Further Reflections on Prospect Theory

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Abstract A menu of paired lottery choices is structured so that the crossover point to the high-risk lottery can be used to infer the degree of risk aversion or preference. When payoffs are hypothetical and gains are transformed into losses by reflecting them around zero, more than half of the subjects exhibit a "reflection effect" (risk aversion for gains and risk seeking for losses). With cash payoffs, however, this pattern is not observed; many subjects exhibit risk aversion for both gains and losses, and the frequency of reflection (about ten percent) is not much greater than the frequency of reverse reflection (risk seeking for gains and risk aversion for losses). Risk aversion is, however, less common in the loss domain.

Keywords: lottery choice, reflection effect, prospect theory, risk aversion, incentive effects, hypothetical payoffs.

One of the most widely cited articles in the economics literature is the Kahneman and Tversky (1979) paper on prospect theory, which is designed to explain a range of lottery-choice anomalies. This theory is motivated by laboratory experiments and can be thought of as a model of the decision process. A key observation is that decision making begins by identifying a reference point, often the current wealth position, from which people tend to be risk averse for gains and risk loving for losses. A striking prediction of the theory is the "reflection effect," that a replacement of all positive payoffs by their negatives, i.e. reflection around zero, reverses the choice pattern. For example, a choice between a 90 percent chance of getting 3,000 and a 45 percent chance of getting 6,000 would be replaced by a choice between a 90 percent chance of *losing* 3,000 and a 45 percent chance of *losing* 6,000. The typical reflection effect would imply a risk-averse preference for high probability of the relatively safe 3,000 gain, but a reversed preference for the risky lottery in the loss domain. Reflected

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choice patterns reported by Kahneman and Tversky (1979) were quite high, e.g. 86 percent of subjects chose the safe lottery (90 percent chance of 3,000) in the gain domain, but only 8 percent chose the safe lottery when all payoffs were transformed into losses. The intuition is that "...certainty increases the aversiveness of losses as well as the desirability of gains." (Kahneman and Tversky, 1979, p.269). The mathematical value functions used in prospect theory (concave for gains, convex for losses) can explain such a reflection effect, even when the safer prospect is not certain, and this paper will report an experimental test of these predictions.

Despite the widespread references to prospect theory in theoretical and experimental work, the direct tests reported in Kahneman and Tversky (1989) and Tversky and Kahneman (1992) are based on hypothetical payoffs. These payoffs, set to be about equal to median monthly income in Israel pounds at the time, were justified:

> Experimental studies typically involve contrived gambles for small stakes, and a large number of repetitions of very similar problems. These features of laboratory gambling complicate the interpretation of the results and restrict their generality. By default, the method of hypothetical choices emerges as the simplest procedure by which a large number of theoretical questions can be investigated. The use of the method relies on the assumption that people often know how they would behave in actual situations of choice, and on the further assumption that the subjects have no special reason to disguise their true preferences. If people are reasonably accurate in predicting their choices, the presence of common and systematic violations of expected utility theory in hypothetical problems provides presumptive evidence against that theory. (Kahneman and Tversky, 1989, p. 265)

The authors acknowledge the argument made by Vernon Smith and James Walker (1993) that using real incentives may reduce decision noise, but they respond:

> In the present study we did not pay subjects on the basis of their choices because in our experience with choice between prospects of the type used in the present study, we did not find much difference between subjects who were paid a flat fee and subjects whose payoffs were contingent on their decisions. ... Although some studies found differences between paid and unpaid subjects in choice between simple prospects, these differences were not large enough to change any significant qualitative conclusions. (Tversky and Kahneman, 1992, p.315)

While the use of hypothetical payoffs may not affect behavior much when low amounts of money are involved, this may not be the case with very high payoffs of the type used by Kahneman and Tversky to document the reflection effect. For example, Holt and Laury (2000) report that switching from hypothetical to real money payoffs has no significant effect in a series of lottery choices when the scale of payoffs is in the range of several dollars per decision problem, as is typical in economics experiments. However, observed risk aversion increases sharply when real money payoffs are scaled up by factors of 20 and 50, yielding payoffs approximately centered around $100. No such scale effects are observed when hypothetical payoffs are increased in an identical manner. In view of economists' skepticism about hypothetical incentives and the fact that the our experiment only involved gains, we decided to reevaluate the reflection effect using actual monetary gains and losses.[1]

Risk seeking over losses has been observed in experiments with financial incentives that implement insurance markets. For example, Myagkov and Plott (1997) use market price and quantity data to infer that a majority of subjects are risk-seeking in the loss domain in early periods of trading, but this tendency tends to diminish with experience. In contrast, Bosch-Domenech and Silvestre (1999) report a very strong tendency for subjects to purchase actuarially fair insurance over relatively large losses. This observation may indicate risk aversion in the loss domain, or alternatively, it may be due to over-weighting the low (0.2) probability of a loss as suggested by the probability weighting function typically assumed in prospect theory. Laury and McInnes (2000) also find that almost all subjects choose to purchase fair insurance against low probability losses. The percentage insuring decreases as the probability of a loss increases, but about two-thirds purchase insurance when the probability of a loss is close to one-half and systematic probability mis-perceptions cannot be a factor. None of these studies were primarily focused on the reflection effect, and therefore, none of them had parallel gain/loss treatments. Taken together, they provide no strong evidence either for or against such an effect.

Market and insurance purchase experiments are useful in that they provide a rich,

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[1] The use of hypothetical payoffs is more likely to make a difference when there are significant interpersonal "relative payoff" considerations. Forsythe, Horowitz, Savin, and Sefton (1994) find that the use of money payments has a significant effect on behavior in dictator bargaining games (yielding more selfish claims). They report no significant effect on the first offers made in ultimatum games, but List and Cherry (2000) report that an increase in the money stakes induces subjects to "learn" not to reject positive offers in such games. For a survey of the effects of using money payoffs in economics experiments, see Smith and Walker (1993), Hertwig and Ortmann (2000), and Camerer and Hogarth (1999), who offer a "labor/capital/production" model of when cash payoffs matter..

economically relevant context. Our approach is complementary; we use a simple tool to measure risk preferences directly, based on a series of lottery choices with significant money payoffs in parallel gain and loss treatments. The design, procedures, results, and conclusions are presented in sections I-IV respectively.

I. Lottery Choice Design

The lottery choice task for the loss domain is shown in Table 1, as a menu of ten decisions between lotteries that we will denote by *S* and *R*. These will be referred to as decisions 1 to 10 (from top to bottom). In decision 1 at the top of the table, the choice is between a loss of $3.20 for *S* and a loss of 20 cents for *R*, so subjects should start out choosing R at the top of the table, and then switch to S as the probability of the worst outcome (-$4.00 for *S* or -$7.70 for *R*) gets high enough. The optimal choice for a risk-neutral person is to choose *R* for the top 5 decisions, and then switch to *S*, as indicated by the sign change in the expected payoff differences shown in the right column of the table. In fact, the payoff numbers were selected so that the range of (absolute) risk aversion measures that cause a switch after decision 5 is symmetric around 0, with a width of plus or minus 0.05.

Table 1. The Ten Lottery-Choice Decisions in the Loss Domain

Option S	Option R	Expected Payoff of S − Expected Payoff of R
0/10 of -$4.00, 10/10 of -$3.20	0/10 of -$7.70, 10/10 of $-0.20	-$3.00
1/10 of -$4.00, 9/10 of -$3.20	1/10 of -$7.70, 9/10 of -$0.20	-$2.33
2/10 of -$4.00, 8/10 of -$3.20	2/10 of -$7.70, 8/10 of -$0.20	-$1.66
3/10 of -$4.00, 7/10 of -$3.20	3/10 of -$7.70, 7/10 of -$0.20	-$0.99
4/10 of -$4.00, 6/10 of -$3.20	4/10 of -$7.70, 6/10 of -$0.20	-$0.32
5/10 of -$4.00, 5/10 of -$3.20	5/10 of -$7.70, 5/10 of -$0.20	$0.35
6/10 of -$4.00, 4/10 of -$3.20	6/10 of -$7.70, 4/10 of -$0.20	$1.02
7/10 of -$4.00, 3/10 of -$3.20	7/10 of -$7.70, 3/10 of -$0.20	$1.69
8/10 of -$4.00, 2/10 of -$3.20	8/10 of -$7.70, 2/10 of -$0.20	$2.36
9/10 of -$4.00, 1/10 of -$3.20	9/10 of -$7.70, 1/10 of -$0.20	$3.03

Since the two payoffs for the *S* lottery are of roughly the same magnitude, this lottery is relatively "safe," and therefore, increases in risk aversion will tend to cause one to switch to the *S* side before decision 6. To see this, note that we can normalize the utility of the lowest payoff, -\$7.70, to be a fixed number, say -1, and we can normalize the highest payoff, -\$0.20, to be 0. Then a utility function that passes through these two points and becomes "more concave" will be more "bowed upward" in the middle, which raises the utility of the two intermediate payoffs, -\$4.00 and -\$3.20. This is the intuition behind why an increase in the Arrow-Pratt coefficient of absolute risk aversion for all payoffs in this region will increase the expected utility of Option S relative to that of Option R. Thus a risk averse person is more prone to switch to the safe option S as we move down the rows of Table 1 than would be the case for a risk neutral person, who makes 5 R decisions before switching (see footnote 3 below for a proof). With absolute risk aversion of 0.1 (±0.5) on this range of payoffs, for example, it is a matter of straightforward calculation to show that the expected-utility maximizing choice is to choose *R* in the top 4 decisions and then switch to *S*. Conversely, risk loving preferences will cause a person to wait longer before switching to *S*, e.g. to choose *R* in the top 6 decisions for an absolute risk aversion of -0.1 (±0.5).[2]

The gain treatment was obtained from Table 1 by replacing each loss with the corresponding gain, so that decision 1 involves a choice between certain earnings of \$3.20 for *S* versus only 20 cents for *R*. This reverses the signs of expected payoff differences in Table 1, so a risk neutral person will choose S for decisions 1-5 before switching (a pattern that is written as *SSSSS/RRRRR*). A risk averse person will wait longer to switch, choosing more than five safe choices. To summarize, risk neutrality implies 5 safe choices in each treatment, risk aversion implies more than 5 choices in either treatment, and reflection would show up as more than 5 safe choices in the gain treatment and fewer than 5 safe choices in the loss treatment, e.g. a risk-averse pattern *SSSSSSS/RRR* for gains and a risk-preferring pattern *RRRRRRR/SSS* for losses. It is useful to distinguish the notion of a reflection effect

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[2] These calculations are meant to be illustrative; we do not mean to imply that absolute risk aversion will be constant over a wide range of payoffs. The lottery choice experiments in Holt and Laury (2000) involve scaling up payoffs by factors of 20 and 50, and we find evidence of decreasing absolute risk aversion. This result is not surprising since it is well known that the absolute risk aversion needed to explain choices between low stakes gambles implies an absurd amount of risk aversion with high stakes. To see this, consider the utility function: $u(x) = -\exp(-rx)$ which exhibits a constant absolute risk aversion of r. Notice that scaling up all money prizes up by a factor of, say, 100, yields utilities of $-\exp(-100rx)$, so this is equivalent to leaving the stakes the same and increasing risk aversion by a factor of 100, which yields an absurd amount of risk aversion.

of this type, which is an empirical pattern, from the predictions of a formal version of prospect theory, the derivation of which will require a slight digression.

We begin by reviewing the essential components of prospect theory. A prospect consists of a set of money prizes, x_i, with associated probabilities, p_i. In its simplest form, prospect theory specifies an expected valuation expression: $\Sigma_i w(p_i)\, u(x_i)$, where $u(x_i)$ is concave over gains (positive x_i) and convex over losses, and $w(p_i)$ is a nonlinear weighting function. It is typically asserted that small probabilities are overweighted: $w(p_i) > p_i$, and that the reverse holds for large probabilities.

Tversky and Kahneman (1992) use nonlinear regression to estimate parameters for the functions: $u(x) = (x)^\alpha$ for $x > 0$ and $u(x) = -\lambda(-x)^\beta$ for $x < 0$, where λ is a "loss aversion" parameter, which is greater than one to accentuate the negative aspect of losses. They report identical estimates of 0.88 for α and β, which makes the utility function concave for gains and convex for losses. With $\alpha = \beta$, the utility for losses is just the (negative) reflection of the utility for gains, scaled down by λ. In particular, this estimated utility function exhibits reflection in the sense that:

$$u(-x) = -\lambda\, u(x) \qquad for\ x > 0. \tag{1}$$

Next we will show that this refection property of utility implies reflection of lottery choices when gains are transformed into losses of equal absolute value. The safe option is preferred in the gain domain if $w(p)\, u(4.00) + w(1-p)\, u(3.20) > w(p)\, u(7.70) + w(1-p)\, u(0.20)$, or equivalently

$$Option\ S\ preferred\ if \quad \frac{w(p)}{w(1-p)} < \frac{u(3.20) - u(0.20)}{u(7.70) - u(4.00)}. \tag{2}$$

Similarly, in the loss domain it is straightforward to show that:

$$Option\ S\ preferred\ if \quad \frac{w(p)}{w(1-p)} > \frac{u(-0.20) - u(-3.20)}{u(-4.00) - u(-7.70)}. \tag{3}$$

But it follows from (1) that the right side of (3) is the same as the right side of (2), since the λ expressions in the numerator and denominator cancel. The reversal of inequalities in (2) and (3) means that if Option S is preferred in the gain domain for any particular value of p, then Option R will be preferred in the loss domain for that probability. Thus an exact reflection in the value function (equation 1) results in an exact reflection in lottery choices. Such a reflection occurs when, for example, $\alpha = \beta = 0.88$, as noted above. Although exact reflection (e.g., 7 safe choices for in the gain domain and 7 risky choices in the loss domain) can be predicted under these strong parametric conditions, such behavior is only rarely observed in our data with real payoffs. Following Kahneman and Tversky, we will focus on the qualitative predictions, i.e. whether there is risk preference in the loss domain, and if so, whether this preference becomes an aversion in the gain domain. As noted above, the observation of more than 5 safe choices in either treatment implies risk aversion, and fewer than 5 safe choices implies risk preference.[3]

II. Procedures

The subjects were students at Georgia State University who responded to classroom and campus announcements about an opportunity to earn money in an economics research experiment. We recruited subjects in groups of about ten participants, which we will refer to as sessions A-H. Subjects came to a dedicated laboratory with separate computer stations, and were instructed not to communicate with each other after we began reading the instructions. Losses typically cannot be deducted from participants' out-of-pocket cash reserves, so it is necessary to provide high initial cash balances. For example, Myagkov and Plott (1997) begin by giving each participant a cash balance of $60. Since we were not as constrained for time as would be the case in a market experiment, we let subjects build up a sizable balance in a task that involves real effort over a substantial period of time, so that they would not view the earnings as windfall gains. Therefore, we appended the lottery choices for losses *and gains* to the end of research experiments being used for several different projects. In all sessions, we began with a simple lottery choice to acquaint them with the ten-sided dice that were used to determine the random outcomes. (In fact, one non-native speaker did not

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[3] In order to clarify these qualitative predictions, consider the Arrow-Pratt coefficient of risk aversion, $r(x) = -u''(x)/u'(x)$, and suppose that r(x) is higher for one utility function than for another on some interval of payoffs, with strict inequality holding for at least one point. Then it is a direct implication of parts (a) and (e) of Pratt's (1964) Theorem 1 that the right side of (2) is higher for the more risk averse utility function. Since the left side is increasing in *p*, this increases the range of probabilities, *p*, for which the safe option is preferred. Conversely, Pratt's Theorem 1 implies that the right side of (3) is lower for the more risk averse utility function, which again raises the interval of probabilities over which the safe option is preferred.

know the meaning of the phrase "throw of a die.") Then we ran them through about an hour of a computerized sequential search experiment (sessions A and B) or of a public goods experiment (all other sessions). Earnings in the initial (pre-lottery) phase averaged about $45. In the hypothetical payment sessions, this initial phase was identical except that payoffs were hypothetical payoffs, and subjects were given a fixed payment of $45 to equalize the wealth positions for the real and hypothetical lottery choice treatments

After finishing the initial tasks, subjects' record sheets showed earnings to that point (or the $45 payment), with lines for six remaining parts (although they only completed four choice tasks) The first and third of these parts were lottery-choice tasks, with alternation in the order of the gain and loss treatments in each pair of sessions. These lottery choice tasks were separated by an intentionally neutral decision, a symmetric matching pennies game with (real or hypothetical) payoffs of $3.00 for the "winner" or $2.00 for the "loser" in each cell.[4] In the lottery choice parts, all ten choices were presented as in Table 1, but with the lotteries labeled as A and B, and without the expected payoff calculations that might suggest risk neutral decisions. Option A was always listed on the left side of the decision sheet, but the correspondence the A/B labels and the S/R options was alternated in half of the sessions. Probabilities were presented in terms of the outcomes of a throw of a ten-sided die,.e.g. "$3.20 if the throw is 1 or 2,...." The instructions also indicated that payoffs would be determined by *one* of the ten decisions in the menu of choices that would be selected *ex post* (again with the throw of a 10-sided die).[5] We collected decisions for all four parts, the gain and loss menus and the two matching pennies games, before determining earnings for each part. While this does not exactly hold (anticipated) wealth effects constant, it does control for emotional responses to winning or losing the matching pennies game or to getting a particularly good or bad throw of the die in the lottery choice task. Moreover, wealth effects do not matter in prospect theory, since the utility valuations are based on gains and losses from the current wealth position.

[4] The instructions for the one-shot matching pennies game with random matching are contained in the appendix to Goeree and Holt (2000). The data from these games are not interesting and will not used.

[5] Similarly, Myagkov and Plott (1997) told subjects that cash earnings would be based on the outcome of one market period, selected at random *ex post*.

III. Results

Since risk preferences can vary independently across subjects, we begin by considering individual choices. Participants will be identified by the session letter and a number. Subject AH1 in hypothetical payoff session AH, for example, exhibits an exact reflection, with risk aversion (SSSSSS/RRRR) for gains and risk seeking (RRRRRR/SSSS) for losses. In contrast, subject A1 in real payoff session A exhibits risk seeking for gains (SSSS/RRRRRR) and risk aversion for losses (RRRR/SSSSSS), which is the reverse of the pattern predicted by prospect theory. Others show similar numbers of safe choices in each treatment (e.g. subject A2 with SSSSSS/RRRR for gains and RRRR/SSSSSS for losses), indicating risk aversion in each case. A few individuals do not exhibit a clean switch point (most notably subject A4 with SSSRS/SRRRR for gains and RRSSR/RSRSS for losses). Nevertheless, in the attached data appendix we have inserted a slash in the position that equalizes the number of "misses" on each side.[6] We use the number of safe choices (relative to the risk neutral prediction of 5) to assign risk preference labels for each treatment.

Figure 1 summarizes the choice data for the hypothetical choice sessions. We used the number of safe choices to categorize individuals as being risk averse, risk neutral, or risk seeking, both in the loss domain (right to left) and in the gain domain (front to back). The "spike" at the back-right part of the graph represents those who exhibit the predicted reflection: risk loving for losses and risk aversion for gains. A majority reflect in this manner, and more than a quarter exhibit exact reflection, with the number of safe choices in the gain domain matching the number of risky choices in the loss domain. The non-reflection choices are fairly evenly distributed in the other cells, so one might characterize the results as "reflection plus noise." Thus we are able to replicate the predicted choice pattern using our lotteries, neither of which involves a certain prospect. Even though the number of subjects is relatively small (21), the consistency with previously reported results of Kahneman and

[6] Although this choice-menu instrument produces some apparent noise in the responses, we have found it to be fairly stable. It is well known that different risk aversion measures can yield seemingly contradictory results, e.g. bids for prospects tend to be low, which might suggest risk aversion if the bid is interpreted as a certainty equivalent. However, an elicited selling price tends to be high, which might suggest risk preference. Kachelmeyer and Shehata (1992) report very large differences between risk preferences inferred in this manner, which they attribute to the willingness-to-pay/willingness-to-accept bias. Similarly, Isaac and James (1999) find large differences between a Becker-DeGroot-Marshack ask-price elicitation methods and risk aversion inferred from bids in an auction with simulated other bidders. Ppeople who bid lower in the auction (consistent with more risk aversion) also tended to demand higher asking prices for the lottery, which is perplexing since high ask prices may indicate less risk aversion.

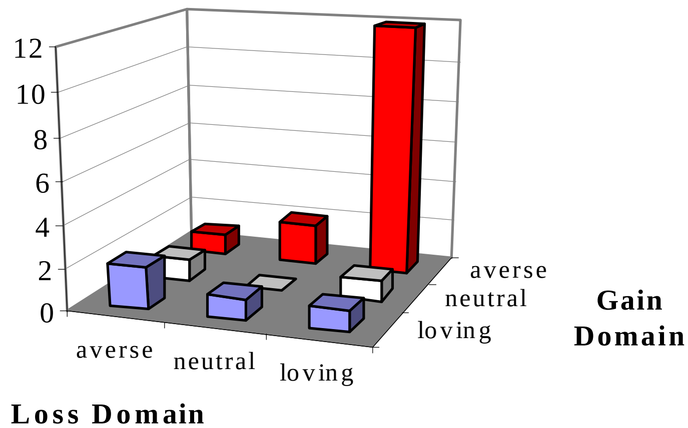

Figure 1. Risk Attitudes with Hypothetical Payments:
A Strong Reflection Effect Plus "Noise"

Tversky and others is striking.

The outcomes with real cash payoffs are quite different, as shown in Figure 2, where the

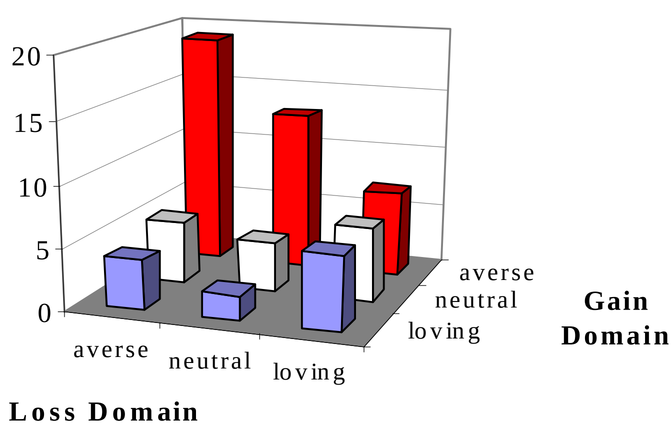

Figure 2. Risk Attitudes with Real Payments: Few Reflections in the Predicted Direction and Some Reverse Reflections

highest spike is in the back-left corner, involving risk aversion for both gains and losses. Nineteen of the sixty-six subjects make decisions that are consistent with risk-preference for losses (in the right column), but only seven of these show the reflection into risk aversion for gains. Moreover, another four subjects demonstrate a "reverse reflection" (not predicted by prospect theory) going from risk loving in the gain domain to risk aversion over losses (the bar in the front-left corner. Almost half appear to have risk preferences that are unchanged by the reflection of payoffs.

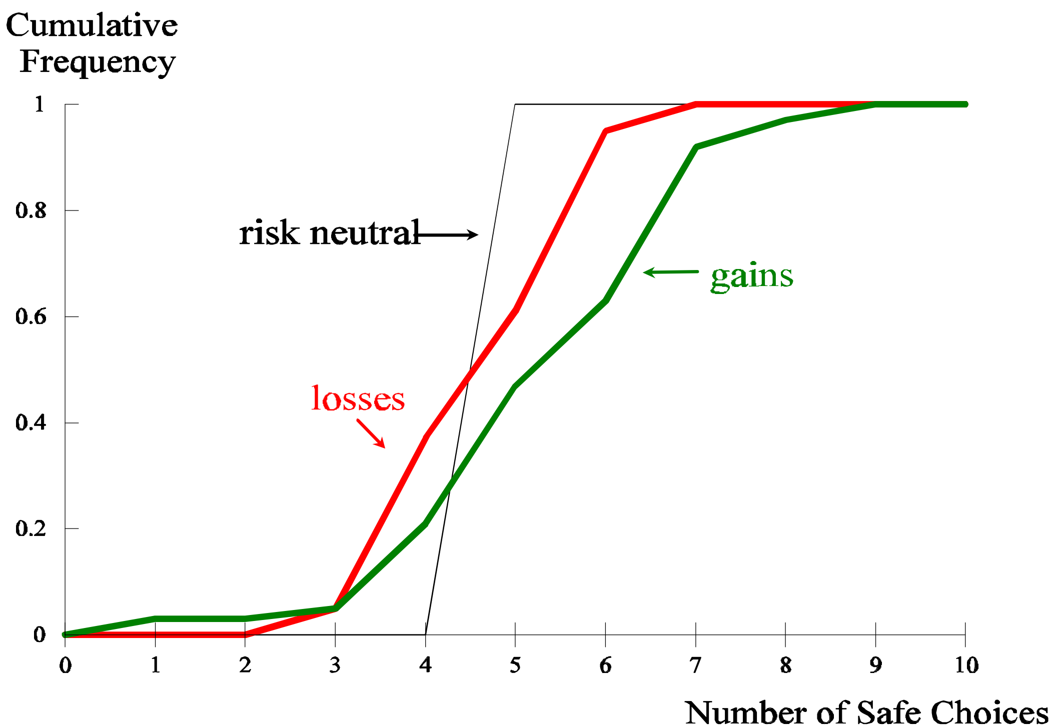

Figure 3. Cumulative Choice Frequencies for the Real Payoff Treatment

Even though the use of real incentives dramatically reduces the incidence of predicted reflections, it is nevertheless the case that there is some evidence that subjects in the real payoff treatment are less risk averse in the loss treatment. As can be seen from the top row of Table 3, a majority are risk averse, whereas less than half are risk averse in the loss treatment. These observations are apparent from Figure 3, which shows the cumulative choice frequencies for the number of safe choices (pooled over both treatment orders). The thin line shows the risk neutral prediction, which involves five safe choices and five risky choices. Therefore, for a risk neutral subject the cumulative probability of four or fewer safe choices is zero and the cumulative probability goes to one at five safe choices. The cumulative distribution for the gain treatment is generally below that of the loss treatment, indicating the tendency to make more safe choices in the gain domain. Based on a Kolmogorov-Smirnov test, this difference is significant at the 5-percent critical level (Chi-Square test statistic of 7.6, with two degrees of freedom).

IV. Conclusion

It is quite plausible that losses from a current reference-point wealth position may figure prominently in any decision calculus, but it is surprising that the leading alternative to expected utility theory has been justified largely on the basis of hypothetical-payoff experiments, especially since the original motivation for change was due to anomalies in the laboratory. When hypothetical payoffs are used, we do see a strong tendency for subjects to "reflect" from risk averse behavior over gains to risk seeking behavior over losses. This strong reflection effect is not observed when we use lotteries with modest money payoffs. Nevertheless, the incidence of risk aversion is reduced in the loss domain for the "normal" (low) payoffs used in this paper. While there is no clear support for a reflection effect in the experiments reported here, our previous research has shown that scaling up payoffs in the gain domain causes dramatic increases in risk aversion, and it seems reasonable to explore the effects of larger losses in subsequent work. Finally, we should note that our experiments are silent on another plausible aspect of prospect theory, "loss aversion," since all lotteries that we consider involve only gains or only losses.

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Instructions Appendix

The remaining part of today's experiment will consist of a series of choices given to you one at a time. Although each part will count toward your final earnings, you will not find out how much you have earned for any of these decisions until you have completed all of them. For one of these decision tasks, all payoffs are negative; for this decision, payoffs will be subtracted from your earnings in the other parts of today's experiment. For all of the other decision tasks, payoffs are positive and will be added to your earnings in the other parts of today's experiment.

Instructions (Gain Treatment)

Your decision sheet shows ten decisions listed on the left. Each decision is a paired choice between "Option A" and "Option B." You will make ten choices and record these in the final column, but only one of them will be used in the end to determine your earnings. Before you start making your ten choices, please let me explain how these choices will affect your earnings for this part of the experiment.

Here is a ten-sided die that will be used to determine payoffs; the faces are numbered from 1 to 10 (the "0" face of the die will serve as 10.) After you have made all of your choices, we will throw this die twice, once to select one of the ten decisions to be used, and a second time to determine what your payoff is for the option you chose, A or B, for the particular decision selected. Even though you will make ten decisions, only one of these will end up affecting your earnings, but you will not know in advance which decision will be used. Obviously, each decision has an equal chance of being used in the end.

Now, please look at Decision 1 at the top. Option A yields a sure gain of $3.20 (320 cents), and option B yeilds a sure gain of $0.20 (20 cents). Next look at Decision 2 in the second row. Option A yields $4.00 if the throw of the ten sided die is 1, and it yields $3.20 if the throw is 2-10. Option B yields $7.70 if the throw of the die is 1, and it yields $0.20 if the throw is 2-10. The other decisions are similar, except that as you move down the table, the chances of the better payoff for each option increase.

To summarize, you will make ten choices: for each decision row you will have to choose between Option A and Option B. You may choose A for some decision rows and B for other rows, and you may change your decisions and make them in any order. When you are finished, we will come to your desk and throw the ten-sided die to select which of the ten Decisions will be used. Then we will throw the die again to determine your payoff for the Option you chose for that Decision. Payoffs for this choice are positive and will be added to your previous earnings, and you will be paid the sum of all earnings in cash when we finish.

So now please look at the empty boxes on the right side of the record sheet. You will have to write a decision, A or B in each of these boxes, and then the die throw will determine which one is going to count. We will look at the decision that you made for the choice that counts, and circle it, before throwing the die again to determine your earnings for this part. Then you will write your earnings in the blank at the bottom of the page. Please note that these gains will be added to your previous earnings up to now.

Are there any questions? Now you may begin making your choices. Please do not talk with anyone while we are doing this; raise your hand if you have a question.

ID: _______

	Option A	Option B	Your Choice A or B
Decision 1	$3.20 if throw of die is 1-10	$0.20 if throw of die is 1-10	
Decision 2	$4.00 if throw of die is 1 $3.20 if throw of die is 2-10	$7.70 if throw of die is 1 $0.20 if throw of die is 2-10	
Decision 3	$4.00 if throw of die is 1-2 $3.20 if throw of die is 3-10	$7.70 if throw of die is 1-2 $0.20 if throw of die is 3-10	
Decision 4	$4.00 if throw of die is 1-3 $3.20 if throw of die is 4-10	$7.70 if throw of die is 1-3 $0.20 if throw of die is 4-10	
Decision 5	$4.00 if throw of die is 1-4 $3.20 if throw of die is 5-10	$7.70 if throw of die is 1-4 $0.20 if throw of die is 5-10	
Decision 6	$4.00 if throw of die is 1-5 $3.20 if throw of die is 6-10	$7.70 if throw of die is 1-5 $0.20 if throw of die is 6-10	
Decision 7	$4.00 if throw of die is 1-6 $3.20 if throw of die is 7-10	$7.70 if throw of die is 1-6 $0.20 if throw of die is 7-10	
Decision 8	$4.00 if throw of die is 1-7 $3.20 if throw of die is 8-10	$7.70 if throw of die is 1-7 $0.20 if throw of die is 8-10	
Decision 9	$4.00 if throw of die is 1-8 $3.20 if throw of die is 9-10	$7.70 if throw of die is 1-8 $0.20 if throw of die is 9-10	
Decision 10	$4.00 if throw of die is 1-9 $3.20 if the throw of die is 10	$7.70 if throw of die is 1-9 $0.20 if the throw of die is 10	

Decision used: ________, Die Throw: _____ Your earnings: _______

Instructions (Loss Treatment)

Your decision sheet shows ten decisions listed on the left. Each decision is a paired choice between "Option A" and "Option B." You will make ten choices and record these in the final column, but only one of them will be used in the end to determine your earnings. Before you start making your ten choices, please let me explain how these choices will affect your earnings for this part of the experiment.

Here is a ten-sided die that will be used to determine payoffs; the faces are numbered from 1 to 10 (the "0" face of the die will serve as 10.) After you have made all of your choices, we will throw this die twice, once to select one of the ten decisions to be used, and a second time to determine what your payoff is for the option you chose, A or B, for the particular decision selected. Even though you will make ten decisions, only one of these will end up affecting your earnings, but you will not know in advance which decision will be used. Obviously, each decision has an equal chance of being used in the end.

Now, please look at Decision 1 at the top. Option A yields a sure loss of −$3.20 (minus 320 cents), and option B yeilds a sure loss of −$0.20 (minus 20 cents). Next look at Decision 2 in the second row. Option A yields −$4.00 if the throw of the ten sided die is 1, and it yields −$3.20 if the throw is 2-10. Option B yields −$7.70 if the throw of the die is 1, and it yields −$0.20 if the throw is 2-10. The other decisions are similar, except that as you move down the table, the chances of the worse payoff for each option increase.

To summarize, you will make ten choices: for each decision row you will have to choose between Option A and Option B. You may choose A for some decision rows and B for other rows, and you may change your decisions and make them in any order. When you are finished, we will come to your desk and throw the ten-sided die to select which of the ten Decisions will be used. Then we will throw the die again to determine your payoff for the Option you chose for that Decision. Payoffs for this choice are negative and will be subtracted from your previous earnings, and you will be paid the sum of all earnings in cash when we finish.

So now please look at the empty boxes on the right side of the record sheet. You will have to write a decision, A or B in each of these boxes, and then the die throw will determine which one is going to count. We will look at the decision that you made for the choice that counts, and circle it, before throwing the die again to determine your earnings for this part. Then you will write your earnings in the blank at the bottom of the page. Please note that losses will be subtracted from your previous earnings up to now.

Are there any questions? Now you may begin making your choices. Please do not talk with anyone while we are doing this; raise your hand if you have a question.

ID: _______

	Option A	Option B	Your Choice A or B
Decision 1	−$3.20 if throw of die is 1-10	−$0.20 if throw of die is 1-10	
Decision 2	−$4.00 if throw of die is 1 −$3.20 if throw of die is 2-10	−$7.70 if throw of die is 1 −$0.20 if throw of die is 2-10	
Decision 3	−$4.00 if throw of die is 1-2 −$3.20 if throw of die is 3-10	−$7.70 if throw of die is 1-2 −$0.20 if throw of die is 3-10	
Decision 4	−$4.00 if throw of die is 1-3 −$3.20 if throw of die is 4-10	−$7.70 if throw of die is 1-3 −$0.20 if throw of die is 4-10	
Decision 5	−$4.00 if throw of die is 1-4 −$3.20 if throw of die is 5-10	−$7.70 if throw of die is 1-4 −$0.20 if throw of die is 5-10	
Decision 6	−$4.00 if throw of die is 1-5 −$3.20 if throw of die is 6-10	−$7.70 if throw of die is 1-5 −$0.20 if throw of die is 6-10	
Decision 7	−$4.00 if throw of die is 1-6 −$3.20 if throw of die is 7-10	−$7.70 if throw of die is 1-6 −$0.20 if throw of die is 7-10	
Decision 8	−$4.00 if throw of die is 1-7 −$3.20 if throw of die is 8-10	−$7.70 if throw of die is 1-7 −$0.20 if throw of die is 8-10	
Decision 9	−$4.00 if throw of die is 1-8 −$3.20 if throw of die is 9-10	−$7.70 if throw of die is 1-8 −$0.20 if throw of die is 9-10	
Decision 10	−$4.00 if throw of die is 1-9 −$3.20 if the throw of die is 10	−$7.70 if throw of die is 1-9 −$0.20 if the throw of die is 10	

Decision used: ________, Die Throw: _____ Your earnings: _______

Data Appendix

Session AH (hypothetical payoffs)

Subject	Initial Cumulative Earnings (show-up fee)	Choices for Gains: (second choice)	Choices for Losses: (first choice)
AH1	$45.00	SSSSSS/RRRR (risk averse)	RRRRRR/SSSS (risk loving)
AH2	$45.00	SSSSS/RRRRR (risk neutral)	RRRRRRRR/SS (risk loving)
AH3	$45.00	SSSSS/RRRRR (risk neutral)	R/SSSSSSSSS (risk averse)
AH4	$45.00	SSSS/RRRRRR (risk loving)	RRRRRR/SSSS (risk loving)
AH5	$45.00	SSSSSSS/RRR (risk averse)	RRRRRR/SSSS (risk loving)
AH6	$45.00	SSSS/RRRRRR (risk loving)	RRRRR/SSSSS (risk neutral)
AH7	$45.00	SSSSSS/RRRR (risk averse)	RRRRRR/SSSS (risk loving)
AH8	$45.00	SSSSSSS/RRR (risk averse)	RRRRRR/SSSS (risk loving)

Session BH (hypothetical payoffs)

Subject	Initial Cumulative Earnings (from public goods)	Choices for Gains: (first choice)	Choices for Losses: (second choice)
BH1	$45	SSSSSS/RRRR (risk averse)	RRRRRR/SSSS (risk loving)
BH2	$45	RSSSSS/SRRR (risk averse)	RRRRRR/SSSS (risk loving)
BH3	$45	SSSSSSS/RRR (risk averse)	RRRRR/SSSSS (risk neutral)
BH4	$45	SSSSSSSSS/R (risk averse)	RRRRRR/SSSS (risk loving)
BH5	$45	SSSSSSSSS/R (risk averse)	RRRR/SSSSSS (risk averse)
BH6	$45	SSSS/RRRRRR (risk loving)	RRRS/SRSSSS (risk averse)
BH7	$45	SSSSSR/SRRR (risk averse)	RRRRRR/SSSS (risk loving)
BH8	$45	SSSSSS/RRRR (risk averse)	RRRRRR/SSSS (risk loving)

Session CH (hypothetical payoffs)

Subject	Initial Cumulative Earnings (from public goods)	Choices for Gains: (second choice)	Choices for Losses: (first choice)
CH1	$45		
CH2	$45		
CH3	$45		
CH4	$45		
CH5	$45		
CH6	$45		
CH7	$45		
CH8	$45		
CH9	$45		
CH10	$45		

Session DH (hypothetical payoffs)

Subject	Initial Cumulative Earnings (from public goods)	Choices for Gains: (first choice)	Choices for Losses: (second choice)
DH1	$45		
DH2	$45		
DH3	$45		
DH4	$45		
DH5	$45		
DH6	$45		
DH7	$45		
DH8	$45		
DH9	$45		
DH10	$45		

Session A (real payoffs)

Subject	Initial Cumulative Earnings (from sequential search)	Choices for Gains: (second choice)	Choices for Losses: (first choice)
A1	$49.39	SSSS / RRRRRR (risk loving)	RRRR / SSSSSS (risk averse)
A2	$35.33	SSSSSS / RRRR (risk averse)	RRRR / SSSSSS (risk averse)
A3	$46.66	SSSR / SRRRRR (risk loving)	RRRRSR / RSSS (risk loving)
A4	$52.41	SSSRS / SRRRR (risk neutral/noisy)	RRSSR / RSRSS (risk neutral/noisy)
A5	$32.75	SSSR/ RSRRRR (risk loving)	RRRRRRR / SSS (risk loving)
A6	$41.42	SSSSSSS / RRR (risk averse)	RRRR / SSSSSS (risk averse)
A7	$38.55	SSSSSSS / RRR (risk averse)	RRRRRR / SSSS (risk loving)
A8	$64.02	SSSSSS / RRRR (risk averse)	RRRR / SSSSSS (risk averse)
A9	$45.54	SSSSS / RRRRR (risk neutral)	RRRR / SSSSSS (risk averse)

Session B (real payoffs)

Subject	Initial Cumulative Earnings (from sequential search)	Choices for Gains: (first choice)	Choices for Losses: (second choice)
B1	$50.96	SSSSSSS / RRR (risk averse)	RRRR / SSSSSS (risk averse)
B2	$39.20	SSSSSSSS / RR (risk averse)	RRR / SSSSSSS (risk averse)
B3	$46.80	R / RRSRRRRRR (risk loving)	RRRRRRR / SSS (risk loving)
B4	$62.55	SSSRS / SRRRR (risk neutral/noisy)	RRRS / RSSSSS (risk averse)
B5	$26.71	SSSSSSSS / RR (risk averse)	RRRRR / SSSSS (risk neutral)
B6	$39.65	SSSSSSS / RRR (risk averse)	RRRRRR / SSSS (risk loving)
B7	$46.75	SSSSSSS / RRR (risk averse)	RRRR / SSSSSS (risk averse)
B8	$58.01	SSSSSSS / RRR (risk averse)	RRRRRR / SSSS (risk loving)
B9	$38.16	SSSSSSS / RRR (risk averse)	RRRRR / SSSSS (risk neutral)

Session C (real payoffs)

Subject	Initial Cumulative Earnings (from public goods)	Choices for Gains: (second choice)	Choices for Losses: (first choice)
C1	$49.80	SSSSSSS / RRR (risk averse)	RRRR / SSSSSS (risk averse)
C2	$44.24	SSSSSSS / RRR (risk averse)	RRRR / SSSSSS (risk averse)
C3	$27.68	SSSSS / RRRRR (risk neutral)	RRRRR / SSSSS (risk neutral)
C4	$48.22	SSSSS / RRRRR (risk neutral)	RRRRRR / SSSS (risk loving)
C5	$31.04	SSSSSS / RRRR (risk averse)	RRRRR / SSSSS (risk neutral)
C6	$56.34	SSSSR / RSRRR (risk neutral)	RRRRRR / SSSS (risk loving)
C7	$58.58	SSSSSSS / RRR (risk averse)	RRRRR / SSSSS (risk neutral)
C8	$26.50	SSSSSS / RRRR (risk averse)	RRRRR / SSSSS (risk neutral)
C9	$30.94	SSSSS / RRRRR (risk neutral)	RRR / SSSSSSS (risk averse)
C10	$30.50	SSSSSSS / RRR (risk averse)	RRRRRR / SSSS (risk loving)

Session D (real payoffs)

Subject	Initial Cumulative Earnings (from public goods)	Choices for Gains: (first choice)	Choices for Losses: (second choice)
D1	$49.34	SSSS / RRRRRR (risk loving)	RRRRRR / SSSS (risk loving)
D2	$53.12	SSSSSSSSS / R (risk averse)	RRRR / SSSSSS (risk averse)
D3	$47.04	SSSSSS / RRRR (risk averse)	RRRRRR / SSSS (risk loving)
D4	$49.70	SSSSSS / RRRR (risk averse)	RRRRR / SSSSS (risk neutral)
D5	$47.98	SSSS / RRRRRR (risk loving)	RRRR / SSSSSS (risk averse)
D6	$46.76	SRS / RSRRRRR (risk loving/noisy)	RRRRR / SSSSS (risk neutral)
D7	$53.32	SSSS / RRRRRR (risk loving)	RRRR / SSSSSS (risk averse)
D8	$54.00	SSSSS / RRRRR (risk neutral)	RRRRRR / SSSS (risk loving)
D9	$47.96	SSSSS / RRRRR (risk neutral)	RRRRRR / SSSS (risk loving)
D10	$54.46	SSSSS / RRRRR (risk neutral)	RRRRRR / SSSS (risk loving)

Session E (real payoffs)

Subject	Initial Cumulative Earnings (from public goods)	Choices for Gains: (second choice)	Choices for Losses: (first choice)
E1	$	SSSS/RRRRRR (risk loving)	RRRRR/SSSSS (risk neutral)
E2	$	SSSSSS/RRRR (risk averse)	RRRR/SSSSSS (risk averse)
E3	$	SSSSSS/RRRR (risk averse)	RRRRR/SSSSS (risk neutral)
E4	$	SSSSS/RRRRR (risk neutral)	RRRRRR/SSSS (risk loving)
E5	$	SSSS/RRRRRR (risk loving)	RSR/SSRSSSS (risk averse)
E6	$	SSSSSSS/RRR (risk averse)	RRRR/SSSSSS (risk averse)
E7	$	SSSSSS/RRRR (risk averse)	RRRRRR/SSSS (risk loving)
E8	$	SSSSS/RRRRR (risk neutral)	RRRRR/SSSSS (risk neutral)

Session F (real payoffs)

Subject	Initial Cumulative Earnings (from public goods)	Choices for Gains: (first choice)	Choices for Losses: (second choice)
F1	$	SSSS/RRRRRR (risk loving)	RRRRRR/SSSS (risk loving)
F2	$	SSSRS/RSRRR (risk neutral)	RRRR/SSSSSS (risk averse)
F3	$	SSSSSSS/RRR (risk averse)	RRRRR/SSSSS (risk neutral)
F4	$	SSSSSSSR/RS (risk averse)	RRRRR/SSSSS (risk neutral)
F5	$	SSSSRS/RSRR (risk averse)	RRRRS/RSSSS (risk neutral)
F6	$	SSSSRSS/SRR (risk averse)	RRRR/SSSSSS (risk averse)
F7	$	SSSSSSS/RRR (risk averse)	RRRRR/SSSSS (risk neutral)
F8	$	SSSSS/RRRRR (risk neutral)	RRRRR/SSSSS (risk neutral)
F9	$	SSSSSSS/RRR (risk averse)	RRR/SSSSSSS (risk averse)
F10	$	SSSSSSS/RRR (risk averse)	RRR/SSSSSSS (risk averse)
F11	$	SSSSSSS/RRR (risk averse)	RRR/SSSSSSS (risk averse)
F12	$	SSSSSSS/RRR (risk averse)	RRRRR/SSSSS (risk neutral)

Session G (real payoffs)

Subject	Initial Cumulative Earnings (from public goods)	Choices for Gains: (second choice)	Choices for Losses: (first choice)
G1	$	SSSRRS/SSRR (risk averse)	RS/SSRSSSSS (risk averse)
G2	$	SSSSSSS/RRR (risk averse)	RRRRR/SSSSS (risk neutral)
G3	$	SSSS/RRRRRR (risk loving)	RRRRRRRR/SS (risk loving)
G4	$	SSSSSSS/RRR (risk averse)	RRR/SSSSSSS (risk averse)
G5	$	SSSSSS/RRRR (risk averse)	RRRR/SSSSSS (risk averse)
G6	$	SSSSSSSS/RR (risk averse)	RRR/SSSSSSS (risk averse)
G7	$	SSSSSS/RRRR (risk averse)	RRRRRR/SSSS (risk loving)
G8	$	SSSSS/RRRRR (risk neutral)	RRRR/SSSSSS (risk averse)

Session H (real payoffs)

Subject	Initial Cumulative Earnings (from public goods)	Choices for Gains: (first choice)	Choices for Losses: (second choice)
H1	$		
H2	$		
H3	$		
H4	$		
H5	$		
H6	$		
H7	$		
H8	$		
H9	$		
H10	$		

Demographic Appendix

In the table that follows, the subject number is on the left, and demographic data codes are:

(A) Age: What is your age?
(B) Gender: What is your gender? 1=male, 2=female
(C) Race: What is your racial or ethnic background? 1=white or caucasian, 2=black or African American, 3=hispanic, 4=aisan, 5=native American, 6=multiracial, 7=other.
(D) Raised: Please specify the state and country where you were raised.
(E) Marital Status: What is your marital status? 1=married, 2=single, 3=divorced/separated, 4=widowed.
(F) Employment: How would you best describe your current employment situation? 1=full-time employment outside of school, 2=part-time employment outside of school, 3=student only, 4=work at school / research assistantship, 5=other.
(G) Own Income: Your own income from all sources before taxes in 1999. Do not include income from other household members. 1=5,000 and under, 2=5,001-15,000, 3=15,001-30,000, 4=30,001-45,000, 5=45,001-60,000, 6=60,001-75,000, 7=75,001-90,000, 8=90,001-100,000, 9=over 100,001.
(H) Income Source: How do you receive your income? 1=fixed source (salary, pension), 2=hourly rate, 3=hourly rate plus tips, 4=loans/scholarships, 5=parents, 6=other.
(I) Student Status: What is your student status? 1=full-time student, 2=part-time student taking less than 12 hours per semester, 3=other, non-student.
(J) Major: What is your major? 1=(specify), 2=undecided, NA=not applicable.
(K) Year in School: What year are you classified for in the current semester? 1=freshman, 2=sophomore, 3=junior, 4=senior, 5=masters student, 6=law student, 7=doctoral student, 8=faculty or other non-student.
(L) Tuition Source: Who is primarily responsible for your tuition and living expenses while you are attending GSU? 1=self, 2=parent, 3=scholarship/grant, 4=loans, 5=combination/other, 6=not applicable.

Appendix: Demographic Data for Sessions A, B and C

Column Key: Age (A), gender (B), race (C), raised (D), marital (E), employment (F), own income (G), income source (H), student status (I), major (J), year in school (K), tuition source(L). See data codes on previous page.

Subject ID	A	B	C	D	E	F	G	H	I	J	K	L
A1	31	1	1	Russia	2	1	5	1	2	NA	8	7
A2	23	2	2	SC	2	2	3	2,4,5	1	BUS	4	6
A3	24	1	1	VA	2	5	3	1	2	MBA	8	1
A4	23	2	2	GA	2	4	2	2,4,5	1	PUB ADMN	5	6
A5	32	2	2	S. Africa	2	3	5	4	1	ECON	5	3
A6	23	2	1	Greece	2	4	1	2,4,5	1	LIT	5	3
A7	20	2	2	GA	2	2	2	2,4,5	1	COMP SCI	2	6
A8	19	1	2	GA	2	2	2	2,4,5	1	CIS	3	2
A9	41	2	6	NY	2	4	2	2,4	1	HEALTH ADM	5	1
B1	21	1	1	MA	2	3	2	2,5	1	BUS	2	2
B2	30	1	4	India	1	3	2	4	1	BUS	5	1
B3	20	1	2	IL	2	2	2	2,4,5	1	BUS	2	1
B4	31	1	6	GA	1	1	3	2	2	EXER SCI	3	1
B5	20	2	2	TX	2	3	1	2	1	2	2	2
B6	20	2	2	GA	2	3	1	2,4,5	1	2	2	1
B7	19	1	2	CA	2	2	2	2	1	CIS	3	1
B8	21	2	1	CT	2	2	2	6	1	BUS	3	2
B9	24	1	3	US	2	1	3	2	1	BUS	3	1
C1	27	2	1	Ukraine	2	4	2	2	3	BUS	8	1
C2	27	2	1	Russia	2	4	3	1,4	1	COMP SCI	7	1
C3	24	2	2	S. Africa	2	3	1	4	1	ECON	5	3
C4	23	2	4	U. Arab. Emer.	2	4	3	2,5	1	BIOLOGY	3	2
C5	18	2	2	GA	2	4	1	2,4,5	1	CRIM JUST	2	3
C6	26	1	3	Columbia	2	5	1	2,5	2	2	8	2
C7	23	1	1	Turkey	2	3	1	5	1	MBA	5	2
C8	20	2	2	Georgia	2	2	2	2,4	1	BUS	2	1
C9	20	1	1	Georgia	2	2	2	3	1	BUS	3	2
C10	25	2	4	China	1	3	3	2	1	CIS	5	1

Appendix: Demographic Data for Session D

Column Key: Age (A), gender (B), race (C), raised (D), marital (E), employment (F), own income (G), income source (H), student status (I), major (J), year in school (K), tuition source(L). See data codes on previous page.

Subject ID	A	B	C	D	E	F	G	H	I	J	K	L
D1	22	1	3	Peru	2	5	1	5	3	NA	9	6
D2	27	2	2	S. Africa	2	3	2	4	1	ECON	5	3
D3	19	1	2	Georgia	2	3	1	2	1	2	1	2
D4	19	2	2	Georgia	2	2	2	2,4,5	2	EDUC	1	2
D5	20	1	2	WA	2	3	2	4	1	BUS	3	3
D6	22	2	2	US	2	2	2	2	1	BUS	4	1
D7	22	2	2	Georgia	2	2	2	2,5	1	PSYCH	4	2
D8	20	1	2	Georgia	2	2	2	2	1	CIS	2	1
D9	30	1	2	France	2	2	3	4	1	RMI	7	3
D10	30	2	3	LA	2	3	3	1,4	1	CRIM JUST	4	4