# N**.
How much of the $**[C]** will you give to person **# N** ________________.

The half of the participants in the ultimatum game received an additional line of instructions which differentiated between the ultimatum and dictator game:

However, **#[N]** may refuse his or her share of the money. If he or she rejects the money, neither of you will get any money at all.

Rejection Clause fo
Ultimatum Game

Experiment 6 Results

Median fractions of the amount given to each *[N]* were used to fit a hyperbolic discount function for each amount in the ultimatum and dictator conditions. Equation 1fit each condition well, as shown by Table 3. Both exponent (*s*) and *k* values vary across conditions. The exponent differs from the Jones & Rachlin (2006) value of 1 due to several factors. First the participants made a judgment rather than a choice (participants were free to write any value they wished). Judgments and choices often yield differing results; choices are more sensitive to independent variables (Dawes, 1998, p. 121-125). Second, participants made only 4 judgments, forcing the equation to fit fewer points. Finally, the exponent is sensitive to magnitude of the values offered, making it difficult to compare across conditions.

In order to make comparisons across conditions, it was necessary to convert individual values into area under the curve (AUC). AUC normalizes both axes (the delay/social distance/probability and the values of indifference points), and then calculates the area between individual points and the axes. AUC calculation is independent of any theoretical assumptions about the shape of discounting functions; it calculates one value to represent a series of choices that can be compared across conditions (Myerson, Green, & Warusawitharana, 2001). An analysis of variance found significant difference between conditions ($F(5,372) = 15.26$, p = .001).

Insert Table 3 here. (Refer to page 84).

Post hoc analysis shows a significantly greater amount of money given in the ultimatum condition than in the dictator condition ($F(1,376) = 6.13$, p = .01). Also, there was a significantly lower proportion of generosity for higher magnitudes than lower ($F(2,375) = 33.36$, $p = .001$). Figures 15, 16, and 17 show the best fitting hyperbolic discount functions for the ultimatum and dictator conditions; Figure 18 shows the AUC comparisons. Note that, the difference between ultimatum and dictator AUC's (what might be called the premium offered for the power to reject) decreased as the endowment increased.

Insert Figure 15 here. (Refer to page 72).

Insert Figure 16 here. (Refer to page 73).

Insert Figure 17 here. (Refer to page 74).

Insert Figure 18 here. (Refer to page 75).

However, within each endowment, this difference between ultimatum and dictator offers (the premium) did not vary monotonically with social distance. The median amounts and the amounts predicted by the fits to Equation 2 of the dictator condition were subtracted from those of the ultimatum condition. For the $100,000 and $1,000 endowments the premium for social distance #1 and #100 was 0. The premium between ultimatum and dictator games is driven by social distance #10 and #50 and by the $10 endowment condition. For example, Figure 19 shows the premium for each social distance for the $1,000 endowment condition.

Insert Figure 19 here. (Refer to page 76).

Experiment 6 Discussion

As predicted, people closer in social distance were offered a greater portion of the endowment than were those further away. Participants offered more when the money could be rejected than when it could not be rejected. Finally, results show a reverse magnitude effect similar to that found in previous social discounting studies (Rachlin & Jones, in press). Participants were more generous with larger amounts of money in absolute terms but they were less generous with larger amounts of money as a percentage of the initial endowment.

Social distance has a strong impact on amount given in both ultimatum and dictator games. As social distance increased the amount offered to the other person decreased. The premium, the difference between ultimatum and dictator offers, shows a similar pattern between individual social distances across all endowments. However, as Figure 19 shows, the premiums were not identical for each social distance.

The relatively small difference between ultimatum and dictator AUC's for the $100,000 endowment (shown in Figure 18) may reflect participants' confidence that high absolute gift amounts would be accepted even though they were small proportions of the initial endowment. The next experiment examines the behavior of the receiver under comparable conditions and will test whether such confidence is justified.

Experiment 7

Experiment 6 showed that the dictator in an ultimatum experiment offers more money to people at closer social relationships than to those further away. When the dictator's offer can be rejected, significantly more money is offered to the receiver across all social distances. Experiment 7 was designed to measure how the receiver responded to a given offer. Social distance impacted how likely a receiver was to reject an offer. One possibility is that receivers will expect higher offers but accept lower offers from people at closer social distances. It may be more difficult to punish those closer to you despite their lack of generosity for fear of harming the social relationship. On the other hand, it may be that receivers expect higher returns from givers at closer social distances and therefore the threshold for acceptance is higher than when the giver is socially closer. A final possibility is that individuals reject offers below a specific threshold regardless of social distance. Previous work with ultimatum games finds that offers less than 40% of the total endowment are frequently rejected (Güth, 1995). Additionally, anonymity increases the likelihood that a receiver will reject a given offer (Handgraaf, Van Dijk, & De Cremer, 2003).

Experiment 7 replicated the ultimatum game of Experiment 6 with the participant acting as the receiver rather than the giver. Participants were asked to make a series of choices to determine the minimum amount of money they would accept from an individual at a given social distance.

Experiment 7 Method

Participants

One hundred nineteen undergraduate students (53 men, 62 women, *m* age 19.04, *sd* = 1.63) from the Stony Brook University department of psychology subject pool completed a pen and paper version of an ultimatum game. Participants were asked to complete the questionnaire as one of several surveys in a packet of materials presented during a mass testing session for partial course credit.

Materials and Procedure

Each participant received an eight-page ultimatum packet that asked them to make a series of choices for each social distance [*N*]. The first page included the social distance scale (see Appendix A) and the following cover story:

> The Game Show
>
> Imagine that you are a contestant on a game show. With you is person **#[*N*]** from your list of 100 people closest to you.

Each following page asked the participants to make a series of choices between keeping and rejecting various amounts of money offered by a participant at a given *[N]*. Three values of the total offered reward were presented: C = $10, C = $1,000, and C = $100,000. Participants were randomly divided into all three magnitudes. Each page contained one social distance: #1, #10, #50, and #100. One half of the participants received packets ordered from closest social distance [1] to furthest [100]; the other half received the furthest social distance [100] to closest [1]. The following example is from the $1,000 magnitude. (The initial prize was $1,000) The amount of money listed in the left column (the amount given to the participant) began at $500 for this condition, $50,000 for the $100,000 condition and $50 for the $100 condition. Each page was similar to the following example; save for the change in *[N]* value across pages and change in magnitude across conditions:

> Imagine that you are a contestant on a game show. With you is person **#[N]** from your list of 100 people closest to you.
> Person **#[N]** on the list wins a $[***C***] prize.

They can keep the entire amount of the money, or give to you any amount of the winnings.
However, you may refuse the amount of the money they offer. If you reject the money, neither of you will get any money at all.
On each of the following lines please choose between accepting and rejecting each offer.

Please Check one box on EACH LINE

[ ] Accept $500 from person [N] or [ ] Reject the offer: both you and [N] will earn $0.
Person [N] retains $500

[ ] Accept $400 from person [N] or [ ] Reject the offer: both you and [N] will earn $0.
Person [N] retains $600

[ ] Accept $300 from person [N] or [ ] Reject the offer: both you and [N] will earn $0.
Person [N] retains $700

-------Down To-------

[ ] Accept $0 from person [N] or [ ] Reject the offer: both you and [N] will earn $0.
Person [N] retains $1,000

Experiment 7 Results

The median response for each social distance increased as social distance increased; however nearly half ($n = 56$) of the participants accepted all offers from every social distance, including the offer of $0. As shown in Figure 20, the median minimum accepted offer for each social distance was 0 except at the furthest social distances in the $1,000 and $100,000 conditions.

Insert Figure 20 here. (Refer to page 77).

Mean minimum accepted offers were computed and fit to a series of functions. The best fitting function was a power function shown as Equation 5. The rate of minimum accepted offer (MAO) increased as a function of social distance [*N*] multiplied by a constant [*k*] and sensitivity [*s*]. The best fitting values for each magnitude are presented in Table 4 and shown in Figure 21.

$$v = 1 + kN^{s} \qquad \text{Equation 5}$$

Insert Table 4 here. (Refer to page 85).

Insert Figure 21 here. (Refer to page 78).

Experiment 7 Discussion

The median receiver in an ultimatum game behaved rationally (as predicted by economic game theory); that is the median receiver accepted all offers except those from givers at the greatest social distances. In more than half of the cases, participants accepted even offers of $0, indicating a strong reluctance to punish the offerer. However, as social distance increased the likelihood of an offer being rejected increased. The median decisions to reject offers for social distances of [*N*] = 50 and [*N*] = 100 were higher than $0 and changes in mean minimum accepted offers fit a power function with a positive exponent (increasing with social distance).

Thus, the social distance between the giver and the receiver directly impacted the receiver's decision whether or not to accept an offer in an ultimatum game. For individuals who are perceived to be close, the receiver is likely to accept all offers: even when the offer is nothing. Only when social distance reached the maximum distance in the social distance scale did the minimum accepted offer begin to rise; lower than the typical finding among anonymous participants (Güth, 1995). Work with anonymous participants (where social distance [*N*] > 100) shows significantly higher MAOs than in the present experiment with with 1 < N < 100 (Handgraaf, Van Dijk, & De Cremer, 2003). Social distance not only predicts the likelihood of rejecting an offer, it potentially asks the participant to weigh future and past interactions with the other individual. A participant deciding whether or not to reject an offer from a person she knows ignores the value of the offer and attends to the closeness of her relationship with the person making the offer.

While, in Experiment 6, participants offered less to people more distant from them, in the present experiment the MAO actually increased with social distance. Moreover, the premium for the right to refuse (the difference between amounts given by ultimatum givers and dictators) did not increase monotonically with social distance. Thus neither the absolute amount given nor the premium given for the right to refuse can be ascribed directly to a veridical perception by the giver of the probability of refusal. People give more to those close to them despite the very low probability that their offer will be refused

Rather than evaluating the relationships directly in economic terms, the ultimatum receiver game may tap into another process: MAO may represent the receiver's level of expected reciprocity. Past relationships and mutual interchange in the past may have a greater influence on MAO than the current offer. Just as the givers in Experiment 6 said they would sacrifice large fractions of their endowment to those close to them, so receivers in the present experiment said they were willing to sacrifice virtually all of the current endowment for the benefit of the giver. This suggests a direction for future studies.

While more work is needed to understand the nature of the relations between social distance and the ultimatum receiver game, the foundation for studying the role of expectancy in social relationships has been laid.

General Discussion

These seven experiments examine the mechanism of social discounting in a number of contexts. Social discounting had a significant impact on altruistic choice across all 7 experiments. In all experiments, as social distance increased the likelihood of an altruistic choice decreased.

Simon (1995) and many other economists (for example see Hoffman, Mccabe, & Smith, 1998 on ultimatum games) have proposed frameworks for how social distance would interact with choice. However, in each case social distance is a label that refers to undefined psychological constructs. Rather than rely on an unmeasured entity to account for unexplained variances, the current studies seek to define the component of social distance in economic games. Social distance is one example of how psychology can inform economics by enabling the measurement of a previously unspecified construct.

Experiments 1 and 2 show that a hyperbolic discount function best describes how social distance affects choice. The greater the social distance, the less money participants were willing to forgo in order to give money to the other person. Social discounting occurs even when there is no benefit for giving money to another. The fact that the overall rates of discounting do not differ overall between Experiment 1 and Experiment 2 implies that the choice to forgo money in order to give it to someone else is independent of whether some portion of the initial endowment is always kept or whether the entire endowment may be given away.

The best fitting equation for social discounting is hyperbolic in form (see Equation 1). This implies that as social distance increases, the amount of money forgone decreases. Future work may investigate the generality of this finding by asking participants to make altruistic choices in the presence of individuals at varying social distances. Face to face contact rather than imagined social interaction may produce less discounting than found in the current studies.

Experiment 3 measured different forms of discounting in a systematic fashion to directly compare the relationship between them. In the experiment, participants completed social, delay, and probability measures of discounting. Individual rates were compared directly. A significant correlation between social and probability discount rates was found.

The relation between social and probability discounting is particularly interesting, when we compare the effect of magnitude on probability and social discount measures. Probability and social discounting both share a reverse magnitude effect; delay discounting exhibits the standard magnitude effect (Yi, de la Piedad, & Bickel, 2006, Green, Myerson, & Ostaszewski, 1999). The reverse magnitude effect says that as magnitude increases rate of discounting increases. In contrast, delay discounting exhibits a standard magnitude effect in which the higher the magnitude the less steeply individuals discount.

Additionally, in Experiment 3, the individual rate of social discounting is related to the level of nicotine dependence, an area of major interest in recent literature. Despite the small number of heavy smokers available for the current study, the predicted relation between smoking and discounting measures was found. When participants were divided into smokers and non-smokers by their rating of nicotine dependence on the FTND, smokers were found to be more selfish than non-smokers. Additionally, smokers are steeper probability discounters than non-smokers.

Although the exact mechanisms for why smokers are less altruistic and less risk averse than non smokers are unknown, the groundwork for future studies of discounting and smoking on altruistic and risky behavior has been laid. Addictive behaviors such as smoking are often a health risk and the decision to consume such substances directly impacts close social relationships. Discounting measures will continue to be a mechanism to evaluate how individuals perceive and participate in risky behaviors.

Experiment 4, where participants estimated the psychophysical distance of their social network, established that participants view social distance in a systematic fashion. Participants were able to give physical distance estimates of their social relationships. The physical distances increase by a power function as social rank increases. The pattern of perceived distance matches previous work in estimating intensity of light, sound, and other psychophysical measures (Stevens, 1956).

Experiment 4 is important for establishing that participants estimate social distance in a similar fashion across all social discounting experiments. For example, when an individual decides to allocate $75 to another person at social distance of #10 we can then make a prediction of how much money they would allocate to person #50 and #100. Further, when we know how individuals allocate to social distances in a game, we can use that information to make predictions about other individuals.

The establishment of a social distance scale allows for social distance to be substituted into any number of behavioral economic measurements. In the present studies, social distance is substituted for delay in a discounting measure and for the anonymity in ultimatum and dictator games. While the individual make-up of a social network remains unmeasured, the social distance scale allows us to quantify the impact of social relationships in order to predict altruistic behaviors.

Experiment 5 asked participants to complete social, delay, and probability discounting measures after playing a single-shot PGG. In the single-shot PGG participants chose between keeping any portion of the money for themselves or to contribute it to the group. The decision to contribute to the group is considered a cooperation choice; the optimal strategy for the game is to keep the money for oneself (defection).

Social and probability discounting rates, but not delay discount rates, correlated with the amount contributed to the group. For social discounting, the steeper the individual discounted, the less money they gave to the group. Steep social discounters were more selfish than shallow discounters. Individuals who had steep probability discounting rates also contributed less money to the group. Steep probability discounters, those who were more risk averse, were less likely to give their money to the group in a single-shot PGG. Risk averse and selfish individuals were less likely to be altruistic. Future work should be designed to partial out the difference between altruism and risk aversion in PGGs.

Finally, Experiments 6 and 7 explored the relation between social distance and behavior in economic games. Experiments 6 and 7 found that in an ultimatum game, amount offered to another person was sensitive to the social distance of the receiver. However, the rejection threshold established by receivers (the cost the receiver will bear in order to punish a less-than-generous giver) was almost zero at the largest social distances. This shows that social distance has an impact on altruistic behaviors: we give more to the people with whom we share close social relationships. However, when it comes to our expectations of reciprocity, we are likely to forgive lack of generosity in those close to us.

The current studies confirm predictions from economic studies of ultimatum and dictator games using social distance instead of the conditions of anonymity (Handgraaf, Van

Dijk, & De Cremer, 2003). Participants acting as a giver in these games offered more money to people at close social relationships over distant ones. Participants acting as a receiver chose not to punish close social distances by rejecting their offers, yet punished the furthest social distances measured by requiring a higher MAO from them.

In conclusion, all seven studies were impacted directly by social distance. In each case, the comparison between a person at [*N*] distance impacted the level of altruistic behavior exhibited. In social discounting, participants sacrificed more money to others at close social distances than to those at further social distances. The individual rate of social discounting was directly related to probability discounting, nicotine dependence, and the amount of cooperation in a single-shot PGG. In ultimatum and dictator games, social distance determined both the amount of money offered and the minimum amount of money required to accept an offer.

These results imply that Simon's (1995) prediction that an individual makes decisions about others as if the other were a more distant extension of the self was essentially correct. As Experiment 4 showed, social distances run a continuum from close to distant that is perceived in a systematic manner. Experiments 1, 2, and 3 establish that the amount of money preferred to be kept by an individual over sharing with another is discounted by the social distance to the other individual in the same way that an individual discounts future rewards over immediate ones. Because of this, social distance can be quantified and useful for understanding behavior in economic games.

In theoretical terms, the discounted value of a social relationship measured by social discounting can account for sub-optimal behavior (i.e. behavior not predicted by game theory). Social influences are prevalent among a majority of the decisions made each day by an individual; the weight of a given relationship impacts decision making directly. The current series of experiments provides a foundation for understanding how such influences impact group behavior (as defined by the median choices made across all participants) but also begin to examine the role of the individual sensitivity.

The usefulness of this body of work is twofold. First, social distance can be an accurate way to measure the impact of a social relationship between two individuals from the viewpoint of the decision maker. Second, social discounting can be a predictive tool for explaining why individuals at distant social relationships are the recipients of less altruistic behaviors than individuals at closer social relationships.

A great deal of work on social discounting is left to be done. The current study did not ask participants to directly map out a social network, nor did it require them to specify who would fill the social ranks; they were asked merely to make a number of varied choices among different social ranks. Although we can not make predictions about individual social networks, we can make predictions of how social distance will influence participant's behavior. Because of this, social discounting will be a useful way to account for patterns of altruistic choice previously unmeasured in behavioral economics.

References

Ainslie, G., & Haslam, N. (1992). Self Control, In: *Choice over time*. Loewenstein, G., Elster, J. Eds., New York, NY, US: Russell Sage Foundation, 177-209.

Baker, F., Johnson, M. W., & Bickel, W. K., (2003). Delay discounting in current and never-before cigarette smokers: similarities and differences across commodity, sign, and magnitude. Journal of Abnormal Psychology, *112*, 382-392.

Baker, F., & Rachlin, H. (2001). Probability of reciprocation in repeated prisoner's dilemma games. *Journal of Behavioral Decision Making*, *14*, 51-67.

Brown, J., & Rachlin, H. (1999). Self-Control and Social Cooperation. *Behavioural Processes, 47*, 65-72.

Bogardus, E. (1938). Social distance and its practical applications. *Sociology & Social Research, 22*, 462-476.

Dawes, R. M. (1988). *Rational choice in an uncertain world*. Orlando, FL: Harcourt Brace Jovanovich.

Etter, J. F., Vu Duc, T., & Perneger, T. V. (1999). Validity of the Fägerstrom test for nicotine dependence and of the heaviness of smoking index among relatively light smokers. *Addiction, 94,* 269-281.

Fëhr, E., & Gachter, S. (2002). Altruistic punishment in humans. *Nature, 415*, 137–140.

Fëhr, E., & Schmidt, K. M. (1999). A theory of fairness, competition, and cooperation. *The Quarterly Journal of Economics, 114*, 817–868.

Forsythe, Horowitz, J. L., Savin, N. E., & Sefton, M. (1994). Fairness in simple bargaining experiments. *Gamesand Economic Behavior*, *6*, 347-369.

Fox, J., & Guyer, M. (1978). "Public" choices and cooperation in N-person prisoner's dilemma. *Journal of Conflict Resolution, 22*, 469-481.

Green, L., & Fisher, E. B. (2000). Economic substitutability: Some implications of health behavior. In W. K. Bickel & R. E. Vuchinich (Eds.) *Reframing Health Behavior Change with Behavioral Economics*. (pp. 115-144). Mahwah, NJ: Lawrence Earlbaum Associates, Inc.

Green, L., & Myerson, J. (2004). A discount framework for choice with delayed and probabilistic rewards. *Psychological Bulletin, 130*, 769-792.

Green, L., Myerson, J., & Ostaszewski, P. (1999). Amount of reward has opposite effects on the discounting of delayed and probabilistic outcomes. *Journal of Experimetnal Psychology: Learning, Memory, & Cognition*, *25*, 418-427.

Güth, W. (1995). On ultimatum bargaining experiments – a personal review. *Journal of Economic Behavior and Organization*, *27*, 329-344.

Handgraaf, M. J., Van Dijk, E., & De Cremer, D. (2003). Social utility in ultimatum bargaining. *Social Justice Research*, *16*, 263-283.

Harris, A. C., & Madden, G. J. (2002). Delay discounting and performance on the prisoner's dilemma game. *Psychological Record, 52*, 429-440.

Heatherton, T.F., Kozlowski, L.T., Frecker, R.C., Fägerstrom, K.O., (1991). The Fägerstrom test for nicotine dependence: a revision of the Fägerstrom tolerance questionnaire. *British Journal of Addiction. 86*, 1119–1127.

Hoffman, E., Mccabe, K. A., & Smith, V. L. (1998). Behavioral foundations of reciprocity: Experimental economics and evolutionary psychology. *Economic Inquiry*, *36*, 335-352.

Jaroni, J. L., Wright, S. M., Lerman, C., & Epstein, L. H. (2004). Relationship between education and delay discounting in smokers. *Addictive Behaviors*, *29*, 1171-1175.

Jones, B., & Rachlin, H. (2006). Social discounting. *Psychological Science 17*, 283-286.

Jorgenson, D. O., & Papciak, A. S. (1981). The effects of communication, resource feedback, and identifiably on behavior in a stimulated commons. *Journal of Experimental Social Psychology, 17,* 373-385.

Kobus, K. (2003). Peers and adolescent smoking. *Addiction, 98*¸ 37-55.

Kollock, P. (1997). Social dilemmas: the anatomy of cooperation. *Annual Review of Sociology, 24*, 183-214.

Komorita, S. S., Parks, C. D., & Hulbert, L. G. (1992). Reciprocity and the induction of cooperation in social dilemmas. *Journal of Personality and Social Psychology*, *62*, 607-617.

Madden, G.J., Begotka, A.M., Raiff, B.R., & Kasten, L.L. (2003). Delay discounting of real and hypothetical rewards. *Journal of Experimental & Clinical Psychopharmacology, 11*, 139-145.

Mazur, J.E. (1987). An adjusting procedure for studying delayed reinforcement. In M.L. Commons, J.E. Mazur, J.A. Nevin, & H. Rachlin (Eds.), *Quantitative analysis of behavior, Vol. 5. The effects of delay and of intervening events on reinforcement value* (pp. 55-73). Mahwah, NJ: Erlbaum.

Mischel, H. N., & Mischel, W. (1983). Development of children's knowledge of self control strategies. *Child Development*, *54*, 603-619.

Myerson, J., Green, L., Hanson, J. S., Holt, D. D., & Estle, S. J. (2003) Discounting delayed and probabilistic rewards: Processes and traits. *Journal of Economic Psychology, 24*, 619-635.

Myerson, J., Green, L. & Warusawitharana, M. (2001). Area under the curve as a measure of discounting. *Journal of Experimental Analysis of Behavior,* 76, 235-243.

Nauta, D., & Hoekstra, J. (1995). Effective choice in the single-shot prisoner's dilemma tournament. *Theory and Decision, 39*, 1-30.

Patterson, F., Lerman, C., Kaufman, V. G., Neuner, G. A., & Audrian-McGovern, J. (2004). Cigarette smoking practices among American college students: Review and future directions. *Journal of American College Health*, *52*, 203-210.

Rachlin, H. (2000). *The science of self-control*. Cambridge, MA: Harvard University Press.

Rachlin, H. (2006). Notes on discounting. *Journal of the Experimental Analysis of Behavior. 85*, 425-435.

Rachlin, H., Brown, J., & Cross, D. (2000). Discounting in judgments of delay and probability. *Journal of Behavioral Decision Making*, *13*, 145-159.

Rachlin, H., & Jones, B. A. (in press). Social Discounting and Delay Discounting. *Journal of Behavioral Decision Making.*

Rachlin, H., Logue, A. W., Gibbon, J., & Frankel, M. (1986). Cognition and behavior in studies of choice. *Psychological Review*, *93*, 33-45.

Rachlin, H., Raineri, A., & Cross, D. (1991). Subjective probability and delay. *Journal of the Experimental Analysis of Behavior*, *55*, 233-244.

Reynolds, Brady (2006). A review of delay-discounting procedures with humans: Relations to drug use and gambling. *Behavioural Pharmacology*, *17*, 651-667.

Sheldon, K. M. (1999). Learning lessons of tit for tat: even competitors can get the message. *Journal of Personality and Social Psychology, 77,* 1245-1253.

Simon, J. (1995). Interpersonal allocation continuous with intertemporal allocation. *Rationality and Society, 7,* 367-392.

Slonim, R., & Roth, A. E. (1998). Learning in high stakes ultimatum games: An experiment in the Slovak Republic. *Econometrica*, *66*, 569-596.

Stevens, J.C., & Marks, L.E. (1965). Cross-modality matching of brightness and loudness. *Proceedings of the National Academy of Sciences of the United States of America*, *54*, 407-411.

Triandis, H. C., & Triandis, L. M., (1960). Race, social class, religion, and nationality as determinates of social distance. *Journal of Abnormal and Social Psychology, 61*, 110-118.

Yi, R., Johnson, M. W., & Bickel, W. K. (2006). Relationship between cooperation in an iterated prisoner's dilemma game and the discounting of hypothetical outcomes. *Learning & Behavior*, *33*, 324-336.

Yi, R., de la Piedad, X., & Bickel, W. (2006). The combined effects of delay and probability in discounting. *Behavioral Processes*, *73*, 149-155.

Figure 1: 2-Player Prisoner's Dilemma Payoff Matrix

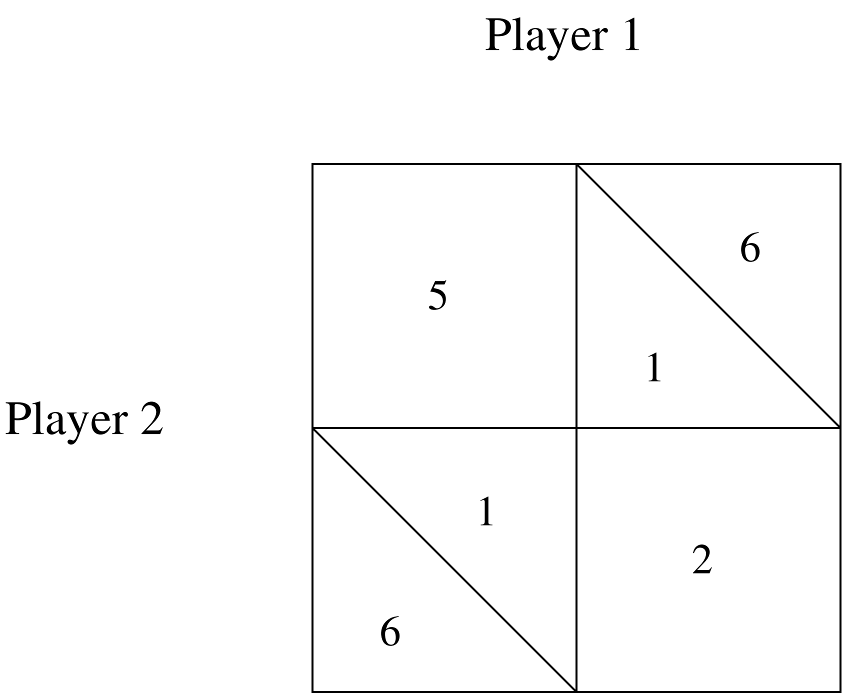

Figure 2: Experiment 1 (Jones & Rachlin, 2006)

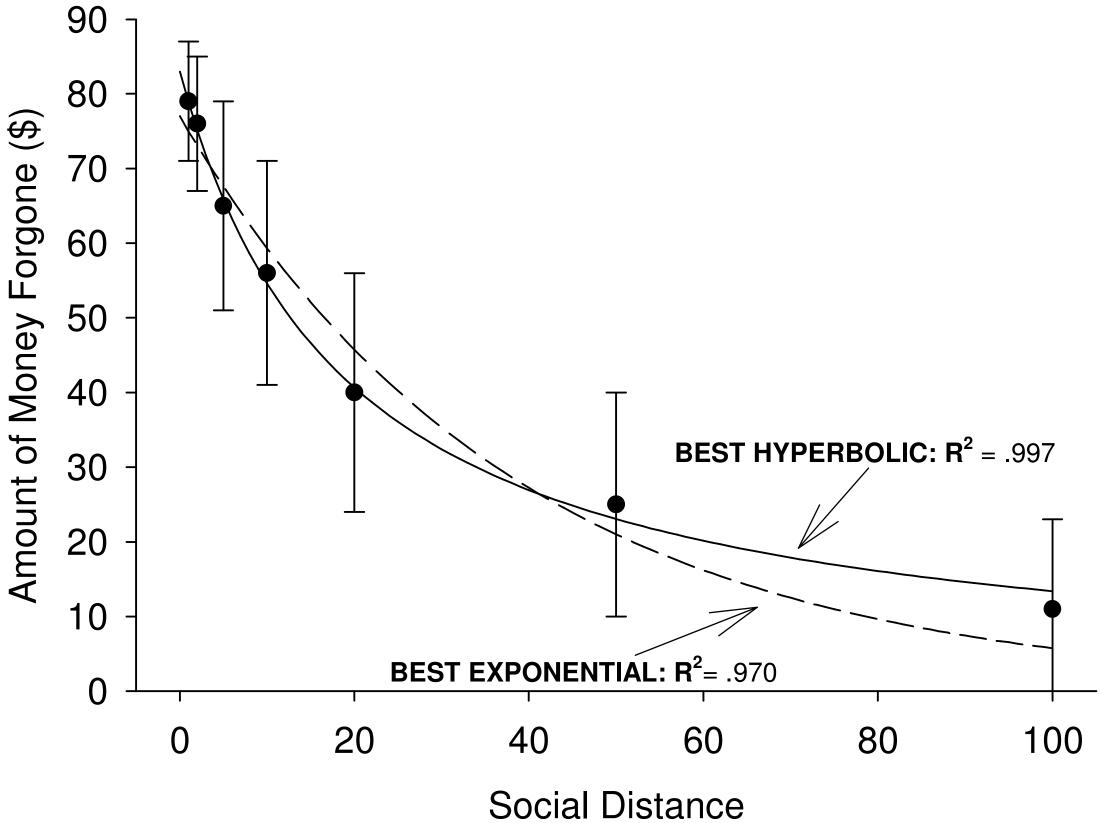

Figure 3: Experiment 1 Histogram of Values of Individual *Social k*

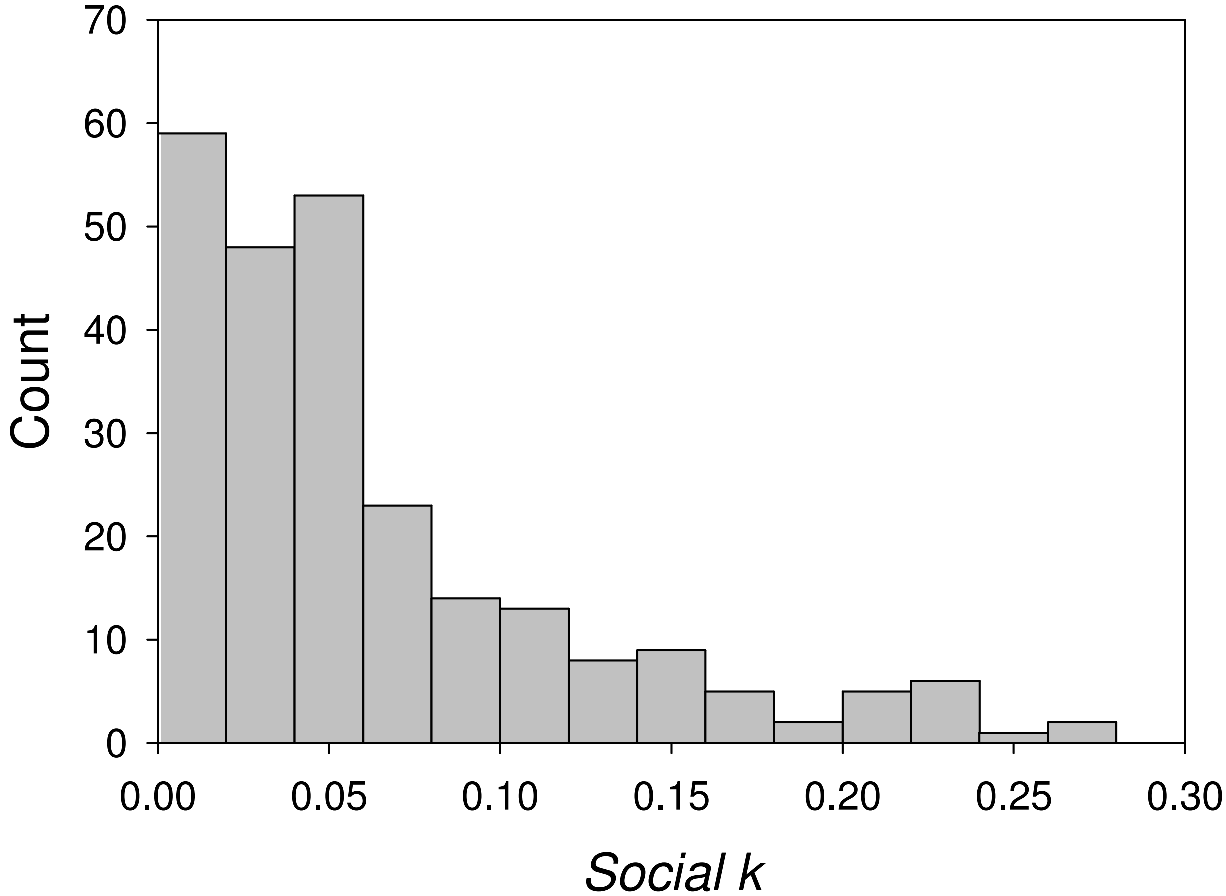

Figure 4: Experiment 1 Log of Individual *Social k* Values

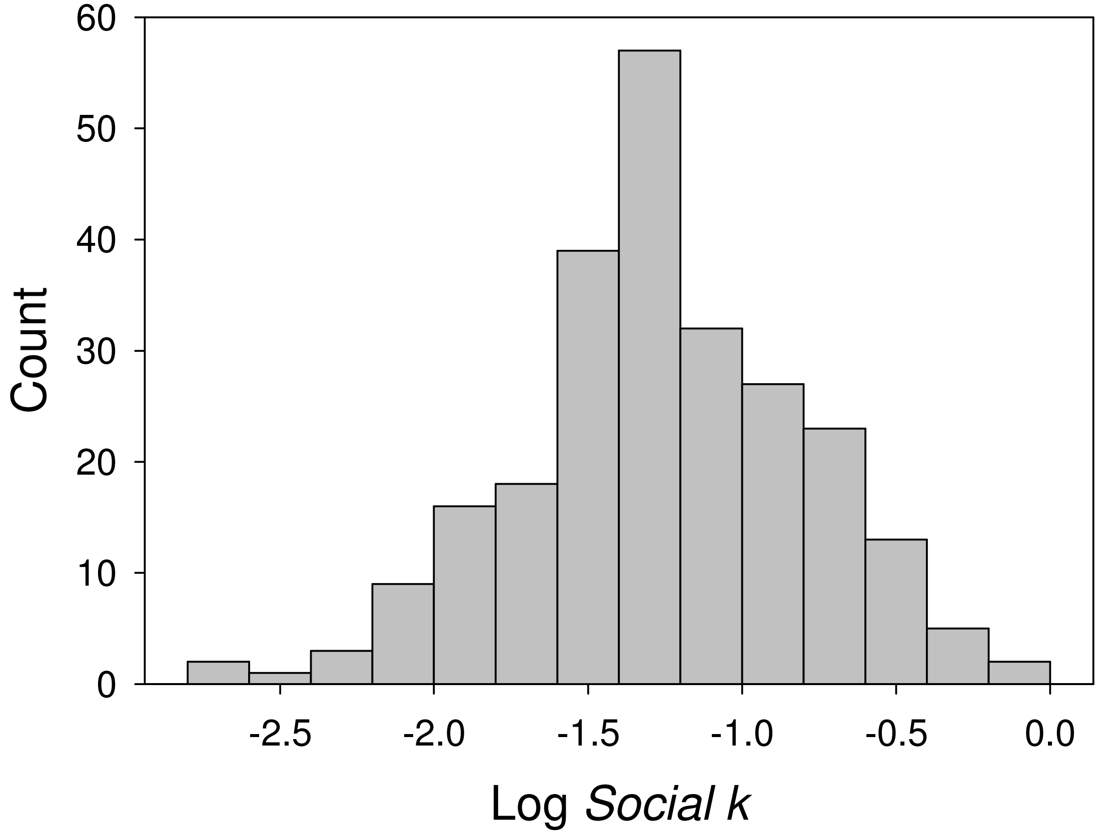

Figure 5: Experiment 2 (Rachlin & Jones, in press)

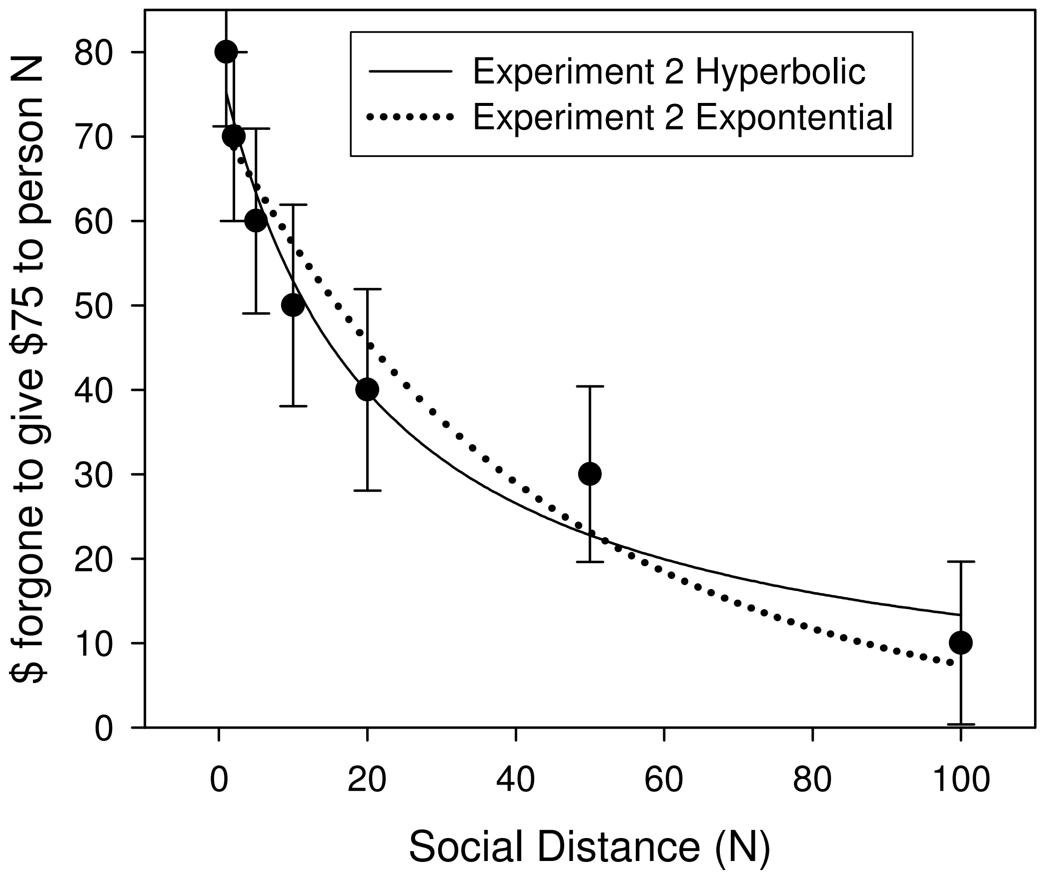

Figure 6: Experiment 2 Log of Individual *Social k* Values

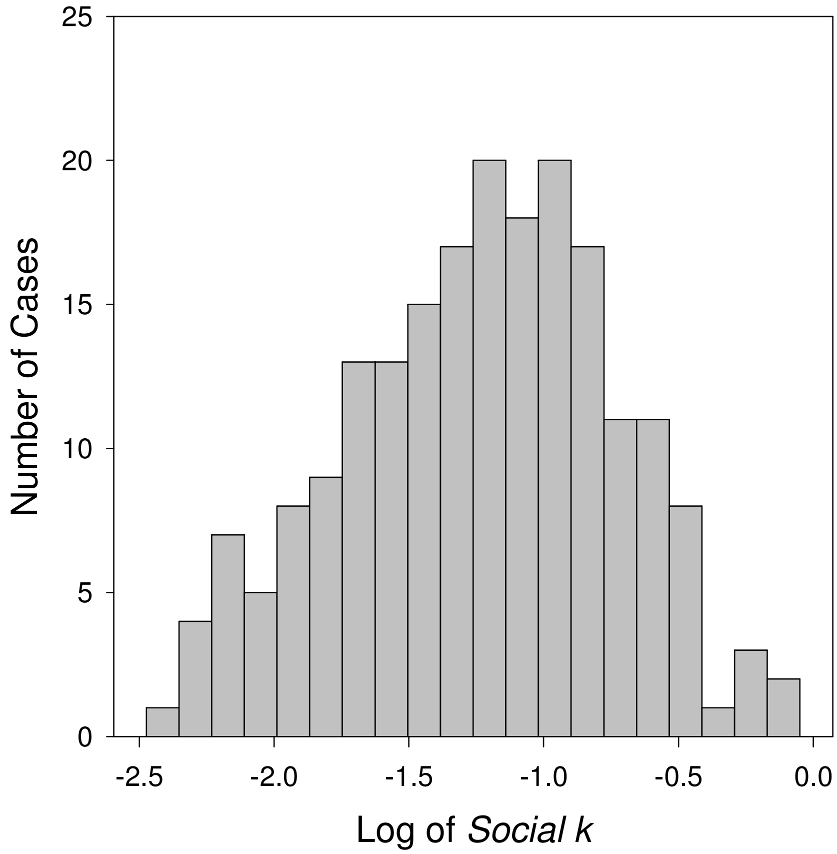

Figure 7: Experiment 2 and Experiment 1

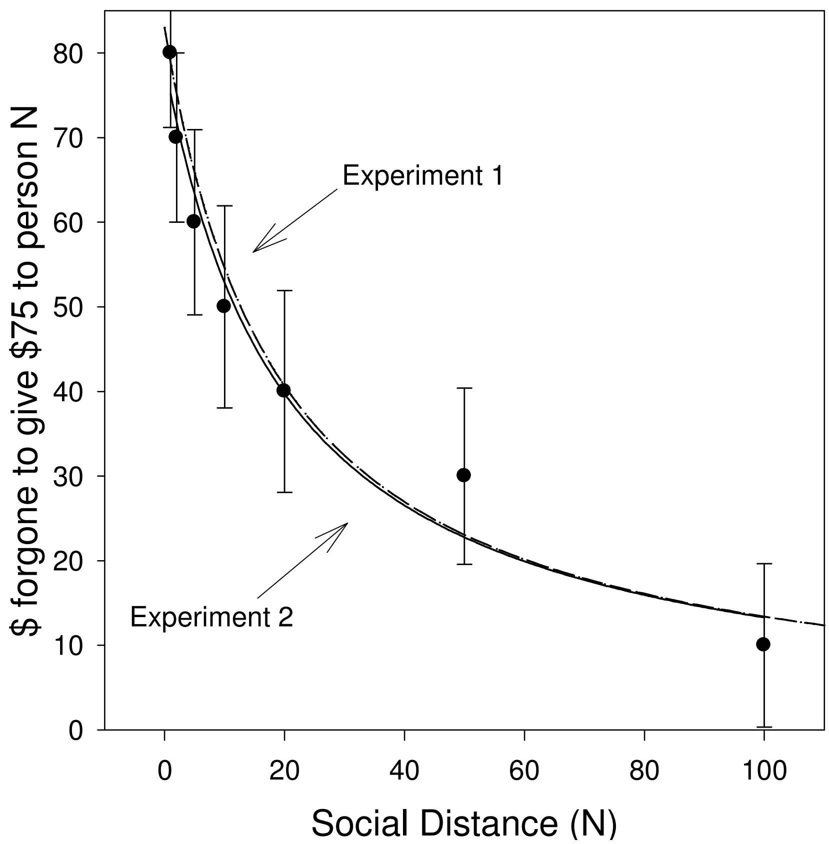

Figure 8: Experiment 3 Log of *Social k*

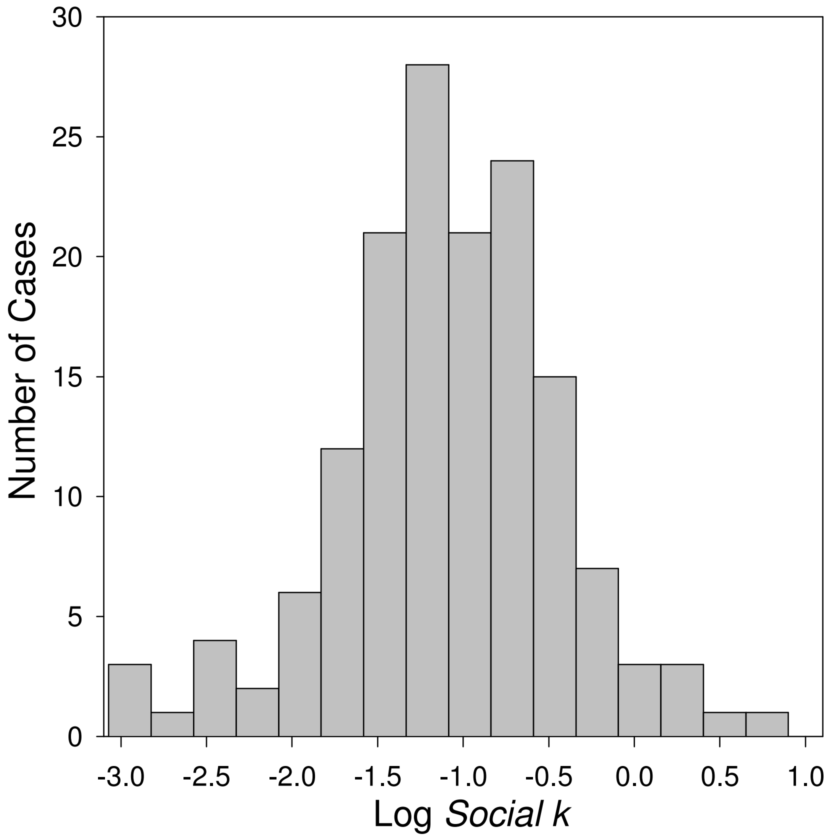

Figure 9: Experiment 3 Log of *Delay k*

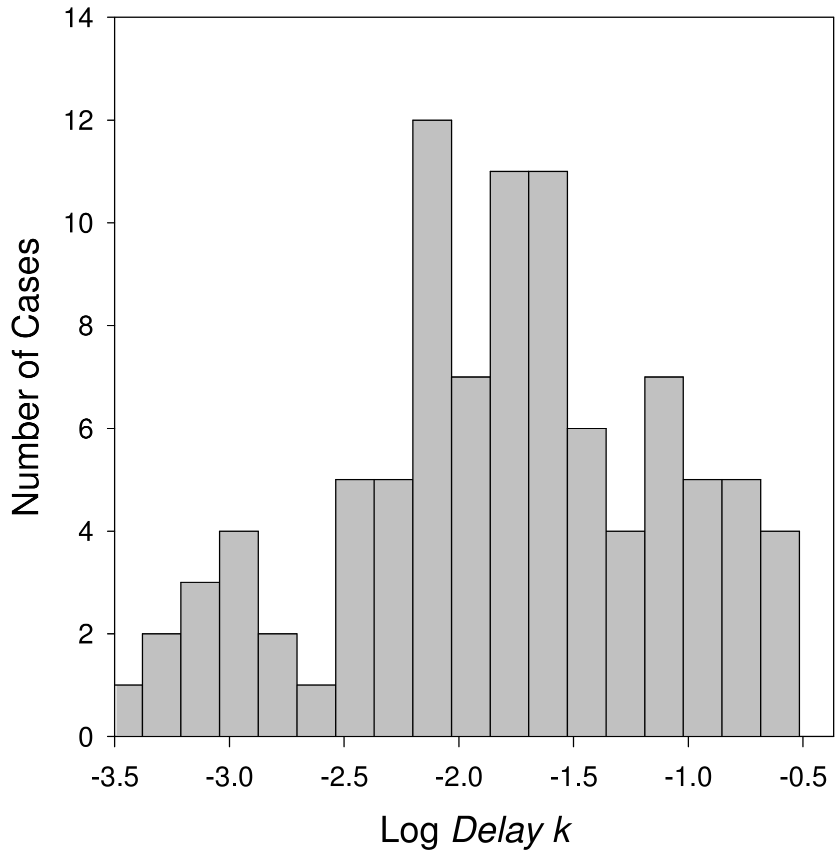

Figure 10: Experiment 3 Log of *Probability k*

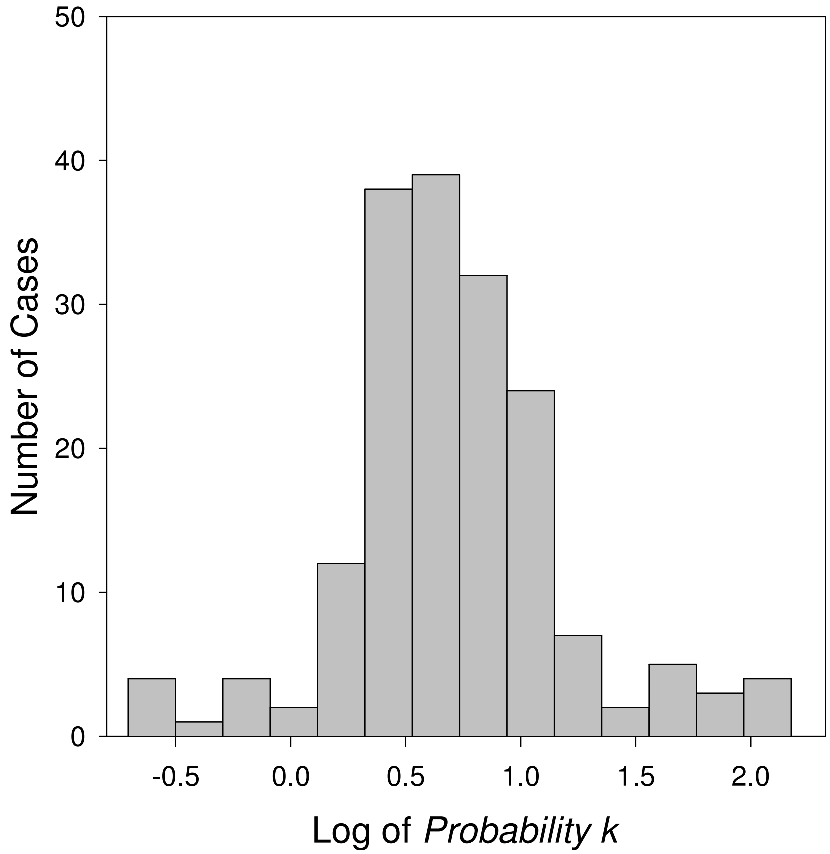

Figure 11: Experiment 3 Log of *Delay k* and Log of *Probability k*

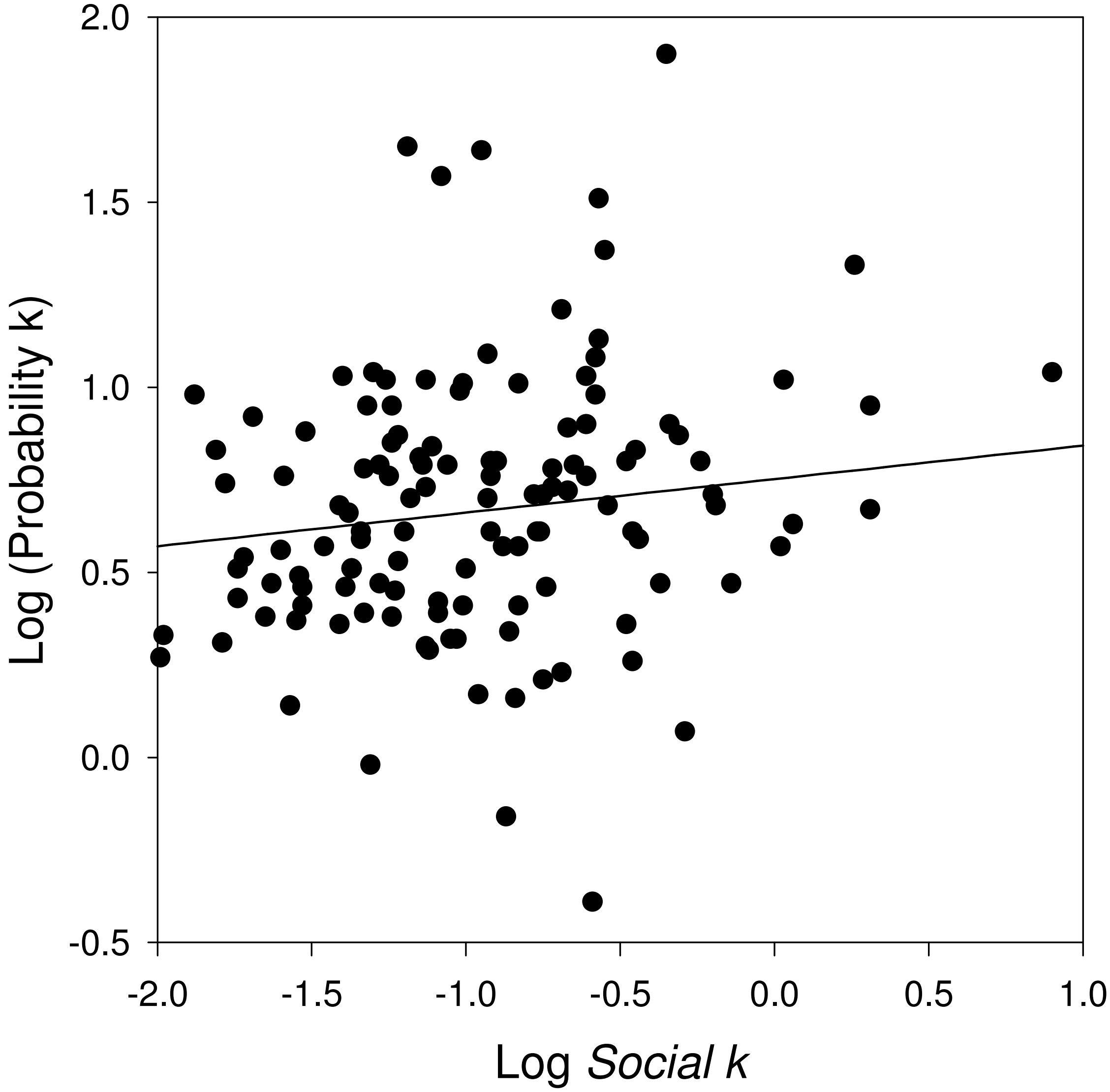

Figure 12: Experiment 4 Social Psychophysics (Logs)

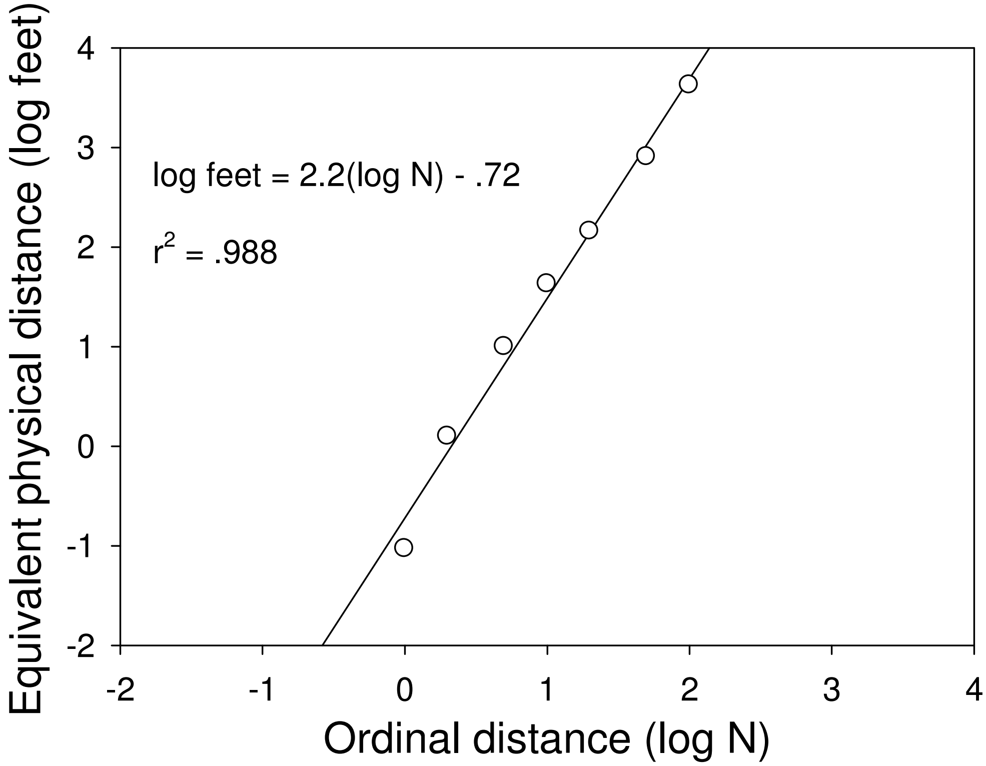

Figure 13: Experiment 5 Log of *Social k* by Percent of Money Given

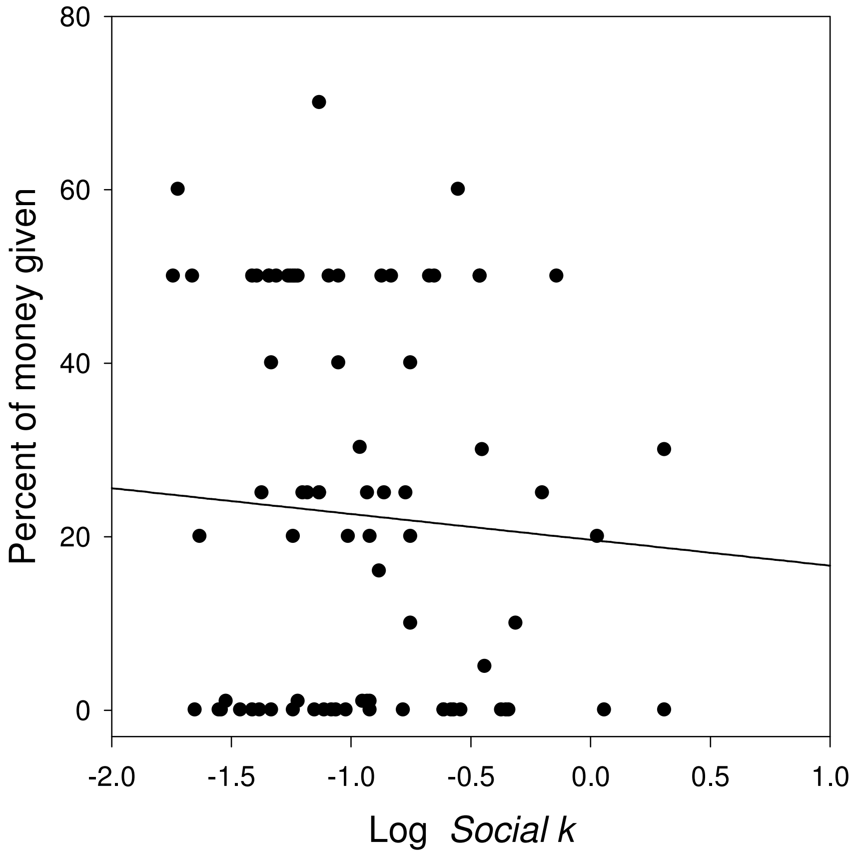

Figure 14: Experiment 5 Log of *Probability k* by Percent of Money Given

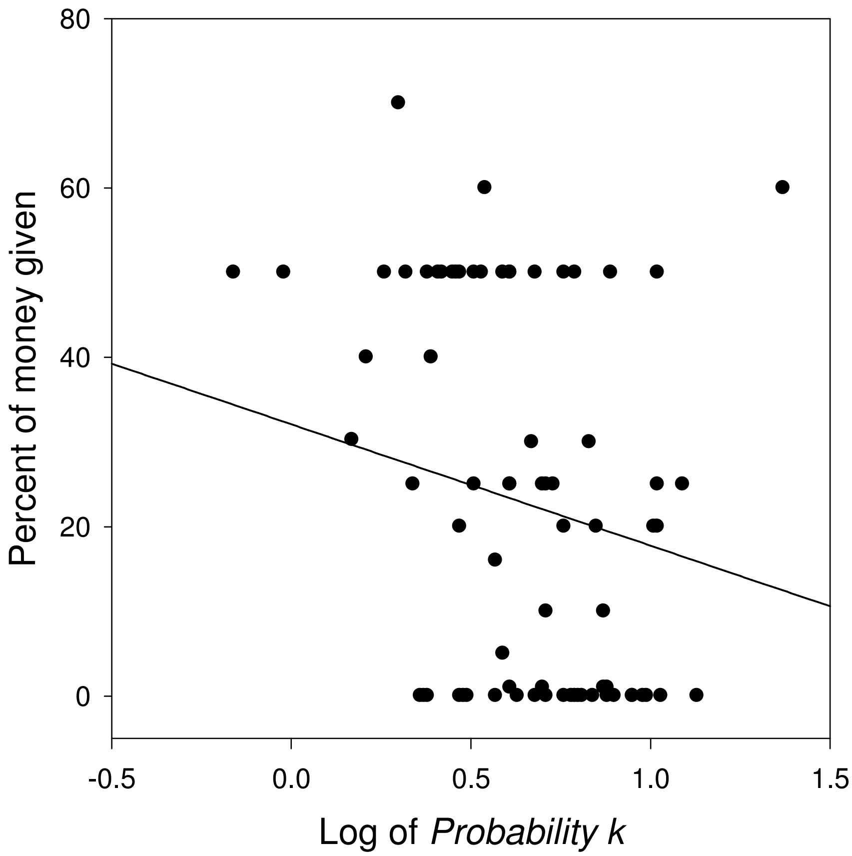

Figure 15: Experiment 6 Median Percentage of Money Offered by Giver in $100,000 Condition of Ultimatum and Dictator Games

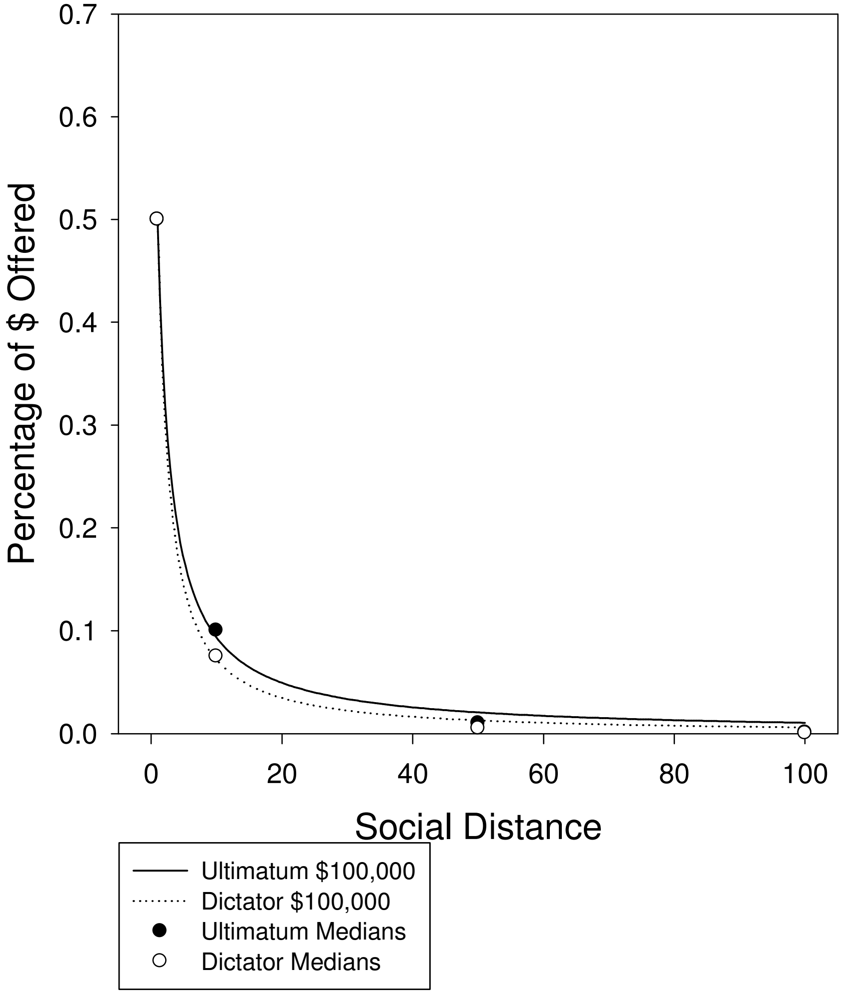

Figure 16: Experiment 6 Median Percentage of Money Offered by Giver in $1,000 Condition of Ultimatum and Dictator Games

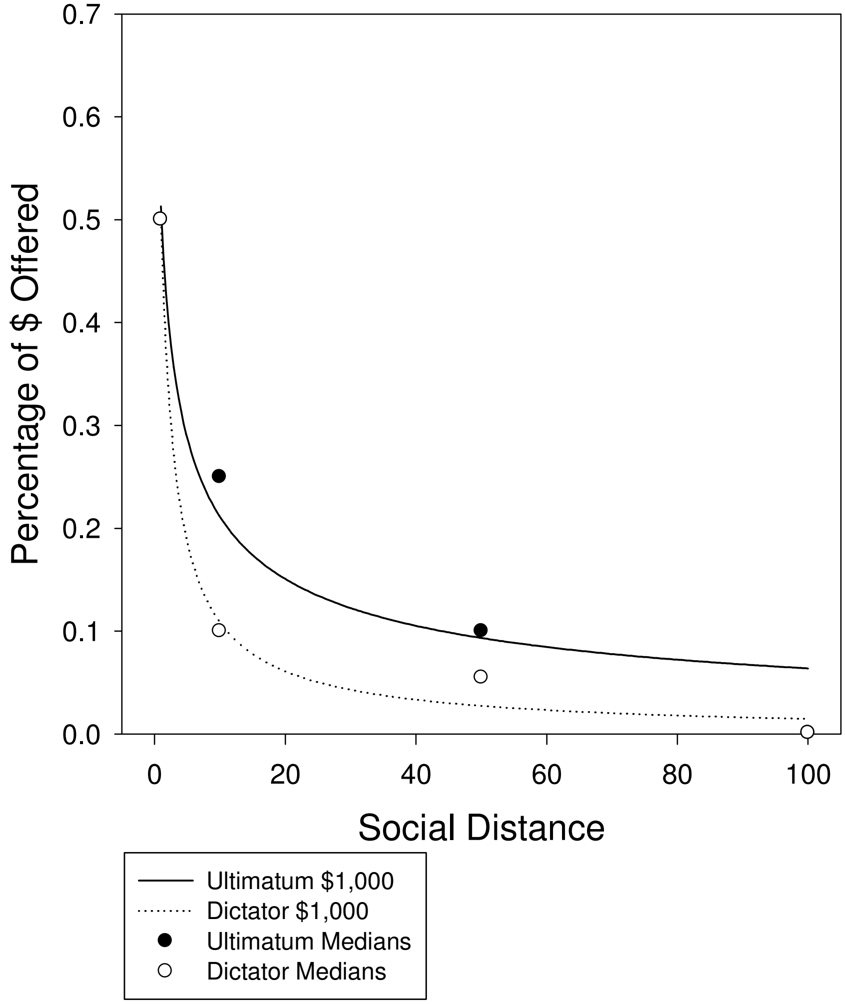

Figure 17: Experiment 6 Median Percentage of Money Offered by Giver in $10 Condition of Ultimatum and Dictator Games

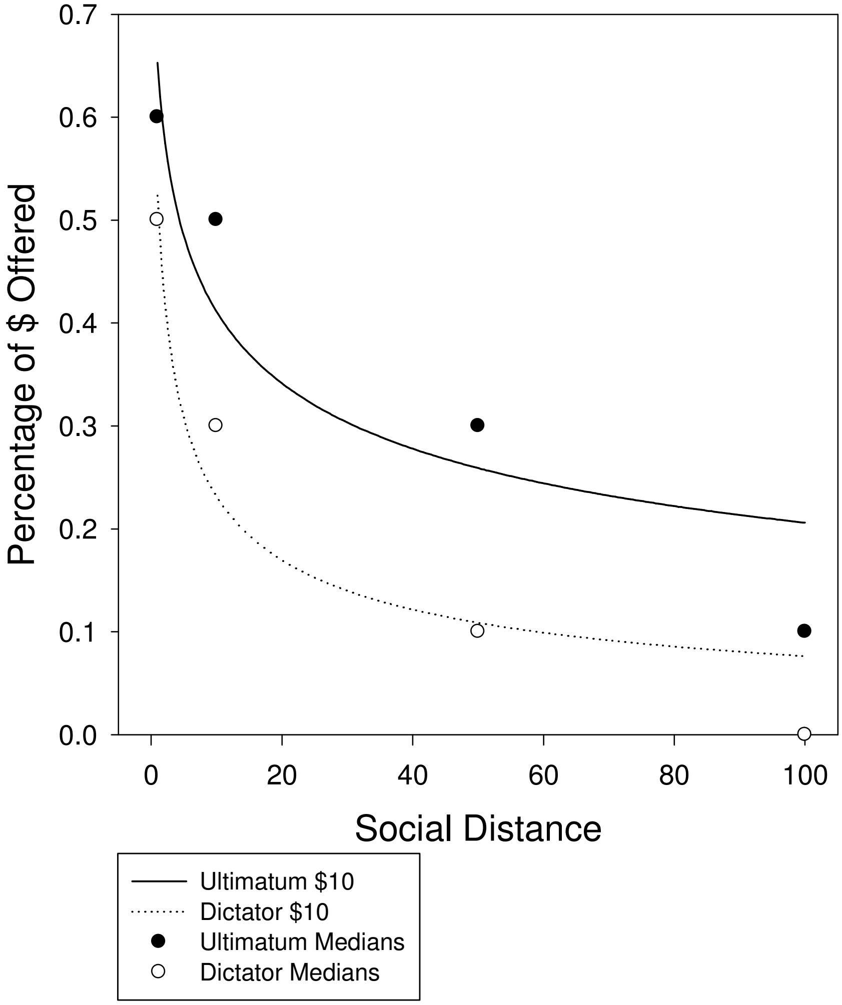

Figure 18: Experiment 6 Area Under the Curve of Ultimatum versus Dictator Game by Magnitude

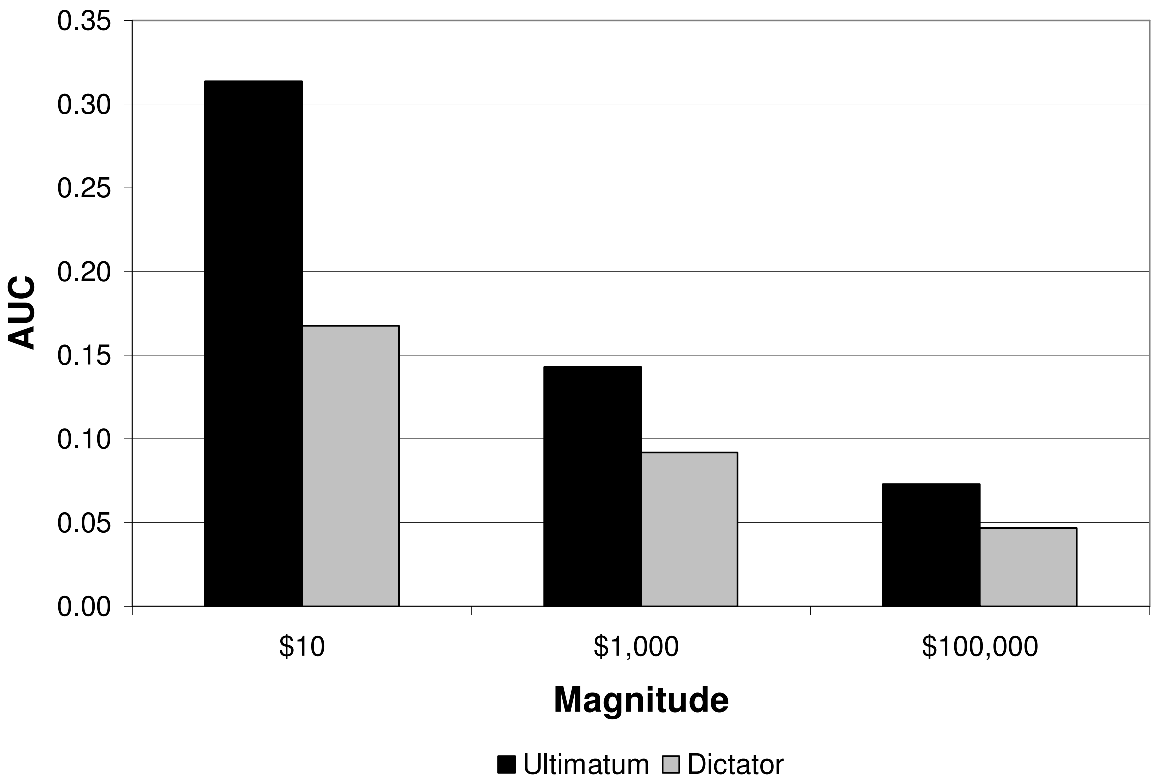

Figure 19: Premium of Social Distances for $1,000 Endowment Condition

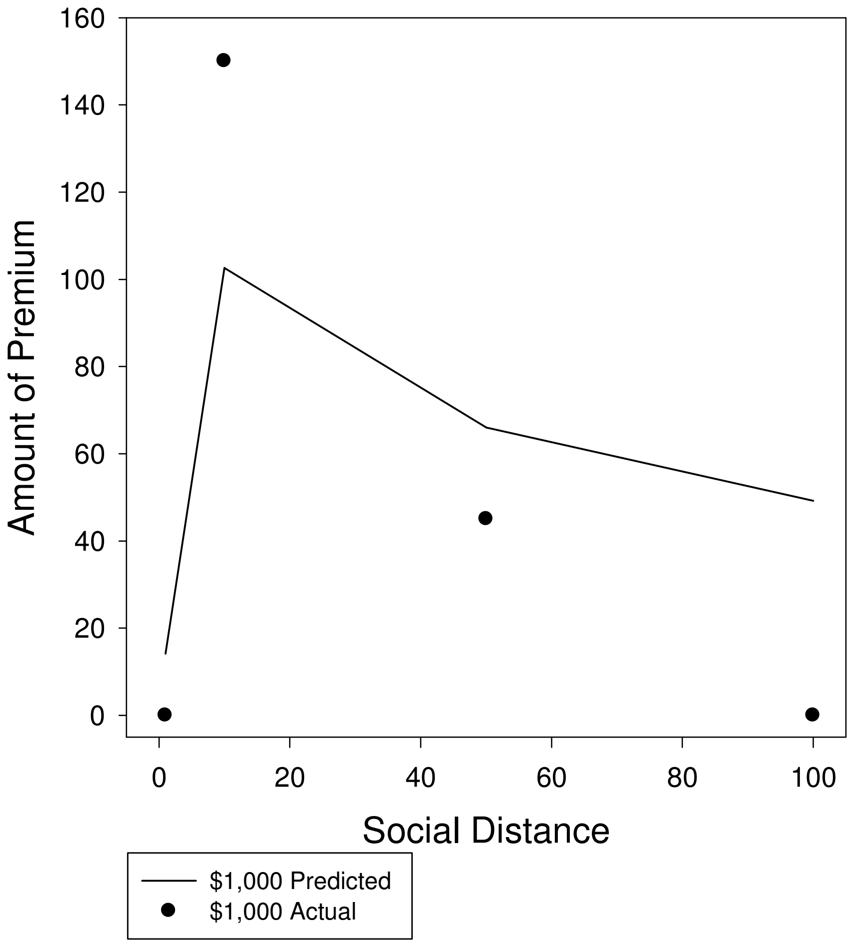

Figure 20: Experiment 7 Ultimatum Game as Receiver: Median Minimum Accepted Offer

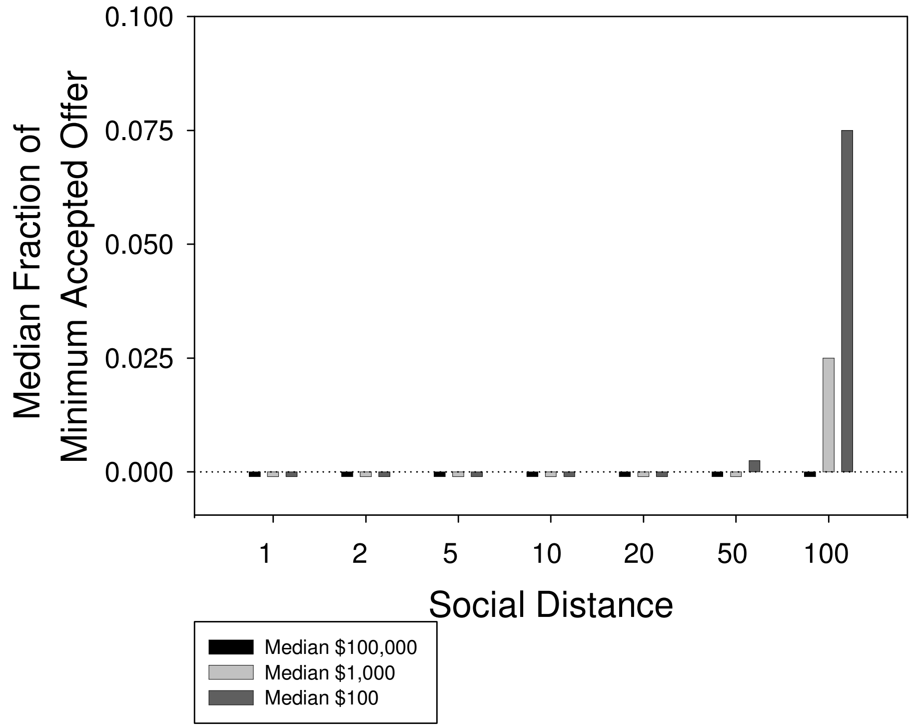

Figure 21: Experiment 7 Ultimatum Game as Receiver: Mean Minimum Accepted Offer

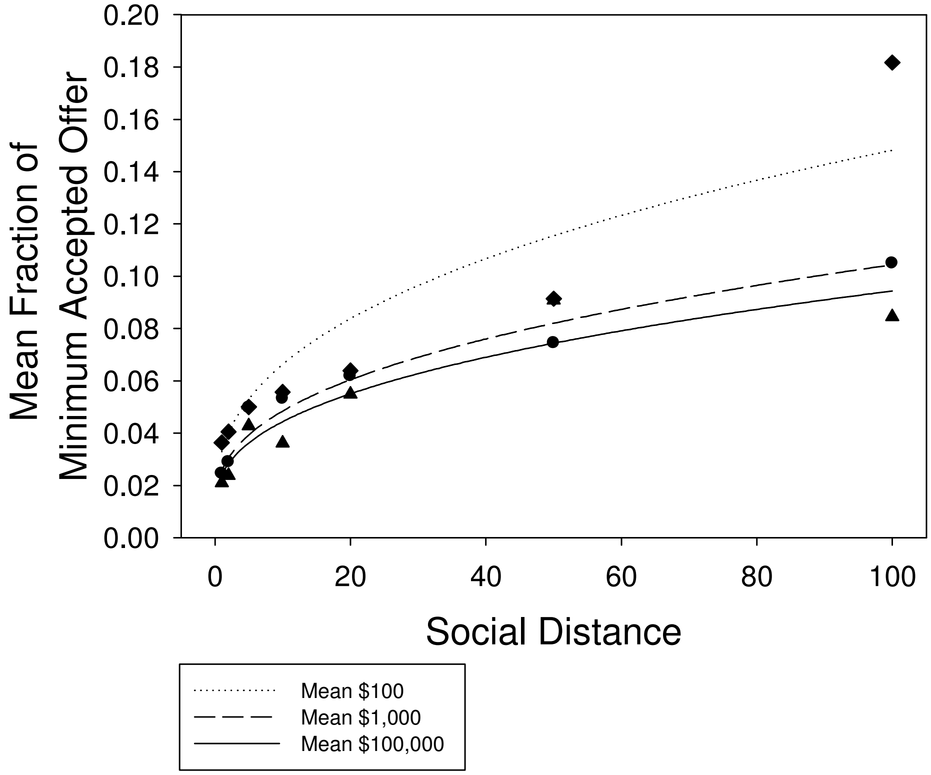

Figure Captions

Figure 1: Shows the payoff matrix for a 2-player PDG. The columns show the payoff for player 1; rows show the payoff for player 2. In cells where two values are shown, the upper right number refers to player 1 and the lower left number refers to player 2.

Figure 2: Shows the best fitting hyperbolic function (Equation 1) and exponential equation for Experiment 1.

Figure 3: Shows the number of cases of individual k_{social} values from Experiment 1.

Figure 4: Shows the number of cases of the log transformation of individual *social k* values from Experiment 1.

Figure 5: Shows the best fitting hyperbolic (Equation 1) and exponential equations of Experiment 2.

Figure 6: Shows the number of cases of the log transformation of individual *social k* values from Experiment 2.

Figure 7: Shows the best fitting hyperbolic function (Equation 1) Experiment 1 and Experiment 2. Filled circles represent medians from Experiment 2. Error bars represent one standard deviation from the median.

Figure 8: Shows the number of cases of the log transformation of individual *social k* values from Experiment 3.

Figure 9: Shows the number of cases of the log transformation of individual *delay k* values from Experiment 3.

Figure 10: Shows the number of cases of the log transformation of individual *probability k* values from Experiment 3.

Figure 20: Shows the median minimum accepted offer by social distance [*N*] by magnitude in Experiment 7.

Figure 21: Shows the best fitting function (Equation 4) of mean Minimum Accepted Offer by social distance [*N*] by magnitude in Experiment 7.

Table 1: Best Fitting Values for Discount Functions in Experiment 3

Condition	*k*	*s*	R^2
Delay	.03	.35	.99
Probability	6.10	.47	.99
Social	.09	1	.96

Table 2: Experiment 3 Correlations of Log of *Social k*, Log of *Probability k*, and Log of *Delay k*

	Log of *Social k*	Log of *Probability k*	Log of *Delay k*
Log of *Social k*	---	r = .250 p = .003 n = 135	r = .064 p = .488 n = 101
Log of *Probability k*		---	r = .165 p = .073 n = 119
Log of *Delay k*			---

Table 3: Experiment 6 Hyperbolic Discount Function and Area Under the Curve Values

Condition		*k*	*s*	R^2	*AUC*
$100,000	Ultimatum	.996	.989	.999	.129
	Dictator	.998	1.113	.990	.096
$1,000	Ultimatum	.948	.594	.960	.174
	Dictator	1.005	.911	.993	.161
$10	Ultimatum	.532	.430	.840	.354
	Dictator	.909	.562	.924	.259

Table 4: Experiment 7 Fit to Equation 4

Condition	*k*	*s*	R^2
$100,000	1.42	.39	.89
$1,000	1.79	.35	.96
$100	1.21	.55	.91

Table Captions

Table 1: Best fitting values for discount functions for median points of Experiment 3

Table 2: Shows the correlation matrix of the log of *social k*, log of *probability k*, and log of *delay k* from Experiment 3.

Table 3: Best fitting values of median points in Equation 1, 2, and 3 for social, delay, and probability discounting measures in Experiment 3.

Table 4: Best fitting values for Equation 5 for means of MAO from Experiment 7.

Appendix A: Social Distance Example

The following experiment asks you to imagine that you have made a list of the 100 people closest to you in the world ranging from your dearest friend or relative at position #1 to a mere acquaintance at #100. The person at number one would be someone you know well and is your closest friend or relative. The person at #100 might be someone you recognize and encounter but perhaps you may not even know their name.
You do not have to physically create the list- just imagine that you have done so.

Appendix B: Social Discounting Example (Experiment 1)

Imagine you made a list of the 100 people closest to you in the world ranging from your dearest friend or relative at #1 to a mere acquaintance at #100.

Now imagine the following choices between an amount of money for you and an amount for the **#N** person on the list. Circle A or B to indicate which you would choose in EACH line.

A. $155 for you alone.	B. $75 for you and $75 for the #N person on the list.
A. $145 for you alone.	B. $75 for you and $75 for the #N person on the list.
A. $135 for you alone.	B. $75 for you and $75 for the #N person on the list.
A. $125 for you alone.	B. $75 for you and $75 for the #N person on the list.
A. $115 for you alone.	B. $75 for you and $75 for the #N person on the list.
A. $105 for you alone.	B. $75 for you and $75 for the #N person on the list.
A . $95 for you alone.	B. $75 for you and $75 for the #N person on the list.
A. $85 for you alone.	B. $75 for you and $75 for the #N person on the list.
A. $75 for you alone.	B. $75 for you and $75 for the #N person on the list.

Appendix C: Social Discounting Example (Experiment 2)

Imagine you made a list of the 100 people closest to you in the world ranging from your dearest friend or relative at #1 to a mere acquaintance at #100.

Now imagine the following choices between an amount of money for you and an amount for the **#[N]** person on the list. Circle A or B to indicate which you would choose in EACH line.

A. $85 for you alone or	B. $75 for the #[N] person on the list.
A. $75 for you alone or	B. $75 for the #[N] person on the list.
A. $65 for you alone or	B. $75 for the #[N] person on the list.
A. $55 for you alone or	B. $75 for the #[N] person on the list.
A. $45 for you alone or	B. $75 for the #[N] person on the list.
A. $35 for you alone or	B. $75 for the #[N] person on the list.
A. $25 for you alone or	B. $75 for the #[N] person on the list.
A. $15 for you alone or	B. $75 for the #[N] person on the list.
A. $5 for you alone or	B. $75 for the #[N] person on the list.
A. $0 for you alone or	B. $75 for the #[N] person on the list.

Appendix D: Delay Discounting Example

Please choose which amount of money you would rather have for each line

A. $75 for you right now. B. $75 for you **after [D]**.

A. $65 for you right now. B. $75 for you **after [D]**.

A. $55 for you right now. B. $75 for you **after [D]**.

A. $45 for you right now. B. $75 for you **after [D]**.

A. $35 for you right now. B. $75 for you **after [D]**.

A. $25 for you right now. B. $75 for you **after [D]**.

A . $15 for you right now. B. $75 for you **after [D]**.

A. $5 for you right now. B. $75 for you **after [D]**.

A. $0 for you right now. B. $75 for you **after [D]**.