VARIATIONS IN INDIVIDUAL DECISION MAKING: CHILDREN, ADULTS, AND ECONOMIC THEORY

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Abstract

This study examines differences in individual decision making between children and adults using a paired lottery choice experiment. A lottery choice experiment involves selecting between two options, one with a small difference in payoffs and one with a large difference in payoffs, for each of ten decisions with increasing probability of obtaining the higher payoff. Based on subject decisions, risk preferences can be inferred. Particular attention is given to age and gender differences. The main result reveals that children choose significantly fewer "safe" lotteries than adults on average. Specifically, children act as risk-seeking in low winning percentage lotteries. There is no significant difference in safe choices between genders in both samples. These findings can prove to be an important asset when developing policies to curb hazardous behavior in children.

Keywords: Lottery choice experiment, Risk preferences, Experimental economics, Individual decision making, Children's decision making

I. Introduction

The focus of this study is to use an economic lottery choice experiment to compare the risk attitudes of children to adults. Differentiating between the risk attitudes of children and adults is of particular interest in terms of encouraging them to engage in new activities (e.g. trying out for sports teams, music lessons, etc.) and from a policy standpoint in order to formulate effective strategies to curb potentially harmful risk-taking behavior of children (e.g. thrill-seeking, drug and alcohol use, etc.). Studying the decisions of children has been traditionally conducted in the fields of behavioral psychology and child psychology. Studies using simple games show that young children are capable of understanding the idea of risk and basing their judgments on both probability and the stakes.[1] Psychologists attribute the increasing use of probability to weigh decisions as age increases to the later development of the prefrontal cortex in the brain.[2]

This study differs from the psychology studies in terms of the motivation given to subjects to carefully weigh their decisions. The psychology studies traditionally rely on hypothetical surveys that may not induce the subjects to truthfully reveal their preferences. In this study, all subjects will be financially motivated to carefully weigh their decisions.

It is hypothesized in this research that, on average, children will act as more risk seeking than adults. A possible reason for the hypothesized risky decisions of children is that they do not understand or do not fear the consequences of their decisions. Adults, through their life experiences, have a greater understanding of the impact of their decisions. For example, if a child injures herself, she does not have to worry about missing work, paying bills, etc. Another possible explanation is that children like to play and learn from their experiences. What adults consider "risky" behavior may be the way a child learns the outcomes from her decisions.

The study continues with a literature review in section two, section three reviews the procedures of the experiment, section four analyzes the data, and section five offers concluding remarks.

II. Literature Review

The lottery-choice format in this study is taken from Holt and Laury (2002). Holt and Laury (2002) present subjects with paired choice lottery choices with probabilities of obtaining the higher payoff

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ranging from 0.1 to 1. Option A is considered the "safe" choice because of the small difference in lottery payoffs ($1.60 or $2.00), while Option B is considered the "risky" choice due to the large difference in lottery payoffs ($0.10 or $3.85). A subject's menu of lottery choices is inferred to obtain her risk preference based on a utility function consistent with constant relative risk aversion. Specifically, the switch over point from option A to option B gives an estimate of the subject's relative risk aversion coefficient. A subject acting as risk neutral would always choose the option with the highest expected payoff. For the menu of choices used in Holt and Laury (2002), a person acting as risk neutral would choose the "safe" option for probabilities of 10%–40% and then switch to the "risky" option for probabilities 50%–100%. A person acting as risk seeking would choose the safe option for probabilities 10% to less than 40% then switch to the risky option. A person acting as risk averse would choose the safe option for probabilities 10% to greater than 40% then switch to the risky option.

Results from Holt and Laury (2002) show that subjects significantly increase their level of risk aversion as lottery payoffs increase (by as much as a multiple of 90 above the stated payoffs). Further, this increase in risk aversion is not seen when the increased payoffs are purely hypothetical. This study raises issues in using hypothetical payoffs in experimental research.

The study that most closely relates to this research is Harbaugh, Krause, and Vesterlund (2002). Their study examines whether children (ages 5 to 20) and adults (ages 21 to 64) offer different choices under risk. Instead of using a lottery-choice format, Harbaugh et al. (2002) offer subjects a choice between a gamble and a certain outcome equal to the expected payoff of the gamble for various probabilities of winning the gamble (2%–98%).

Harbaugh et al. (2002) are interested in determining which participants choose the risky decision, whether these choices change with age, and whether participants tend to make choices that were in line with the four-fold pattern of risk attitudes that is consistent with the prospect theory model of risk preferences:

1. Risk-seeking over small-probability gains,
2. Risk-aversion over high-probability gains,
3. Risk-seeking over high-probability losses, and
4. Risk-aversion over small-probability losses.

When examining all of the participants over all gambles, participants pick the gamble 56% of the time, and are more likely to gamble over losses than over gains. On average, their results show that participants' are more risk seeking over losses than over gains. An example of risk seeking with losses would be choosing a gamble with the probability of losing many tokens being 70% and the probability of losing zero tokens being 30% versus a certain smaller loss. An example of risk seeking with gains would be choosing a gamble with the probability of gaining many tokens being 30% and the probability of gaining zero tokens being 70% versus a certain smaller gain.

When looking at the proportion of all participants choosing the gamble over its expected value by the probability of getting the payoff and whether the gamble is over a gain or a loss, a clear pattern emerges. Children's behavior over both losses and gains appear consistent with a tendency to underweight low-probability events (e.g. subject views a 10% chance of winning as 5%) and overweight high-probability ones (e.g. subject views an 80% chance of winning as 90%), the opposite of the four-fold pattern. In contrast, adult behavior followed the objective probabilities (i.e. adults were closer to acting as risk neutral according to expected utility theory). over both gains and losses.

Harbaugh et al. (2002) also test rationality. For a subject to be irrational, the subject would choose the certain option on one choice and choose the gamble when presented with another choice between an identical gamble and a higher certain option. Surprisingly, children acted irrationally only slightly more often than adults. Harbaugh et al. (2002) explain this phenomena as the result "that the accumulated experience evaluating risks, making decisions, and bearing the consequences of those decisions that accompanies age somehow moves peoples' risk preferences towards objective probability weighting" (p. 30). Results also show that the number of irrational choices declines when the payoffs increase showing that compensation does affect behavior.

III. Procedures

The lottery-choice procedures used in Holt and Laury (2002) are used to elicit risk preferences in this study. The payoffs for Option A were $16.00 and $12.00. The payoffs for Option B were $32.00 and $1.00. Option A is considered the "safe" choice while Option B is considered the "risky" choice (except in decision 10) because the difference in the payoffs is greater for Option B than Option A (see Appendix 1 for the decision sheet). Although the pay-outs do not change for each option, the probability of obtaining the higher payoff increases as one proceeds down the decision sheet. Since the probability of obtaining the high payoff in the first decision is 0.1, it is expected that choosing Option B indicates risk-seeking behavior. Since the probability of obtaining the high payoff in the tenth decision is 1, it is expected that all subjects will choose Option B due to the certainty of payoff. The decision sheet is designed so that a subject acting consistently with risk neutral behavior will select Option A for the first four decisions and Option B for the last six decisions.[3] Individuals who have one crossover from selecting Option A to Option B are considered to be following expected utility theory.

The experimental data was gathered in two sessions: the first in a sixth grade classroom (ages 11 and 12) at Centerville Elementary School in Lancaster, Pennsylvania and the second with randomly selected students (average age 21) at Millersville University in Millersville, Pennsylvania. There were 21 subjects comprising of males and females in each session.[4] Subjects were seated among their peers in a classroom.[5] Upon entry, the subject received a packet containing directions, a sample decision sheet and the actual decision sheet. To ensure that identical information was given to each set of subjects, a script was read aloud that reviewed the directions and completed a practice problem. The script for the sixth grade subjects as well as the script for the adult subjects can be found in appendices 2 and 3, respectively.[6]

After the script was read aloud, subjects were taken through an example. The example included the procedure for determining the chosen lottery and payment outcomes by using a decision sheet with different payoffs than the real decision sheet used in this study. The chances of obtaining each payoff however were the same as those on the actual decision sheet. After completing the example and all questions were satisfied, subjects completed the decision sheet.

Upon completion of the decision sheet, a ten sided die was rolled twice. The first die roll indicated the decision that would be used to determine compensation. The second die roll indicated the payoff. For example, suppose that the first die roll was a five and the second die roll was an eight. A five indicates that decision five would be used and an eight indicates the payoff of the chosen option. In this example, an eight for decision five yields $12.00 if Option A was selected and $1.00 if Option B was selected.

The payoff mechanisms differed for each session. Adult subjects were paid their earnings privately in cash. Sixth grade subjects were not paid their earnings upon the request of the Millersville University Institutional Review Board and the administration at the elementary school. Therefore, in order to create individual incentive for the sixth grade subjects, they would receive a pizza party if their collective earnings exceeded $250. If the sixth graders collectively earned less than the $250 threshold, they received free ice cream at lunch.[7] The $250 threshold was established by an estimated 25 sixth grade participants multiplied by the average earnings for a person acting risk neutral ($20) divided by two. The total earnings for the sixth grade subjects were $345.00, an average of $16.43 per subject. The average earnings for an adult subject was $26.05.

A debriefing was conducted at the elementary school to the entire sixth grade class. At the time this experiment was being conducted, the sixth grade at Centerville Elementary School was learning about scientific method. This experiment was presented to the sixth grade by going through the steps of the scientific method in terms that they were familiar with: identification of topic, review of literature, material, procedures, results, and conclusion. Students were taken through an example of the experiment during the procedures section and were notified of their collective earnings when reviewing the results.

IV. Analysis

The main hypotheses are that children will be more risk seeking than adults and males may be more risk seeking than females. Data are analyzed to see if any significant findings can be drawn from age and gender differences. The total number of safe choices (total number of times Option A was selected) is used as a crude measurement of a subject's risk preference with a higher total number of safe choices indicating greater levels of risk aversion. Tests are conducted comparing sixth grade subjects versus adults and gender effects within each sample using two sample tests and regression analysis. An attempt is also made to account for an interaction of a safe choice with the lottery-winning percentage through the linear probability model.

The data are summarized in Table 1. The first summary statistic examined is the mean, or average. The mean number of safe choices for sixth grade subjects is 4.57 while the mean number of safe choices for adult subjects is 5.76. On average, adults selected more "safe" choices than "risky" choices. The second summary statistic to analyze is the median, or center most point. The median for sixth grade subjects is 5 while the median for adult subjects is 6. The third summary statistic analyzed is standard deviation. The standard deviation for sixth grade subjects is 1.36 which is just slightly more than the standard deviation for adults of 1.34. The final summary statistics analyzed include the maximum number of safe choices and the minimum number of safe choices. For sixth grade subjects, the minimum number of safe choices selected by a subject is two compared to adult subjects with a minimum of three safe choices. For one sixth grade subject, the "risky" choice was selected for all but two decisions, behavior consistent with that of a risk seeker. The maximum number of safe choices for sixth grade subjects is seven compared to a maximum of nine safe choices for adult subjects. For one adult subject, the "safe" choice was selected for every decision except for the tenth decision where the higher payoff was certain showing extremely risk averse behavior.

Two sample t-tests and nonparametric Wilcoxon rank-sum tests were conducted to examine differences in average total safe lottery choices between children and adults. The first test showed that adults chose significantly more safe lotteries than four (t-test p-value of 0.0000113), but children did not (t-test p-value of 0.0694). Four is the number of safe lotteries that aligns with risk neutral preferences according to expected utility theory. On average, adults acted with behavior consistent with risk aversion to a greater degree than sixth grade subjects. The second test showed adults chose significantly more safe lotteries than children (t-test p-value of 0.012; Wilcoxon rank-sum test p-value of 0.010). Finally, both tests do not find a significant difference in the total number of safe choices between genders at the 10% significance level for each sample of ages.[8]

Figure one shows the relative frequency for each lottery winning percentage for sixth grade subjects, adult subjects, and risk neutrality. The figure shows that for a low lottery winning percentage, sixth grade subjects' behavior was dramatically more risk seeking than adult behavior. Adult behavior closely mimicked risk neutrality in their lotteries. For high lottery winning percentages, adult behavior again was closer to risk neutrality than sixth grade behavior, although these differences are not as pronounced as the low-winning percentage lotteries.

Regression Analysis

Two separate regressions were run to analyze the outcome of safe decisions. The first regression using Ordinary Least Squares has a dependent variable of the total number of safe decisions and independent variables of age (adult=1), gender (male=1), and if the decisions of a participant followed expected utility theory (subject made one switch from selecting Option A to selecting Option B). Results from the first regression can be found in Table 2.

Regression results show that being an adult is a significant factor in determining the total number of safe decisions because the adult variable has a p-value

TABLE 1.
Summary Statistics of Total Safe Lottery Choices

	Adult Full Sample	Adult Male	Adult Female	Sixth Grade Full Sample	Sixth Grade Male	Sixth Grade Female
Mean	5.762	6	5.444	4.571	4.556	4.583
Median	6	6	6	5	4	5
Mode	6	6	6	5	4	5
Standard Deviation	1.338	1.537	1.014	1.363	1.014	1.621
Range	6	6	3	5	3	5
Maximum	3	3	4	2	3	2
Minimum	9	9	7	7	6	7
n	21	12	9	21	9	12

of 0.035. Adults choose 1.13 more safe lotteries than children on average. Results show that gender and whether or not expected utility theory is followed are not significant factors in determining the total number of safe decisions, as they have p-values of 0.588 and 0.946, respectively. These regression results support the two-sample test results.

The second regression attempts to confirm the findings in Figure 1, relating the probability of choosing the safe lottery to the subject's gender (male=1), age (adult=1), and lottery winning percentage. A logit regression with a binary dependent variable of lottery choice (safe=1) is used. Since each subject made ten lottery choices, these observations are not independent. To account for the dependency across observations, the standard errors are clustered by subject.[9] For the logit regression to be consistent with Figure 1, the coefficient on the lottery winning-percentage is expected to be negative, because Figure 1 shows the average number of safe lottery choices decreasing as the lottery winning-percentage increases. The coefficient on the interaction term is expected to be negative. A negative interaction coefficient suggests that, as the winning-percentage increases, adults are less likely than children to choose the safe lottery. Finally, due to the lower percentage of children choosing the safe lottery in low-winning percentages, the coefficient on adults is expected to be positive.

TABLE 2.
OLS Estimates of Total Safe Lottery Choices

	Coefficient	Robust Standard Error	t-Stat	P-value
Constant	4.448	0.379	11.74	0.000
Adult	1.134	0.517	2.19	0.035
Male	0.254	0.465	0.55	0.588
EUT	0.039	0.571	0.07	0.946

n = 42
Y = Number of Safe Choices
$R^2 = 0.178$

Results from this regression can be found in Table 3.

All coefficients match their expected signs and are significant. To further explain how the independent variables influence the probability of choosing the safe lottery, Figure 2 displays 95% confidence bands of the regression's predicted probability of choosing the safe lottery for different values of the independent variables. The confidence intervals do not overlap for the 10%-50% winning percentage lotteries, indicating that

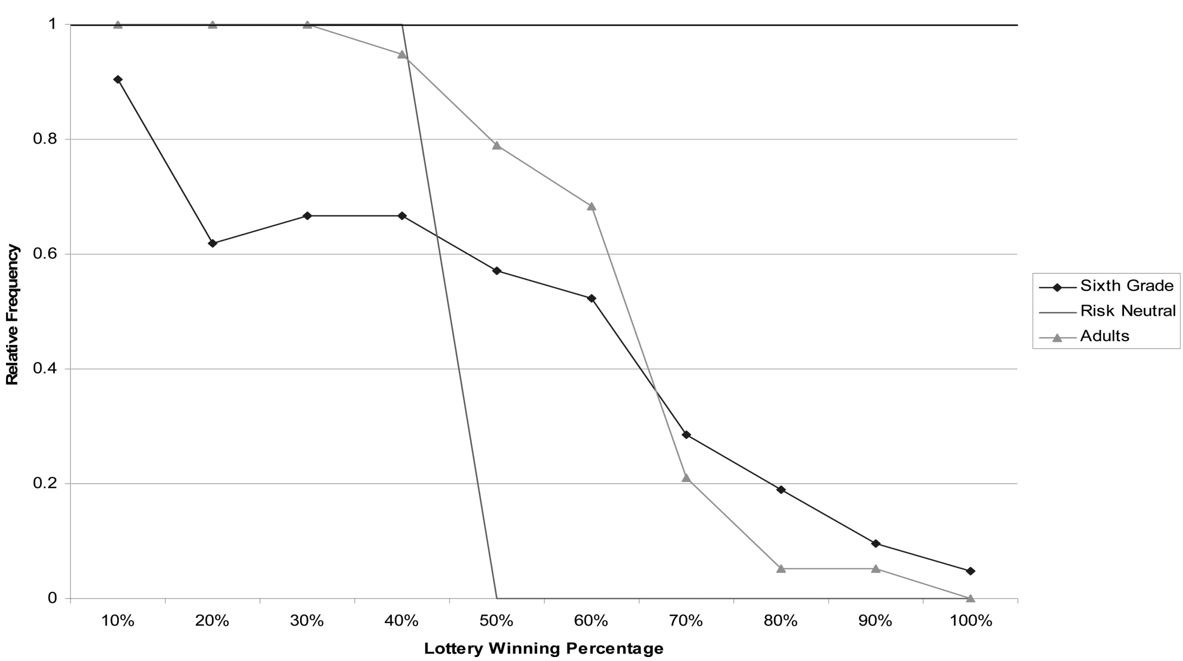

FIGURE 1. Percentage of Safe Lottery Choices.

children are significantly less likely than adults to choose the safe lottery for these winning percentages. The confidence bands overlap for the remaining lottery winning percentages. The confidence bands support the observation from Figure 1, suggesting that adults are less likely to deviate from the risk neutral pattern of lottery-choices.

TABLE 3.
Clustered Logit Regression Estimates of the Probability of Choosing the Safe Lottery

	Coefficient	Clustered-Robust Standard Error	t-Stat	P-value
Constant	2.221	0.509	4.36	0.000
Adult	5.172	1.590	3.25	0.001
Win %	−4.470	0.847	−5.28	0.000
Adult*Win %	−7.511	2.544	−2.95	0.003

n = 420
Y = Safe Choice
$R^2 = 0.416$
p = 0.000

V. Conclusions

This study examines individual decision making between children and adults using a lottery choice experiment. A lottery choice experiment involves selecting between two options, one with a small difference in payoffs and one with a large difference in payoffs, for each of ten decisions with increasing probability of obtaining the higher payoff. Based on subject decisions, risk preferences can be inferred. Particular attention focuses on age and gender differences. The two main hypotheses are children will act as if more risk seeking than adults and males will act as if more risk seeking than females. The main result reveals that children choose significantly fewer "safe" lotteries than adults on average. Specifically, children are more likely to act as risk seekers in low winning percentage lotteries. Also, there were no gender differences in the choices for both sets of subjects. To contrast with these results, Harbaugh et al. (2002) found that children were more likely than adults to choose the safe option in low winning percentage lotteries and

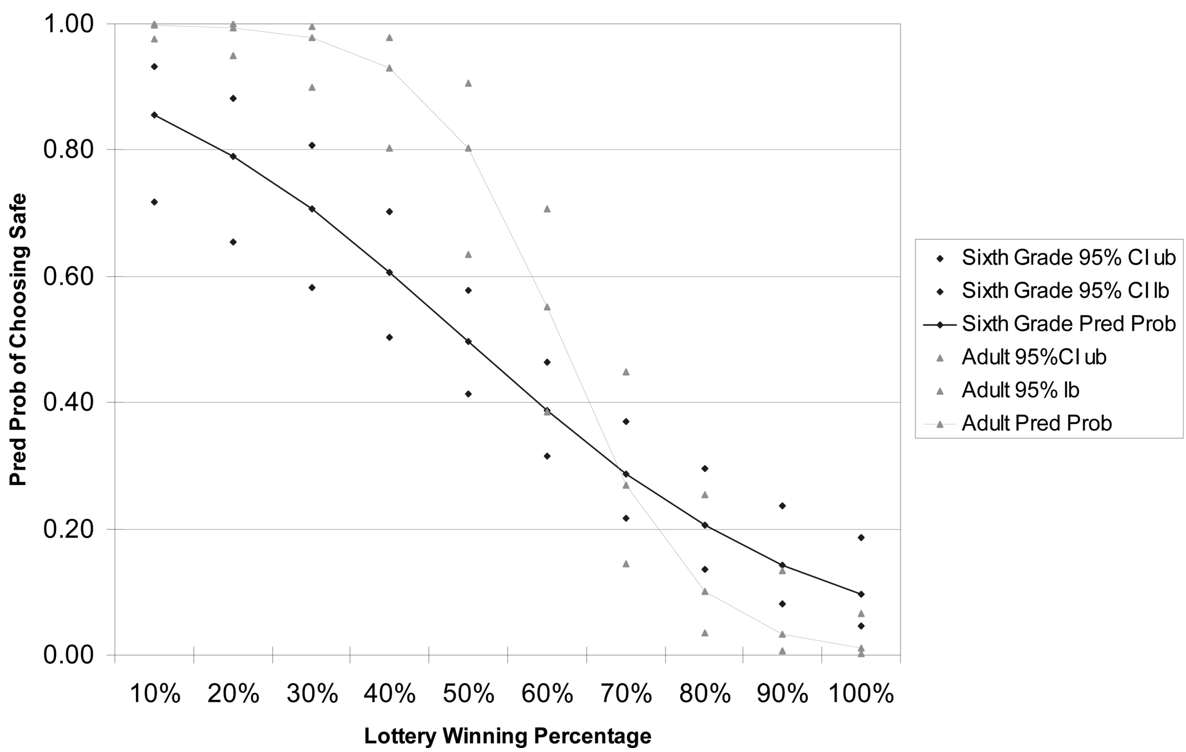

FIGURE 2. Probabilty of Choosing the Safe Lottery.

less likely than adults to choose the safe option in high winning percentage lotteries.

As noted in endnote 8, a significant number of child subjects exhibited decisions not consistent with expected utility theory. If these decisions are removed from the sample, all significance in results reported in the previous section is lost. While previous research has noted that the decisions of some child subjects fail a rationality test (e.g. Levin et al. (2007), Harbaugh et al. (2002)), the number of inconsistent choices offered by child subjects in this research is greater than that reported in previous research. The incentive structure used in this experiment (a necessary condition to gain Institutional Review Board approval to conduct the research) may have contributed to the results of this study in a number of ways. First, the children could have placed a higher value than adults on the amount of money at stake on the decision sheet. If this is the case, then Holt and Laury (2002) suggest the safe choices among children would have been greater than adults. This study found the opposite. However, since the children were paid collectively at a later date while the adults received their cash payment immediately, the incentive structure may not have enough to provide a salient experiment for the children. Holt and Laury (2002) show that safe choices decrease in hypothetical compared to actual payments.

Another explanation of the experimental results that cannot be ignored is that children exhibit a playfulness lacking in adults and learn through the trial and error of their experiences. With the (perhaps) low incentives given to children to carefully weigh their decisions, children may have "experimented" by choosing the risky option in low probability lotteries just to learn from the experience. What is measured as risky behavior according to expected utility may be an attempt by children to judge future decisions from the outcome of their lottery-choice decision. In this sense, it could be possible for adults to learn from children and learn more through experience rather than being afraid to take chances.

Appendix 1

Actual Decision Sheet

Gender (circle one): M F

Age ________

	Option A	Option B	Your Choice A or B
Decision 1	\$16.00 if throw of die is 1 \$12.00 if throw of die is 2–10	\$32.00 if throw of die is 1 \$1.00 if throw of die is 2–10	
Decision 2	\$16.00 if throw of die is 1–2 \$16.00 if throw of die is 3–10	\$32.00 if throw of die is 1–2 \$1.00 if throw of die is 3–10	
Decision 3	\$16.00 if throw of die is 1–3 \$12.00 if throw of die is 4–10	\$32.00 if throw of die is 1–3 \$1.00 if throw of die is 4–10	
Decision 4	\$16.00 if throw of die is 1–4 \$12.00 if throw of die is 5–10	\$32.00 if throw of die is 1–4 \$1.00 if throw of die is 5–10	
Decision 5	\$16.00 if throw of die is 1–5 \$12.00 if throw of die is 6–10	\$32.00 if throw of die is 1–5 \$1.00 if throw of die is 6–10	
Decision 6	\$16.00 if throw of die is 1–6 \$12.00 if throw of die is 7–10	\$32.00 if throw of die is 1–6 \$1.00 if throw of die is 7–10	
Decision 7	\$16.00 if throw of die is 1–7 \$12.00 if throw of die is 8–10	\$32.00 if throw of die is 1–7 \$1.00 if throw of die is 8–10	
Decision 8	\$16.00 if throw of die is 1–8 \$12.00 if throw of die is 9–10	\$32.00 if throw of die is 1–8 \$1.00 if throw of die is 9–10	
Decision 9	\$16.00 if throw of die is 1–9 \$12.00 if throw of die is 10	\$32.00 if throw of die is 1–9 \$1.00 if throw of die is 10	
Decision 10	\$16.00 if throw of die is 1–10	\$32.00 if throw of die is 1–10	

Decision used:_______ Die Throw: ________ Your earnngs:______

Appendix 2

Sixth Grade Script

Students are seated in a classroom type setting. Each student will receive a packet containing directions, an example paper, and a decision sheet.

We are going to do an experiment. It will take about 30 minutes. You will choose between two options for ten different problems. Based on your answers, you will earn money towards a sixth grade class prize. You personally will not earn cash, but you will receive a prize. You and your classmates will receive free ice cream at lunch for participating. However, if you and your classmates earn more than $250 collectively, you will have an entire sixth grade class pizza party so it is important that you choose your decisions wisely.

How much you are able to earn for your class depends on your choices. Pay attention, because the better you understand things, the better your chance to get the pizza party. There are no right or wrong answers so please do not consult your neighbor for help. In front of you are a set of directions. Please read them to yourself as I read them out loud to you.

The sheet of paper in front of you shows ten decisions. *Hold up the decision sheet.* Each decision is a choice between "Option A" and "Option B." You will make ten choices by placing an "A" or "B" in the "Your choice" box on the right. *Point to the "your choice" box.* Only one choice will be used in the end to determine your earnings for the class activity. Remember, the more you are able to earn, the more your class earns, and the more your class earns, the greater your chances of having a pizza party.

Here is a ten-sided die that will be used to determine earnings; the sides are numbered from 0 to 9. *Hold up die.* We are going to use the 0 as 10. After you have made all ten decisions, I will throw the die twice. The first role will select which one of the ten decisions will be used, and the second roll to determine what your individual earnings are for the option you choose. Even though you will make ten decisions, only one of the decisions will be used to determine your earnings. Obviously, each decision has an equal chance of being used since we are rolling the dice at random.

Lets do a few examples together. Look at your example decision sheet. *Hold up a copy of the example sheet.* For Decision 1, would you prefer to have a 1 in 10 chance of getting $4.00 and a 9 in 10 chance of getting $3.00 or would you prefer to have a 1 in 10 chance of getting $8.00 and a 9 in 10 chance of getting $0.25. In option A, you cannot get less than $3.00 whereas in option B, you could only get $0.25. However, in option A, the maximum amount you could receive is $4.00 whereas in option B, you could get $8.00. Put an "A" or "B" in the "your choice" box at the far right depending on which option you prefer.

After you do this for each of the ten decisions, I will roll a ten sided die. The number that comes up is the decision that will be used to determine your class's earnings. For example, if a 5 is rolled, then we will look at decision number 5. *Point to decision 5.* I will then collect your papers. Dr. Baker will then go out into the hall and roll the dice for each of your papers. The number that comes up will determine how much you earned for the class activity. So say for decision number 5 you selected option A. Dr. Baker will roll the dice. He rolls a seven. A seven for option A in decision five yields $16.00. *Point to where to shows $16.00 for this decision.* You have just earned $16.00 towards the class activity.

Lets go through another example. For Decision 2, would you prefer to have a 2 in 10 chance of getting $4.00 and an 8 in 10 chance of getting $3.00 or would you prefer to have a 2 in 10 chance of getting $8.00 and a 8 in 10 chance of getting $0.25. Once again, in option A, you cannot get less than $3.00 whereas in option B, you could only get $0.25. However, in option A, the maximum amount you could receive is $4.00 whereas in option B, you could get $8.00. The difference for decision two is your odds of getting each payoff. In decision two, you have a greater chance of getting the higher payoff than in decision one. But is this a greater enough chance? Put an "A" or "B" in the "your choice" box at the far right depending on which option you prefer.

After you do this for each of the ten decisions, I will roll a ten sided die. The number that comes up is the decision that will be used to determine your class's earnings. For example, if a 2 is rolled, then we will look at decision number 2. I will then collect your papers. Dr. Baker will then go out into the hall and roll the dice for each of your papers. The number that comes up will determine how much you earned for the class activity. So say for decision number 2 you selected option B. Dr. Baker will roll the dice. He rolls a ten. A ten for option B in decision two yields $1.00. You have just earned $1.00 towards the class activity.

Now, please look at your decision sheet. Option A pays $16 if the throw of the die is 1, and it pays

$12 if the throw is 2–10. Option B pays $32 if the throw of the die is 1, and it pays $1 if the throw is 2–10. The other decisions are similar.

After you have made all 10 choices, please turn your paper over. After everyone is finished, we will throw the ten-sided die once to select which one of the ten decisions will be used. I will then collect your papers. Dr. Baker will throw the die a second time to determine your money earnings for the Option you chose for that decision. Earnings will go toward either free ice cream at lunch or a pizza party.

Please keep in mind that there are no right or wrong answers. Remember that your answers are YOUR choices so please do not look at your neighbor's paper. The amount of money you can earn for each decision does not change, but your chances of earning that money change with each decision. Remember each decision has an equal chance of being selected. You will have as much time as you need.

Are there any questions?

Appendix 3

Adult Script

Students are seated in a classroom type setting. Each student will receive a packet containing directions, an example paper, and a decision sheet.

We are going to do an exercise. It will take about 30 minutes. You will choose between two options for ten different decisions. Based on your answers, you will earn money.

How much you are able to earn depends on your choices. Pay attention, because the better you understand things, the better your chance to get more money. There are no right or wrong answers so please do not consult your neighbor for help. We are now going to go over the instructions and an example. Please refer to your instructions sheet if needed.

Please look at the example decision sheet. It shows ten decisions. *Hold up the example decision sheet.* Each decision is a choice between "Option A" and "Option B." You will make ten choices by placing an "A" or "B" in the "Your choice" box on the right. *Point to the "your choice" box.* Even though you will make ten decisions, only one of the decisions will be used to determine your earnings. Since the decision is chosen at random, it is best to treat each decision as the chosen one, so think carefully about your choice for each decision.

Here is a ten-sided die that will be used to determine earnings; the sides are numbered from 0 to 9. *Hold up die.* We are going to use the 0 as 10. After you have made all ten decisions, I will throw the die twice. The first role will select which one of the ten decisions will be used. The second roll determines the payoff for the option you choose.

Lets do an example together. Look at your example decision sheet. (note: the example decision sheet contains different payoffs than the real decision sheet). In Decisions 1, the payoffs for Option A are $5 if the die roll is 1–9 or $6 if the die roll is 10. The payoffs for Option B are $1 if the die roll is 1–9 or $9 if the die roll is 10. Put an "A" or "B" in the "your choice" box at the far right to make your decisions. Notice, the payoffs for each decision remain the same, but the opportunity of receiving the payoff changes for each decision.

After you do this for each of the ten decisions, you will go out into the hall. I will roll a ten sided die. The number that comes up is the decision that will be used to determine your earnings. *Roll die on student's desk, ask for verification of number.* So, (number rolled) is the decision to be used. I will then roll the dice again. The number that comes up will determine the payoff you receive. *Roll die again on different student's desk. Ask for verification.* Since this roll was (number rolled), you would earn ___ if you chose Option A and you would earn ___ if you chose Option B.

Please keep in mind that there are no right or wrong answers. Remember that your answers are YOUR choices so please do not look at your neighbor's paper.

To summarize, you will make ten individual choices: for each decision you will choose between Option A and Option B. You may choose A for some decisions and B for others, and you may change choices and make them in any way you choose. You make a choice by writing clearly "A" or "B" in the "Your Choice" box to the right of each decision. After you have made all ten choices, please alert the experimenter. You will be instructed to go out into the hall. One die roll will determine which decision will be used. A second die roll will determine your earnings. You will be paid in cash and sign a receipt.

Are there any questions?

Look at the real decision sheet. Please be sure to fill in your gender and age.

Appendix 4

EXAMPLE Decision Sheet

	Option A	Option B	Your Choice A or B
Decision 1	$6.00 if throw of die is 1 $5.00 if throw of die is 2–10	$9.00 if throw of die is 1 $1.00 if throw of die is 2–10	
Decision 2	$6.00 if throw of die is 1–2 $5.00 if throw of die is 3–10	$9.00 if throw of die is 1–2 $1.00 if throw of die is 3–10	
Decision 3	$6.00 if throw of die is 1–3 $5.00 if throw of die is 4–10	$9.00 if throw of die is 1–3 $1.00 if throw of die is 4–10	
Decision 4	$6.00 if throw of die is 1–4 $5.00 if throw of die is 5–10	$9.00 if throw of die is 1–4 $1.00 if throw of die is 5–10	
Decision 5	$6.00 if throw of die is 1–5 $5.00 if throw of die is 6–10	$9.00 if throw of die is 1–5 $1.00 if throw of die is 6–10	
Decision 6	$6.00 if throw of die is 1–6 $5.00 if throw of die is 7–10	$9.00 if throw of die is 1–6 $1.00 if throw of die is 7–10	
Decision 7	$6.00 if throw of die is 1–7 $5.00 if throw of die is 8–10	$9.00 if throw of die is 1–7 $1.00 if throw of die is 8–10	
Decision 8	$6.00 if throw of die is 1–8 $5.00 if throw of die is 9–10	$9.00 if throw of die is 1–8 $1.00 if throw of die is 9–10	
Decision 9	$6.00 if throw of die is 1–9 $5.00 if throw of die is 10	$9.00 if throw of die is 1–9 $1.00 if throw of die is 10	
Decision 10	$6.00 if throw of die is 1–10	$9.00 if throw of die is 1–10	

Appendix 5

Raw Data

Sixth Grade

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
C-1	1	1	1	1	1	1	1	0	0	0	**7**
C-2	1	0	0	1	0	0	0	0	0	0	**2**
C-3	1	0	0	1	0	1	1	0	0	1	**5**
C-4	1	1	0	1	1	0	1	0	0	0	**5**
C-5	1	0	1	0	1	1	0	1	0	0	**5**
C-6	1	0	0	0	0	1	1	0	1	0	**4**
C-7	0	1	1	0	1	0	1	0	0	0	**4**
C-8	1	1	1	0	1	0	0	0	0	0	**4**
C-9	1	1	1	1	1	1	0	0	0	0	**6**
C-10	1	0	1	0	0	1	0	1	0	0	**4**
C-11	1	0	0	1	1	1	0	1	0	0	**5**
C-12	1	1	1	1	1	1	0	0	0	0	**6**
C-13	1	1	1	1	0	0	0	0	0	0	**4**
C-14	1	1	1	1	1	0	0	0	0	0	**5**
C-15	1	0	1	1	0	0	0	0	0	0	**3**
C-16	1	1	1	1	1	1	1	0	0	0	**7**
C-17	1	1	1	1	1	1	0	0	0	0	**6**
C-18	1	1	0	1	0	0	0	0	0	0	**3**
C-19	0	0	1	0	1	0	0	0	1	0	**3**
C-20	1	1	0	1	0	1	0	1	0	0	**5**
C-21	1	1	1	0	0	0	0	0	0	0	**3**
Total	**19**	**13**	**14**	**14**	**12**	**11**	**6**	**4**	**2**	**1**	**96**
Average	0.90	0.62	0.67	0.67	0.57	0.52	0.29	0.19	0.10	0.05	4.57

Appendix 6

Raw Data

Adults

	1	2	3	4	5	6	7	8	9	10	Total
M-1	1	1	1	1	1	1	1	0	0	0	**7**
M-2	1	1	1	1	1	1	1	0	0	0	**7**
M-3	1	1	1	1	0	0	0	0	0	0	**4**
M-4	1	1	1	1	1	1	0	0	0	0	**6**
M-5	1	1	1	1	1	0	1	0	1	0	**7**
M-6	1	1	0	0	1	1	0	1	0	0	**5**
M-7	1	1	1	1	1	1	1	1	1	0	**9**
M-8	1	1	1	0	0	0	0	0	0	0	**3**
M-9	1	1	1	1	1	0	0	0	0	0	**5**
M-10	1	1	1	1	1	1	0	0	0	0	**6**
M-11	1	1	1	1	1	1	0	0	0	0	**6**
M-12	1	1	1	1	0	0	0	0	0	0	**4**
M-13	1	1	1	1	1	1	0	0	0	0	**6**
M-14	1	1	1	1	1	1	0	0	0	0	**6**
M-15	1	1	1	1	0	0	0	0	0	0	**4**
M-16	1	1	1	1	1	0	0	0	0	0	**5**
M-17	1	1	1	1	1	1	0	0	0	0	**6**
M-18	1	1	1	1	1	1	0	0	0	0	**6**
M-19	1	1	1	1	1	1	0	0	0	0	**6**
M-20	1	1	1	1	1	1	1	0	0	0	**7**
M-21	1	1	1	1	1	1	0	0	0	0	**6**
Total	**21**	**21**	**20**	**19**	**17**	**14**	**5**	**2**	**2**	**0**	**121**
Average	1.00	1.00	0.95	0.90	0.81	0.67	0.24	0.10	0.10	0.00	5.67

Notes

1. Specifically, Reyna and Ellis (1994) showed that young children (age 4) did not use levels of risk to guide their decisions, while older children (age 11) did choose a gamble less frequently as its riskiness increased. Further, the choices of older children were more susceptible to framing issues (gains vs. losses), while this effect was not present in young children. Schlottmann (2001) showed that children (ages 6 and 9) were able to use expected values to guide their decision making for risky choices. In contrast to Schlottmann, Levin et al. (2007) show that younger children (ages 5–7) are not sensitive to expected value changes in their decision making, and both younger and older children (ages 8–11) made more risky decisions than adults when it was disadvantageous to do so.
2. Levin et al. (2007) contains a nice summary of the neuropsychology literature explaining brain development related to adaptive decision making.
3. A person acting as risk neutral would choose the option with the greatest expected value. In this experiment, Option A has the greater expected value for decisions 1–4 and Option B has the greater expected value for decisions 5–10.
4. Of course the strength of the experimental results would increase with an increase in sample. However, it was not feasible for this study due to limited funding. The sample sizes are in line with other economics experimental research. Additionally, it would be useful to test individuals older than 21 for the adult group to see if the results hold across older age groups. Harbaugh et al. (2002) do find that college students and older adults have the

same qualitative pattern of choices over risk, but age is a significant factor in estimating a subject's probability in choosing a gamble over a safe outcome.

5. Peer pressure was not considered to play a role in this experiment as subjects simultaneously completed their own decision sheet at their own seat without the interference of anyone. Further, subjects knew their decisions would not be made public to any of their peers.
6. Please note the scripts are similar except for the discussion regarding compensation.
7. This incentive structure presents a number of issues that perhaps influence the results. First, the amounts used in the decision sheet were chosen to give the adults enough incentive to carefully weigh their decisions. Since the amounts were identical for the children experiment, the children could view the payments as significantly higher than the adults. Second, although previous research (e.g. Murnghan and Saxon (1998)) has used collective payoffs, this nature of the incentive scheme may not have been enough to induce saliency in the children's experiment. Finally, it was assumed that the children preferred a pizza party to ice cream. If a child preferred ice cream to the pizza party, then he/she would not try to maximize earnings.
8. It must be noted that the choices of the majority of child subjects (13 of 21) exhibited multiple switch points between safe and risky lotteries. The choices of almost all adult subjects (20 of 21) did not exhibit multiple switch points. Choices exhibiting multiple switch points between safe and risky lotteries are not consistent with expected utility theory. The significance of all results reported in this section is removed when only the decisions consistent with expected utility theory are used.
9. For a detailed discussion of the heteroskedasticity-robust Huber/White sandwich estimator of variance in clustered samples see, for example, Cameron and Trivedi (2005, Chapter 21, Section 21.2.3). The specific implementation utilized here is documented in Rogers (1993).

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