Effects of exposition and explanation on decision making

Brown University Economics: Honors Thesis

Rohan Thakur
Advisor: Professor Louis Putterman
# Contents

Acknowledgements .................................................................................................................. 3
Introduction .................................................................................................................................. 4
Aim ............................................................................................................................................... 7
Violations of Rationality .............................................................................................................. 11
Literature review ......................................................................................................................... 18
Experimental Design ................................................................................................................... 26
Data analysis ................................................................................................................................. 39
Discussion of results .................................................................................................................... 47
Conclusion .................................................................................................................................... 53
References ...................................................................................................................................... 55
Tables and figures ......................................................................................................................... 57
Appendix IA ................................................................................................................................... 67
Appendix IB ................................................................................................................................... 73
Appendix IIA ................................................................................................................................ 79
Appendix IIB ................................................................................................................................ 85
Appendix IIIA ............................................................................................................................... 91
Appendix IIIB ............................................................................................................................... 98
Appendix IV A ................................................................................................................................ 105
Appendix IVB ................................................................................................................................ 111
ACKNOWLEDGEMENTS

I would first like to thank my thesis advisor, Professor Louis Puttermann for all his help and patience, without which this thesis would not have been possible. I would also like to thank Professor Dror Brenner for his valuable input. I would like to acknowledge my fellow undergraduates Lucas Husted, and Lloyd Rajoo, with whom I worked on my final project for the Behavioral Economics course in Spring 2012, from which the idea for this thesis was born. I would also like to thank Professor Mark Dean for teaching that course. I would like to thank the Brown University Dean’s Office for helping me fund this project. Finally, I would like to thank all those who took the time out to participate in my experiments. I am grateful to you all.
**INTRODUCTION:**
Simple and complex violations of rationality exist all around us. There have been many experiments that have been done to explore these violations, but little work has been done to test the robustness of these errors. Are errors in economic rationality due to confusion or preferences? I propose an experiment that would test three effects using the same multi-step process to see if simple violations in rationality can be “corrected.” The errors to be tested have different levels of complexity, from simple errors in logic like the “sunk-cost bias” to more pervasive and subconscious errors like “framing effect.” Specifically the effects to be tested are: the sunk-cost bias, the framing effect, and ambiguity aversion.

The experimental design used to test for each of the above biases resembles previously performed experiments that showcase these violations of rationality. Subjects were tested for all three biases, having been placed in one of four treatment groups. Each of these groups consisted of fifteen subjects. The first group was the control group in which subjects were simply tested for the three biases. The second group was the exposition group. In this group, before making their choices, subjects had to write a paragraph explaining the decision problem, thereby forcing them to exert a certain level of mental energy thinking about the problem. The third group was the multiple explanation group. Subjects in this group were provided with a spread of explanations (three correct and three incorrect), obtained from the exposition group, before they made their decisions. The fourth group was given the experimenters’ explanation, i.e. only a correct explanation of how to reach

---

1 Behavioral economists usually use “framing effects” to describe a variety of effects arising from framing. This paper will deal with a particular kind of framing problem which will be referred to as “the framing effect” throughout this paper. The exact explanation of this framing problem will follow in the next section.
the right (normatively optimal) decision. All explanations were provided to the subjects before they make their decisions, in order to provide a "nudge"[13].

Moves in the normative direction in the exposition stage indicate that participants perhaps were “lazy” and did not truly think about the question. Kahneman described this as the “lazy controller” in his book Thinking Fast and Slow [3]. Exposition forces participants to exert more mental effort. Moves in the normative direction with given normative and non-normative rationales indicates that subjects were earlier confused, but have the ability to pick out a correct explanation with relation to the effect under scrutiny. Moves in the normative direction with the experimenters’ explanation indicates that a strong “nudge” [13] is required to mitigate the bias. The move in the normative direction in this stage may also, however, be due to experimenters’ bias, which will be discussed later. Failure to move in the normative direction after all treatments indicates that participants make these choices based on innate preferences for “irrationality” and that indeed, models that explain these effects are worthwhile and important, as they are pervasive elements of basic human instinct.

The hope is that this study will separate the “weak” violations of rationality from the “strong” ones. For example, a weaker violation could be “corrected” out in the exposition stage, but in contrast, a “strong” violation may require an economist’s explanation in order to convince a significant number of subjects.
In this paper, I will first discuss the aim and motivation for the experiment, explaining why my research is useful and unique. Then, I will provide thorough descriptions of the sunk cost bias, the framing effect, and ambiguity aversion, with examples, followed by a complete literature review of all relevant materials. After this, I will discuss in detail the experimental design used. This will be followed by an analysis of the data, discussion of the results and a conclusion.
**AIM**

In Spring 2012, I took a course titled Behavioral Economics with Professor Mark Dean. In this course, I learnt that there exist several violations of rationality which go against the assumptions of standard economics. Having studied the violations, I realized I was interested in the strengths of these violations, and what it would take to make people realize the fallacies in their choices. In this paper, I would like to answer the following question: are common behavioral violations of rationality due to confusion or due to preferences? In other words, are people violating standard economic models purely based on preferences, or are they completely unaware that they are making decisions that deviate from standard models of rationality, and can these decisions be easily corrected? In the words of Tversky and Slovic [4], “Many decision theorists believe that the axioms of rational choice are similar to the principles of logic in the sense that no reasonable person who understands them would wish to violate them.” I agree with this logic and would like to test whether people still violate rationality when informed about their mistakes and provided some level of explanation about effects that lead to these mistakes. I will also test if some level of exposition helps in getting rid of irrationality.

There has been a significant amount of research about behavioral mistakes and violations of rationality, but so far as I am aware, there has been little research examining the nature of these mistakes. If people quickly learn from their mistakes and actually change their behavior when they see alternate explanations for how the questions can be answered, or with some level of exposition, then it could be the case that many of these errors are likely to have been due to confusion (i.e., people may not take into account the complete nature of
their choice sets). If these errors cannot be corrected out, then they will indeed prove to be stronger violations of rationality. Essentially, I wish to create a meter by which to test the significance of deviations from rationality i.e., what level of exposition and explanation, if any, rids subjects of “irrational” behavior.

This is an important question to answer because it could potentially help policy makers significantly. Knowing why certain irrationalities exist, i.e., to what degree of confusion and genuine preference they owe their existence could help policy makers “nudge” [13] people for their own benefit. For example, if they knew why people exhibit the sunk cost bias, and how easy it is to remove this irrationality, policy makers could provide some sort of information to help people make decisions in order to not exhibit this bias, which would undoubtedly benefit them. At the same time, they would be better enabled to predict the behavior of the masses and use their funds to design policy appropriately. On the flipside, if it is found that it is the case that people exhibit a bias strictly due to preference, then this would save policy makers a significant amount of money that would be wasted trying to educate the public for their “benefit”, when they actually prefer the irrationality.

Additionally, this sort of study could help traders in the stock market. If companies know how to get rid of the sunk cost bias and framing effects, they can train traders in such a way as to be aware of these biases when receiving new economic data, in order not to fall prey to these common logical errors.
This will also help test the robustness of existing economic models. If a bias is exhibited due to preference by a majority of the population, then it would be logical to consider models that attempt to explain the bias as worthwhile; however, if a bias is exhibited due to confusion, then the model that explains it will be found lacking.

In addition, it may be the case that many biases are caused because of an insufficient investment in mental energy. This idea is different than models that attempt to take into account the costs of making decisions; it means that perhaps it is the case that subjects do not think about their decisions or do not truly understand the ramifications of their actions. This idea has been explored in a lot of the work that Kahneman [3] has done in his psychological experiments.

Experiments have been performed in the past where experimenters have attempted to influence subjects and tried to make them choose the normatively optimal option by providing explanations to decision problems. However, when a subject is presented with the experimenter's explanation to a problem, he may feel pressured to act in accordance with it, and therefore may choose the normative action despite his preferences. For this reason, my experiment has a unique stage of multiple explanation in which subjects are provided with explanations, both normative and non-normative, taken from other subjects. There are three normative and three non-normative explanations, presented in random order so that subjects do not feel pressured to follow any particular one. Therefore, despite exerting a level of influence over the subjects by picking the explanations, experimenters’
bias is almost absent in this stage since subjects cannot possibly feel pressured to pick a particular explanation in order to please the experimenter.

It is also important to note that most of the literature referred to in this essay was published in psychology journals. Thus, there were no monetary incentives affecting the decisions of the subjects. Despite the best intentions of the experimenters, subjects could easily have picked answers in accordance with normative explanations in order to prevent expending mental energy. Decisions could have been made at random without giving much thought to the problem at hand, since fixed payment was guaranteed. All experiments carried out for this thesis were modified so that they had clear monetary incentives for the subjects. All experiments were carried out as per the norms of experimental economics.
VIOLATIONS OF RATIONALITY
The violations of rationality discussed in this paper are the sunk cost bias, the framing effect, and ambiguity aversion. In this section, these three biases will be discussed and explained in some detail. The existing literature relevant to these biases will be further discussed in the literature review section, and the experimental design used to test for these biases will be explained in a separate experimental design section.

SUNK COST BIAS
Sunk costs are defined as past costs that have already been incurred and cannot be recovered. For example, if a company makes a one-time expenditure of $1 million on a project that cannot be recovered, this expenditure can be regarded as a sunk cost. A clearer example at the personal level is the following. Suppose you have paid $100 for tickets to a concert that is to take place in two weeks time. Now suppose that when the day of the concert arrives, you feel like watching television at home instead of going for the concert. It is a common fallacy to assume that you must go for the concert in order to extract the value of the money that was spent on the concert tickets. That money cannot be recovered, and if staying at home to watch television gives you more utility than going for the concert, then that is what you should do. The money spent on the concert tickets should be treated as a sunk cost. To explain this example further, having paid the price of the tickets, the following two outcomes can take place.

1. You go for the concert, having already paid the price of the ticket.
2. You stay at home and watch television, having already paid the price of the ticket.
The idea that you should still go for the concert is known as the sunk cost bias, and is a common logical error. Since in either outcome, the price of the ticket has been paid already, you should pick the option that you think will help you achieve your objectives (In this case, assume the objective to be enjoyment). In this case, since we know that staying at home to watch television maximizes enjoyment, it is the option that should be picked.

Traditional economics supposes that people would not take sunk costs into account when making decisions, and exhibiting the sunk cost bias is deemed irrational behavior. However, in real life, the findings of behavioral economics suggest that people are loss averse, i.e. people get strong disutility from making losses, which influences them to keep sunk costs in mind while making decisions.

I believe that once the sunk cost bias is explained to people, they will not fail to see the irrationality of exhibiting this bias. I expect some level of explanation to make people realize their mistake.

So far the major laboratory research on the sunk cost bias has been done in the form of questionnaires placing people in hypothetical situations and asking them what they would do if they had incurred a cost that they could not recover. My experiment will test for the sunk cost bias in a setting with clear monetary incentives.
FRAMING EFFECT

The framing effect is a common cognitive bias, wherein people react differently to the same choice when it is framed or presented differently. This effect is especially common when a loss is framed as a gain or vice versa. The classic example of different frames of a situation is the one where a glass containing water up to the halfway mark is simultaneously described as being half full and half empty. If people decided whether or not to drink the water depending on which description they received, they would be exhibiting the framing effect. According to classical economics, this is irrational because framing of a problem does not decide the utilities one receives (that is simply decided by the amount of water, which is the same in both cases), and it assumes that people understand the true nature of the problem and are not tricked by the wording.

Prospect theory says that a loss is felt more deeply than a gain (loss aversion). Moreover, a sure win is favored over a lottery with the same expected value, however a sure loss is considered worse than a lottery of possible losses. The framing effect exploits this characteristic by presenting only one of these frames to subjects. It is difficult when presented with a problem, to think of the reverse framing of the problem, hence people are often found to exhibit this bias. The most common example of this is Kahneman and Tversky’s Asian Disease Problem [15]. The following are the two different frames of the Asian Disease Problem. Subjects participating in this experiment were presented with only one of the two frames. The numbers in square brackets represent the percentage of people that picked the option when presented with the question.
1. “Imagine that the US is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows.

Program A: If Program A is adopted, 200 people will be saved [72%].
Program B: If Program B is adopted, there is 1/3 probability that 600 people will be saved, and 2/3 probability that no people will be saved [28%].
Which of the two programs would you favor?”

2. “Imagine that the US is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows.

Program C: If Program C is adopted 400 people will die [22%].
Program D: If Program D is adopted there is 1/3 probability that nobody will die, and 2/3 probability that 600 people will die [78%].

Which of the two programs would you favor?”

Upon examination of the problem, it is easy to see that Program A and Program C have identical outcomes, and Program B and Program D have identical outcomes. However, when the experiment was performed, subjects presented with the first frame tended to
pick Program A and save 200 lives for certain, while those presented with the second frame did not find 400 certain deaths to be acceptable, and picked Program D so that there was a 1/3 chance of saving 600 lives.

I am interested in the framing effect because it is the simplest violation of rationality, yet extremely hard to see. I believe that subjects will be able to understand without much effort that their decisions should not depend on tricky wording, but simply on probabilities and outcomes. A modified version of the Asian Disease problem will be used in the experiment to test for framing effects.

**AMBIGUITY AVersion**

Ambiguity aversion is the tendency to choose known risks over unknown risks. This should not be confused with risk aversion. When choosing between two options with risk, someone is said to be risk averse if he picks the option with less risk despite having the same or higher expected value as the other option. The probabilities corresponding to all these risks, however, are known. Ambiguity aversion, on the other hand, arises from a situation where probabilities may be uncertain. Hence, one can only work with expected probabilities.

The most famous example of ambiguity aversion is the Ellsberg paradox. In this example, there are two urns. Urn A contains 50 red balls, and 50 black balls. Urn B contains a hundred red and black balls, but the proportion of the red and black balls is not known. The

---

2 There are different variations of the Ellsberg Paradox. I found the one described above to be best suited as an example to explain ambiguity aversion.
subject is asked to choose a color and an urn. In order to win, he must successfully pick out a ball of his chosen color from his chosen urn. Thus, the strategy should be to pick a color and an urn that maximizes the probability of picking successfully.

In this problem, people tend to go with Urn A. Now suppose the subject picks the color red and Urn A. The probability of him picking out a red ball is known to be 50%. If we assume that he is not indifferent between the two urns, from his choice we can infer that he believes that there are more red balls in Urn A than in Urn B. This means that the number of red balls in Urn B is less than 50. However, this implies that the number of black balls in Urn B is greater than 50, since the total number of balls in Urn B is known to be 100. Therefore, to maximize his chances of winning, according to his beliefs, the subject should have picked the color black, and Urn B. This would have given him a greater than 50% chance of winning.

The expected distribution of balls in Urn B is 50 red and 50 black, so ideally subjects should be indifferent. However, most subjects still pick Urn A. This is due to ambiguity aversion.

In my experiment, a slightly modified version of the Ellsberg Paradox problem will be used. The modification has been made so that the assumption that subjects are not indifferent, does not have to be made.

---

3 This modification will be explained in detail in the experimental design section of the paper.
It will be interesting to see how subjects respond to explanations of ambiguity aversion. Subjects may still choose Urn A simply because they are not willing to take the risk of obtaining an unfavorable distribution of balls in their case.
LITERATURE REVIEW
In this section, I will provide an overview of papers which have previously researched topics similar to the ones under consideration in this essay. Some relevant literature relating to the topics discussed, and the biases being tested will be analyzed.

Slovic and Tversky [4] in 1974 begin to question the degree to which subjects would choose the normative response given various rationales. The principle in question was Savage’s Independence Principle. In their paper “Who Accepts Savage’s Axiom” [4] they stage a faux hypothetical argument between two fake doctors, Dr. A and Dr. S, who argue for and against explanations for violations in rationality.

Dr. S contends that evidence that people switch in the normative direction shows that they were simply confused and are now learning to be more rational. He believes that “… violations should be treated as errors of judgment due to carelessness, lack of proper incentives, or simple misunderstandings.” In his opinion, it sometimes takes significant exposure to an axiom to internalize it, and therefore it is the case that violations are due to a poor understanding of the principle, despite the clear explanations that were provided by the authors.

Dr. A contends that since not everyone switched to the more consistent, “rational” choice, subjects could prefer to reject this axiom. The majority of people choose to violate SIP\(^4\) as an axiom. Why should it then be considered an axiom of rational choice? Even after

\(^4\) Savage’s Independence Principle (SIP) asserts that “if two alternatives have a common outcome under a particular state of nature, then the ordering of the alternatives should be independent of the value of the common outcome.” [4]
presented with clear arguments, most of the time they stick with their initial preferences. Just because they are sometimes convinced under certain conditions to adopt SIP, this does not mean that it should be considered an axiom. Further, he makes the intriguing point that “there is no way to distinguish between outright rejection of the axiom and failure to understand it.” He likewise brings into question the idea of experimenter bias. When Slovic and Tversky offered counterarguments, they saw that for the Allais paradox⁵, only four out of 29 individuals switched their choices. Furthermore, the subjects saw the argument of “Dr. A” as more convincing i.e., they seemed to like the irrational argument more.

In a related study MacCrimmon [2] found that subjects selected as more logical “the argument that was compatible with their initial preferences.” However, Slovic and Tversky modified the experiment and made the explanations more clear and compelling. They ran another experiment to test the independence principle and found that when they gave the arguments before any choice had been made, and included a section where they made sure that people understood the arguments, many more conformed to rationality. Obviously, this analysis relies heavily on more persuasive tactics by experimenters.

Slovik and Tversky’s paper [4] proved to be a key inspiration for my study. The initial idea is the same, but my design is more compatible with the field of economics, since at every stage, subjects have actual monetary incentives affecting their decision and actions.

---

⁵ This is a counterexample to SIP.
Moreover, the four stages show more clearly at what level there is a more significant shift towards traditional rationality. Another difference between my study and the one mentioned above is that since the authors themselves wrote both explanations in their multiple explanation stage, there may have been a bias involved. However, in my experiment’s multiple explanation stage, all normative and non-normative will come from previous subjects themselves, thereby greatly mitigating the bias involved. It will be interesting to see whether subjects prefer irrationality in some cases, and which arguments they are convinced by.

The Stankovic and West study, titled “Discrepancies between Normative and Descriptive Models of Decision Making and the Understanding/Acceptance Principle” [7] also has a close relation to my study. In it, they describe the normative and non-normative models of decision. The normative model of decision describes decision making that follows the accepted (economic) model, while the descriptive model attempts to explain decision making with the possibility of departures from model, because often people do not make decisions exactly the way the model predicts.

They conducted 6 augmented experiments, including some well known experiments like the Prisoner’s Dilemma, Newcomb’s Problem, and an experiment on sunk cost bias. The basic design of the experiment consisted of subjects undergoing the experiment as usual, with the modification being that these subjects were then given one of three treatments: a) an explanation of the normative decision, b) an explanation of the non-normative decision

---

6 All these problems and effects are well described by the authors in their paper.
and c) explanations of the normative and non-normative decisions. For example, the sunk cost bias experiment asked the subjects to decide, hypothetically, whether to continue watching a bad movie they had paid $6.95 to see, or to switch to another TV program. In this case, argument a) provided the rationale that money spent was “water under the bridge”, and should not affect one’s decision, while b) provided the non-normative rationale that switching channels would have “wasted $6.95. In this case, and for the case of the Newcomb experiment, all treatments led to a statistically significant shift in the direction of the normative decision that was larger than the shift in the non-normative direction.

These results, together with the data that subjects with higher SAT and NFC (need for cognition) scores were more likely to make the normative decision, thus reinforced the understanding/acceptance principle proposed by Tversky and Slovic [4], that “the deeper the understanding of a normative principle, the greater the tendency to respond in accord with it”. However, this principle was not supported by the subsequent 3 experiments, for example the Bayesian Disease problem and the Prisoner’s Dilemma, which showed that better educated individuals who HAD received the explanations shifted away from the normative, or optimal decision. This could be explained by a popular critique of the idea, that non normative behavior is irrational, i.e. that often “participants have a different construal of the problem and are responding normatively to a different problem”, the “inappropriate norm argument” [5]. I hope to use these ideas in my experiment, where I will use Stankovich’s techniques of explanation discover whether participants are committing these violations due to confusion or preference. However, one important
critique of Stankovich and West is their use of experiments that differed drastically in their complexity. While it is logical to assume that the explanations given about sunk cost bias were internalized in the intended manner by the experimental subjects, it seems unlikely that the explanations about Bayesian decision making were internalized to a similar extent, if at all! For my experiment, I hope to restrict my scope to violations of rationality that can reasonably be expected to be explained to someone with little or no knowledge of it in one sitting.

Langer and Applebee [8] compared recall performance of three different writing task groups and a non-writing control group. These task groups were made to answer comprehension questions, write summaries of the passages, and formulate an argument, using the passage. These passages were drawn from various social studies texts. All the writing groups performed better than the control, leading to the conclusion that analytic writing leads to better retention of material.

Sieck and Yates [11] found that exposition (writing explanations for choices) reduced the framing effect. They believe that this was because exposition encouraged subjects to calculate probabilities, something they would have been disinclined to do otherwise. Subjects were made to write explanations before making choices. They were told that their choices were anonymous, and would never be associated with them, and were simply for their own benefit. It was also found that exposition made subjects more confident about their choices. These effects however, were small, and we must be wary of these results, since there is also literature which suggests that exposition has detrimental effects.
For example, Wilson and Schooler [10] discovered that providing reasons can impair the quality of affective decisions. They argue that explanation is harmful to performance when the relevant aspects of a situation are inaccessible, and not easily verbalized. Therefore, in some situations, exposition may be unhelpful. I wish to test for myself whether exposition helps get rid of some simple biases, and therefore, one stage of the experiment is devoted to exposition. This stage is useful since it forces subjects to expend some effort and search within themselves for an answer and an explanation, without any outside help.

Tversky and Kahneman’s study title “The Framing of Decisions and the Psychology of Choice” [15] proved to be critical to understanding the framing effect. The authors begin by stating that “Rational choices should satisfy some requirements of consistency and coherence. The framing effect is a basic violation of this.” They go on to explain the framing effect with a well suited example in the following way. “Veridical perception requires that the perceived relative height of two neighboring mountains, say, should not reverse with changes of vantage point. Similarly, rational choice requires that the preference between options should not reverse with changes of frame. Because of imperfections of human perception and decision, however, changes of perspective often reverse the relative apparent size of objects and the relative desirability of options.”
Tversky and Kahneman believe that the framing effect can be explained using prospect theory. According to prospect theory, people display contradictory attitudes towards risk involving losses and gains. This is perfectly illustrated by the Asian Disease Problem, which will be used in my experiment, and explained in detail in the experimental design section. Basically, in this problem, people prefer taking the option with risk when the question is framed in terms of making losses, but choose the sure thing when the problem is framed in terms of gains. According to prospect theory, people have an S shaped value function, which is concave for gains, convex for losses, and steeper for losses than for gains, which makes them loss averse. This is why they will often take a sure gain, but when framed as a sure loss, they prefer to take the risky option instead.

The authors say that the addition of monetary payoffs did not eliminate the framing effect. I will test this hypothesis, since my framing effect design will be the Asian Disease Problem with monetary incentives. This will be described in more detail in the experimental design section.

In order to test the sunk cost bias, a design was required that tested the bias in a setting with monetary incentives. Such a setup was found in Phillips, Kogut and Battalio’s paper [14] titled “Sunk and Opportunity Costs in Valuation and Bidding.” They tested for the sunk cost bias in lottery and auction settings. In the lottery setting, subjects are asked to value identical lottery tickets with different prices. Since all tickets have the same expected value, the idea is that the valuation of the ticket should not change with price, which should be

---

7 Refer to Figure 1 for a hypothetical value function that fits the given description.
treated as a sunk cost. However, when the data was analyzed, it was found that subjects do not treat prices as sunk costs. This experimental design was found to be relevant to my experiment, and was used as a test for the sunk cost bias. It will be explained in detail in the experimental design section of the paper.
EXPERIMENTAL DESIGN
In my experiment, the following biases were tested: sunk cost bias, framing effect and ambiguity aversion. Every subject participated in exactly one of four treatment groups. In each treatment subjects were tested for all three biases. Each treatment had exactly fifteen participants. In this section, I will first describe the four treatments. Then, the experimental design to test each bias will be discussed in detail. While describing the experimental design for each bias, I will also discuss the variations the test undergoes in each treatment.

The four treatment groups are the following. They were conducted in the order in which they are listed:

1. Control Group: This group performed the tests for all three biases in their simplest forms. Therefore this group simply tested whether the biases exist, and was conducted to form a foundation on which the other stages were built.

2. Exposition Group: This group performed the experiments for the three biases in exactly the same way as the control group with a slight difference. Before every decision, participants in this group were asked to write a short paragraph explaining their decisions. They were assured that the paragraphs they wrote would never be associated with their names so that they could feel free to write their honest opinions. The purpose of this stage was to force the subjects to exert a certain level of mental energy. Since they had to write a paragraph before making their decision, they had to have a good understanding of the problem. Therefore, the
expectation was that subjects in this stage would generally perform better than subjects in the control group.

3. Multiple Explanation Group: This group performed the experiments for the three biases in exactly the same way as the control group with the difference that before making their decisions, the subjects were presented with six explanations, three of which were normatively optimal, while the other three were non-normative. They were asked to read these explanations in order to help them with the decision making process. At the start, it was assumed that I would be able to obtain sufficiently good explanations for each category. This did not turn out to be true in every case. If there were not enough good explanations, then subjects were provided with fewer than six explanations.

This group is what stands out from most previously conducted experiments that are similar to this one. Past experiments have included normative and non-normative explanations written by the experimenter, or only normative explanations written by the experimenter. The problem with that approach lies in the fact that subjects may believe that the experimenter wants them to follow a certain path of action and may feel compelled to do so. In this experiment, since the explanations were taken from previous subjects, there was no pressure felt by the subjects from the experimenter to perform the experiment in a certain manner. If subjects have a fair understanding of the problem, this stage is constructed in a manner that tests their ability to pick out a normatively optimal explanation from a spread of explanations.
4. **Experimenter's Explanation Group:** This group performed the experiments for the three biases in exactly the same way as the control group with the difference that before making each decision, subjects were provided with the experimenter's explanation for the normatively optimal decision. This explanation was provided in order to serve as a strong “nudge” in the normative direction. If subjects in previous stages had failed to move to the normative decision, a clear explanation from the experimenter was expected to surely convince them, unless their beliefs were completely contrary to the explanation, and they had a complete understanding of, but a different answer to the problem at hand. However, there are also problems with this methodology. A possible interpretation of a significant move in the normative direction could be that subjects did not understand the problem, but simply went with the experimenter’s explanation in order to please the experimenter, or because they trust the experimenter’s judgment and believe that it is probably wise to go along with his intuition. This is the problem of experimenter’s bias which is certainly found in this stage.

Now the tests for each individual bias will be discussed, along with the variations through each stage. Before this, however, the following is a general note about the conditions under which the experiments were performed.

All instructions were printed and presented to subjects on paper. They had to write or circle all answers on the sheets provided. All outcomes were generated later by the
experimenter, and final payments were calculated and delivered to the subjects’ campus mailboxes within 3 days. Subjects were asked to switch off their cell phones and not to speak to each other. If they had questions, they were asked to raise their hands and call the experimenter. They were made to sign their consent to participate in the study. Once the experiment began, they went through stages one, two and three, which represented tests for the sunk cost bias, the framing effect, and ambiguity aversion respectively. Note that all the versions of the instructions are attached as the appendices.

Appendix IA, IB – Control group instructions
Appendix IIA, IIB – Exposition group instructions
Appendix IIIA, IIIB – Multiple Explanation group instructions
Appendix IVA, IVB – Experimenter’s Explanation group instructions

Stage 1  Sunk Cost Bias

In most previous experiments, the sunk cost bias has been tested in the form of a questionnaire, placing people in hypothetical situations, and asking them what they would do in such a situation. I wished to test the sunk cost bias in a lab setting, in line with the norms of experimental economics. This meant testing for the sunk cost bias with a design that had clear monetary incentives for the subjects, so that they knew that every decision they made could possibly affect their payoff. The design used for this test was a slight modification of the one used by Phillips, Battalio and Kogut [14] in their paper on sunk costs, which was found to be ideal for the purposes of this experiment. The following is a description of the design.
Subjects were provided with an initial balance of $2.50. The balance was set at this amount so that their final payoff for this stage could never go below $0. Each subject was allowed to hold as many of six identical lottery tickets, labeled A1-A6, as they wanted. The tickets increased in price from $0.00 to $2.50, but represented the same lottery, their payoff of which was the outcome of a die roll, plus an additional dollar. So, for example, if the outcome was 1, the payoff was $2.00, if the outcome was 2, the payoff was $3.00, and so on with an outcome of 6 leading to a payoff of $7.00. It was made clear to the subjects that at the end of the experiment, only one of these tickets would be selected to be played. If they held the ticket selected, they would be obligated to pay the price of the ticket, which would be deducted from their initial balances. Subjects would not have to pay the prices of the tickets that they held which were not selected to be played.

Subjects were also asked to provide a valuation for every ticket that they held. This was explained to them as being the amount at which they would be indifferent between receiving cash equal to this amount, or the lottery ticket itself. They were asked to value each ticket on a scale of $0.00 to $10.00. To make sure that they valued tickets at their true valuation, the Becker, Degroot, and Marshak procedure (BDM) was used. This worked as follows. A random valuation on the same scale was generated by the experimenter. If the experimenter’s valuation for the selected ticket was greater than the subject’s valuation for this ticket, then the subject simply received the experimenter’s valuation. If the experimenter’s valuation for the
selected ticket was less than or equal to the subject’s valuation of this ticket, then the subject played the lottery represented by the ticket.

The idea to make the payment of price a contractual agreement at the beginning of the experiment was to convey that the cost of the ticket was sunk, even though it would actually be collected later. Hence, ideally, to maximize earnings, subjects should have valued tickets identically and regarded the prices as sunk costs.

Since this design was slightly hard to grasp, three examples were provided to the subjects, and the outcomes of these three examples were thoroughly discussed and explained by the experimenter. This stage of the experiment did not begin till all subjects claimed to understand how the experiment worked.

The last few paragraphs provided a description of how the control group performed this stage. There were two decisions that the subjects had to make. The first was which tickets to hold, and the second was how much to value each ticket held.

The subjects of the exposition group were asked to write short paragraphs before they decided which tickets to hold, and before they decided what valuations to give the tickets that they were holding.

The multiple explanation group received the following explanations before making their decisions (These explanations, as stated before, were obtained from the
paragraphs written by the subjects of the exposition group). They first received the following list of explanations before they decided which tickets to hold.

1. “I would like to hold all tickets with the exception of ticket 6. I can ensure that if a ticket is chosen, I can get at least $2.50 back. E.g. Ticket 5 = (2.50 – 2) = $0.50 + any valuation > 2.50 with or without lottery. I hold A6 as well because I am not risk averse in this case.”
2. “Expected value of each ticket is approximately $4.50, I think... so all tickets are worth it.”
3. “I would like to hold all tickets to maximize my chances of both playing the lottery and the possibility of having my tickets bought by the experimenter. The possibility of having more money is worth losing some.”
4. “I would choose to hold all tickets because the maximum amount I could lose is $2.50 seeing as if I’m holding ticket 6 and it gets selected, then 2.50 will be deducted from my initial balance and if my valuation is greater than the experimenter’s, I choose to gain.”
5. “Low cost ones, several so that ticket is chosen. Low cost means that I can value lower which gives a better chance of getting paid.”
6. “I’m going to hold all the tickets because for any one of them I think the payoff is higher than the cost.”

Then they received the following list of explanations before they were asked to provide their valuations for the tickets they had chosen to hold.

<table>
<thead>
<tr>
<th></th>
<th>Valuation = Expected value – price</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>4.50</td>
</tr>
<tr>
<td>T2</td>
<td>4.00</td>
</tr>
<tr>
<td>T3</td>
<td>3.50</td>
</tr>
<tr>
<td>T4</td>
<td>3.00</td>
</tr>
<tr>
<td>T5</td>
<td>2.50</td>
</tr>
<tr>
<td>T6</td>
<td>2.00</td>
</tr>
</tbody>
</table>

2. “Valuation at which indifferent, same as payment schedule. Each ticket valued at $4.50”
3. “I choose $4.50 for all tickets because that’s the expected value of the lottery. If $V_1 > 4.50$, then there is only upside for me.”

4. “I would choose to value all tickets at $10 because this is the highest valuation so is likely to be the same, if not higher than the experimenters so I know one ticket will always be deducted from my initial balance but I will also always get to play the lottery and stand to gain.”

5. “Cost doesn’t matter. Average price of lottery is about $4.5”

6. For low cost tickets I don’t have much to lose at lottery, so I give myself a 50% chance to at least make my valuation.

The experimenter’s explanation group similarly, received the following explanation before deciding which tickets to hold.

“The expected value of a die roll is 3.50. Since each lottery is identical, and gives you the outcome of a die roll plus a dollar, the expected value of each lottery is $4.50. Thus, for each lottery, price is less than expected value. Therefore, all tickets should be held.”

The explanation they received before providing valuations was the following:

“Once a ticket is held, its price is irrelevant to the outcome it will give you, and should be treated as a sunk cost, i.e. a cost that cannot be recovered. Thus, valuation should depend simply on the expected value of the ticket. Since the expected value of every ticket is $4.50, and the tickets represent the exact same lottery, one should value each ticket identically at $4.50 in order to maximize earnings.”

**Stage 2 Framing effect**

For this stage of the experiment, a slightly modified version of Kahneman and Tversky’s [15] Asian Disease Problem was used. The Asian Disease Problem in itself is simply a hypothetical question. In this experiment, monetary payoffs were assigned to outcomes.
After finishing the sunk cost bias test, subjects moved to this stage two of the experiment, which is a test for the framing effect. They were provided with one of the two frames of the Asian Disease Problem. In each treatment group, seven subjects received the first version of the problem, while eight subjects received the second. In the appendices, the instructions received by those who did the first version of the problem are labeled as ‘A’, and those who did the second version are labeled as ‘B’.

Both versions started with the following introductory line to introduce them to the hypothetical scenario:

"Consider the following hypothetical scenario. Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which without any intervention is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume the exact scientific estimates of the consequences of the programs are as follows."

Version 1 received the following options and payoff table:

<table>
<thead>
<tr>
<th>Earnings</th>
<th>Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>0 people saved</td>
</tr>
<tr>
<td>$2</td>
<td>200 people saved</td>
</tr>
<tr>
<td>$6</td>
<td>600 people saved</td>
</tr>
</tbody>
</table>

In the group of 600 people,

A. Program A: If this program is followed, 200 people will be saved with certainty.
B. Program B: If this program is followed, there is a one-third probability that 600 people will be saved, and a two-thirds probability that no people will be saved

Version 2 received the following options and payoff table:

In the group of 600 people,
A. Program C: If this program is followed, 400 people will die with certainty.
B. Program D: If this program is followed, there is a one-third probability that nobody will die, and a two-third probability that 600 people will die.

<table>
<thead>
<tr>
<th>Earnings</th>
<th>Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>600 people dead</td>
</tr>
<tr>
<td>$2</td>
<td>400 people dead</td>
</tr>
<tr>
<td>$6</td>
<td>0 people dead</td>
</tr>
</tbody>
</table>

Usually subjects in version 1 pick Program A, while those in version 2 pick Program B. The above was a description of how the control group performed the experiment. The exposition group wrote a paragraph about their reasoning before choosing their preferred program.

The following explanations were given to Version 1 subjects in the multiple explanation stage.

1. “I prefer the certainty of knowing that at least some people will be saved and that I will be paid money.”
2. “I’d choose A because I would rather not risk no one being saved.”
3. “While A is sure money, B is a significantly larger reward which is worth the 1/3 chance.”
4. “Expected value is not a good measure here. Take the risk free option!”
5. “I would choose Program A because it guarantees lives saved and $2. With program B, I may end up with nothing.”

The following explanations were given to Version 2 subjects in the multiple explanation stage.

1. “I’m risky, therefore D.”
2. “If C is followed, I know 200 people will survive with certainty. I would have to choose C because I would have a guaranteed $2.”
3. “It looks like the least risky option is to save 200 lives with certainty.”
4. “C because it lets you definitely save 200 people.”
5. “D because if all these people are going to die why not take the risk to save all of them?”
6. “Expected values are equal. I choose C to guarantee that 200 people live.

In the experimenter’s explanation stage, the following explanation was provided to the subjects.

“The framing effect is a common bias found in behavioral economics, where the same question or task framed differently, elicits different responses from subjects. In this example, realize that your options could have been framed as the following.”

Here, subjects were shown the other framing of the options available to them. Then they were told,

“You should now be able to see that there is no difference in the outcomes between options a. and c., and options b. and d. Therefore, regardless of the framing of the question, your answer should be the same. Remember to only choose your true preferences no matter how a question is framed.”

Stage 3  Ambiguity Aversion

After subjects finished the framing effect test, they proceeded to stage 3 of the experiment, which was a test for ambiguity aversion. This experiment is a slight modification of the decision problem in the Ellsberg Paradox. There are two urns labeled A, and B. Urn A is known to contain 49 Red and 51 Black balls. Urn B is known to contain 100 Red and Black balls, but the proportion of balls is unknown. Subjects were asked to pick an urn, from which a ball would be randomly picked for them. If the ball turned out to be red, they won $2, otherwise they won $0. Subjects
were assured that the number of red versus black balls in Urn B would be generated by a Random Number Generator.

Therefore, in this stage the subjects’ interests lie in picking the urn which has the higher probability of giving them a red ball. In this case the probability of picking a red ball from Urn A is known to be 49%, while the expected probability of picking a red ball from Urn B is 50%. Therefore, subjects should choose Urn B, otherwise they can be regarded as being ambiguity averse.

In the control group experiment, the problem explained above was stated, and subjects were asked to select an urn.

In the exposition group they were made to explain their choice before they picked an urn.

In the multiple explanation group, they received the following explanations before they made their choice.

1. “Urn A is essentially 49% of picking a red ball. However, Urn B, has a 51% chance of the urn having 49 or more red balls so overall greater chance of picking a red ball.”
2. “B because on average there should be more red balls in it (higher payoff).”
3. “I think there is a near 50/50 chance of choosing a red ball from Urn A, while there is a 50/50 chance that there are more red balls than black in Urn B. I think it almost doesn’t matter which Urn is chosen.”
4. “The overall probability of red ball for Urn B is 50%, and that of Urn A is 49%.”
5. “Urn B has the probability of having 0 red balls or 100. It’s definitely a riskier choice. I think I would be better off choosing Urn A because I at least know it actually contains red balls.”
6. “I prefer the larger degree of certainty of Urn A rather than the risk of Urn B, so I choose Urn A. Choosing Urn B involves two levels of risk, whereas Urn A only has one variable. Therefore I choose Urn A.”

In the experimenter’s explanation treatment, the following explanation was provided to subjects before they made their choice.

“In this experiment, you should realize that if you pick urn A, the probability of obtaining a red ball is 49%. If you pick urn B, the expected probability of obtaining a red ball is 50%. This is because the share of red balls may be any share from 0% to 100% with equal probability, so on average the share of red balls is 50%. Thus, if you want to maximize your chances of winning, you should pick urn B even though the true probabilities of picking red and black balls from this urn are ambiguous.”
**DATA ANALYSIS**

In this section, all the data collected from the experiments will be thoroughly analyzed.

Note that a discussion of the results will follow in the next section. In this section, for the most part, the results will simply be stated.

Since each treatment group in this experiment consisted of only fifteen participants, it is important to test whether the data is balanced across the groups. This is the first test that will be conducted. I will test to see whether participant sample is balanced with respect to parameters like gender, concentration and semester level.

Next, the three effects under consideration\(^8\) will be tested in order to gauge whether there was a significant shift in decision making from the control group to any particular treatment group. The results of the effect in each individual treatment group will also be discussed.

Since the sample size was small, no assumptions could be made about the distribution of the data. For this reason, apart from simple regressions, non-parametric tests were used to test the data. The tests most suited to the purposes of this experiment were the Mann Whitney U Test, the Fisher-Exact Test, and the Chi Square Goodness of Fit Test.

---

\(^8\) The effects under consideration are the sunk cost bias, the framing effect, and ambiguity aversion.
Testing the balance of the sample:

The results of the tests conducted to determine whether the treatment groups were balanced can be found in Table 1. Tests were conducted with respect to gender, concentration and semester level. Analytical and non-analytical concentrations were separated, and upperclassmen and underclassmen were separated. Tests were conducted to check for a balance across these categories. Note that lists of analytical and non-analytical concentrations can be found in the notes below Table 1. The definitions used to separate upperclassmen from underclassmen can also be found in the notes below Table 1.

Most results indicate that the data is fairly balanced across treatment groups. However, there is one significant result that must be kept in mind as we go through the rest of the results. The number of upperclassmen in the exposition stage was found to be significantly larger than the number of upperclassmen in the control group. This may have a slight impact on the results.

Testing the Sunk Cost Bias:

To see whether subjects followed a systematic pattern in valuation across tickets, the following regression was run for each individual subject:

\[ Z_i = \alpha + \beta P_i + \varepsilon_i \]

for \( i = 1, ..., 6 = \text{number of tickets selected}, \)

where \( Z_i \) is the value recorded by the subject for the \( i \)th ticket, and \( P_i \) is the price of the \( i \)th ticket. It is assumed that the random disturbance term \( \varepsilon_i \) is distributed such that it has zero
mean and a finite variance. A coefficient estimate of $\beta$ significantly different from zero would indicate that a subject systematically changed the value assigned to each ticket depending on the price of the ticket, while an estimate of zero would indicate the value assigned to each ticket either did not change or did not systematically change relative to the price of each ticket. Note that it is unusual to run regressions with such small numbers in economics, but this is the method used in the design of Battalio, Phillips and Kogut [14].

The results of these regressions are presented in Table 2, in which every subject’s choices are represented. In the control group, it can be seen that subjects clearly exhibit the sunk cost bias. Only 26.67% of the subjects value the tickets identically. The other 73.33% of the subjects follow a significant pattern across tickets, with respect to price. Now, the results of the exposition group will be discussed, followed by a test to see whether there is a significant shift towards the normative direction. The same procedure will then be followed for multiple explanation and experimenter’s explanation stages. Note that at this point, it was noticed that there was only one participant who showed a valuation which did not significantly change proportional to changes in ticket price. It was thus easy to classify subjects as exhibiting and not exhibiting the bias. This classification was used so that a Fisher Exact Test could be performed to see if there was a significant movement towards the normatively optimal choice, i.e. valuing all tickets identically.

In the exposition stage, 46.67% of the subjects valued the tickets identically. 46.67% values the tickets following a significant pattern across tickets. Thus, it can be seen that exposition helped somewhat reduce the sunk cost bias. In order to see the significance of the change, a
Fisher Exact Test was conducted for the exposition group versus the control group. The results of the test are summarized in Table 3. The Fisher Exact coefficient was found to be 0.450, which is not a statistically significant result.

In the multiple explanation stage, 53.33% of the subjects valued the tickets identically, while 46.67% of the subjects followed a significant pattern across tickets. This is a large move towards the normative direction in comparison to the control group. In fact, in terms of percentage, it is exactly double. The significance of this move was tested once again, using the Fisher Exact Test. The results of the test are summarized in Table 4. The Fisher Exact coefficient was found to be 0.264, which is not a statistically significant result.

In the experimenter's explanation stage, 73.33% of the subjects valued the tickets identically. Once again, this is a large move in the normative direction. The significance of this move was tested using the Fisher Exact Test. The results of the test are summarized in Table 5. The Fisher Exact coefficient was found to be 0.027, which is a statistically significant result.

Therefore, to summarize, there were gradual, increasing moves towards the normative direction through the stages. However, the shifts in choice were not significant for the exposition and multiple explanation stages. A significant result was obtained for the experimenter's explanation stage.
Testing the framing effect:

A major problem encountered in testing the framing effect, was the shortage of number of participants. Since only fifteen subjects could be managed for every treatment, only seven and eight subjects were assigned the “save” and “die” framings of the Asian Disease Problem, respectively. Nevertheless, the following was the procedure used for data analysis.

For the framing effect, first, the proportion of subjects who chose the safe option versus the proportion of subjects who chose the risk option was calculated for the control group, for each framing of the Asian Disease Problem. These proportions can be found in Tables 6a) and 6b) respectively. Then, in order to test whether there was a significant move away from the control group results, a chi square goodness of fit test was conducted for every treatment with the control group proportions used as inputs. As an aside, a Fisher Exact Test was conducted for each treatment group in order to ascertain whether framing actually had an effect on choice in this experiment. From here onwards, I will refer to the group that received the “save” framing as group 1, and the one that received the “die” framing as group 2, in each treatment. Note, in order to see the percentage of subjects who chose the safe option for each framing, in every stage, refer to Figure 2.

In Control Group 1, 71.43% chose the safe option. In Control Group 2, exactly 50% chose the safe option. These proportions were used as inputs into the chi square goodness of fit tests for subsequent treatments. The Fisher Exact Test indicated that though framing led to
different choices, the effect was not significant. The coefficient was found to be 0.608. This result can be found in table 6 c).

In the exposition stage, the framing effect seemed to disappear completely. Results were nearly identical across framing. When the Fisher Exact Test was run to determine whether framing had an effect on choices, the Fisher Exact coefficient was found to be 1.00. This strongly indicates that the null hypothesis that the two frames lead to identical results cannot be rejected. This result can be found in Table 7 a). Then, the Chi Square Goodness of Fit Test was conducted on Exposition Group 1 and Exposition Group 2, in order to compare results to the control group. These results can be found in Tables 7 b) and 7 c) respectively. The p value for Exposition Group 1 was found to be 0.99 which indicates that choices did not move away from Control Group 1 choices. However, the p value for Exposition Group 2 was found to be 0.15, which indicates that it moved away from the results of Control Group 2, but not significantly.

The same procedure was repeated for the Multiple Explanation Group. The Fisher Exact Test coefficient was found to be 0.01 which indicates that framing, in this case, had a significant impact on choices. This result can be found in Table 8 a). Then, the Chi Square Goodness of Fit Test was conducted on Multiple Explanation Group 1 and Multiple Explanation Group 2, in order to compare results to the control group. These results can be found in Tables 8 b) and 8 c) respectively. The p value for Multiple Explanation Group was found to be 0.40 which indicates that choices moved away from Control Group 1 choices, but not significantly. The p value for Multiple Explanation Group 2 was found to be 0.03,
which indicates that it significantly moved away from the results of Control Group 2. In this treatment, the results of groups 1 and 2 moved in such a way as to significantly increase the framing effect.

The same procedure was repeated for the Experimenter’s Explanation Group. The Fisher Exact Test coefficient was found to be 0.12 which indicates that framing, in this case, had an almost significant impact on choices. This result can be found in Table 9 a). Then, the Chi Square Goodness of Fit Test was conducted on Experimenter’s Explanation Group 1 and Experimenter’s Explanation Group 2, in order to compare results to the control group. These results can be found in Tables 9 b) and 9 c) respectively. The p value for Experimenter’s Explanation Group 1 was found to be 0.09 which indicates that choices moved away from Control Group 1 choices significantly. The p value for Experimenter’s Explanation Group 2 was found to be 0.03, which indicates that it significantly moved away from the results of Control Group 2. In this treatment, results of groups 1 and 2 moved in such a way that the framing effect still existed.

**Testing ambiguity aversion:**

Table 10 summarizes the results of each treatment in testing for ambiguity aversion. In the control group 66.67% of subjects chose the normative choice. This number was found to be lower for the exposition group, at 46.67%. Results identical to the control group were found for the multiple explanation group, with 66.67% of participants opting for the normatively optimal choice. For the experimenter’s explanation group, 86.67% of subjects chose the normatively optimal option.
Once again the Fisher exact test was conducted for each treatment, in order to compare it with the control group, and to test if treatment had an impact on choice. In this test, since the number of normative choices in the control group was already quite high, no significant results were obtained. The Fisher Exact Coefficients for the exposition, multiple explanation, and experimenter’s explanation groups were 0.46, 1.00, and 0.39 respectively. These results can be found in Tables 11, 12, and 13 respectively. From these results, we can make the following inferences. In the exposition stage, there was a move away from the normatively optimal choice. This move was not significant. In the multiple explanation stage, there was no change in the proportion of normative to non-normative choices. In the experimenter’s explanation group, there was a move towards the normatively optimal choice, but this move was not found to be significant.
DISCUSSION OF RESULTS
This section will discuss the results obtained from data analysis in the previous section. I will start by examining the results found in the control group. Then, each effect will be examined individually, and the results of the different treatments will be discussed. This will be followed by a conclusion section, which will involve a discussion of the overall significance and relevance of each stage, and a reflection on the results.

Control Group
The control group received no explanations and was simply allowed to perform tests for each bias without any kind of influence. The expectation was that people would exhibit the biases being tested. For the sunk cost bias, and framing effect, this is exactly what was found. In the sunk cost bias test, a large proportion of participants kept the prices of the tickets in mind, and used them to dictate the valuations of the tickets significantly, thereby exhibiting the sunk cost bias. Without any sort of help, subjects did not seem to clearly understand that prices were sunk costs.

Subjects also exhibited the framing effect as expected. Control Group 1 had a higher proportion of subjects who chose the risk free option than Control Group 2. This is in line with the theory that people are loss averse\(^9\). Thus when a question is framed in terms of losses, people will not choose to incur a sure loss, but are found to choose the same option when it is framed as a sure gain, as in the Asian Disease Problem.

\(^9\) Remember the value function in Figure 1.
The test for ambiguity aversion provided somewhat surprising results. Two-thirds of the participants chose the urn with unknown proportion of red and black balls. The majority of subjects seemed to understand that despite the ambiguity involved, on average they would win a larger sum of money betting on the urn with unknown risk than the one with known risk. The expectation was that less than half the subjects would pick this urn.

**Sunk Cost Bias**

To summarize the results obtained in the previous section, the sunk cost bias was confirmed to a smaller degree in each treatment after the control group. Subjects seemed to have a better understanding of the problem with increasing influence, and thus exhibited the sunk cost bias to a smaller degree. The exposition, multiple explanation, and experimenter’s explanation stages, all led to shifts in the normative direction, compared to the control group. The shift, however, was only found to be statistically significant for the experimenter’s explanation stage.

These results were in line with expectations. Since the level of influence increases through the stages, it is natural to assume that results will move in the normative direction proportionally. It was expected, however that the multiple explanation stage would lead to a significant shift towards the normatively optimal choice. A possible interpretation of this stage’s failure to produce the desired result is that the explanations for non-normative choices were presented more clearly than those for normative choices. For example, the following explanation for valuation of tickets seemed convincing to subjects:
1. “Valuation = Expected value – price

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>4.50</td>
</tr>
<tr>
<td>T2</td>
<td>4.00</td>
</tr>
<tr>
<td>T3</td>
<td>3.50</td>
</tr>
<tr>
<td>T4</td>
<td>3.00</td>
</tr>
<tr>
<td>T5</td>
<td>2.50</td>
</tr>
<tr>
<td>T6</td>
<td>2.00</td>
</tr>
</tbody>
</table>

An increase in the number of subjects who valued their tickets exactly in this manner was observed. Thus, subjects in this stage may be highly influenced by incorrect explanations, written convincingly. Subjects may also find explanations that comply with their pre-existing beliefs to be more convincing.

In the experimenter’s explanation stage, a significant shift towards the normatively optimal choice was observed. This was once again in line with expectations. Subjects read the explanation given by the experimenter, and seemed to understand the rational way of going about the problem. However, the fear is that subjects did not thoroughly understand the problem, and simply wanted to comply with what they thought was the way in which the experimenter wanted them to act.

Thus, it is found that the sunk cost bias decreases with increasing levels of influence. Therefore, subjects certainly do not prefer irrationality. They seem to choose the correct answer once their understanding of the problem is enhanced.
Framing effect

The framing effect experiments provided somewhat surprising results. In the exposition group, the framing effect disappeared almost completely. The proportion of subjects choosing the “safe” option was almost the same for both framings of the problem. The participants of Exposition Group 1 had exactly the same choices as those of Control Group 1. However, the choices of Exposition Group 2 differed from those of Control Group 2. Writing out their thoughts helped participants of Exposition Group 2 not follow loss averse behavior. Most of them chose the option which gave them a sure loss, which usually does not happen when choices are framed as losses.

In the multiple explanation group, the framing effect was found to be even more prevalent than in the control group. Multiple Explanation Group 1 had even more participants who chose the sure gain, and Multiple Explanation Group 2 had even more participants who avoided the sure loss, as compared to Control Groups 1 and 2 respectively. While most explanations for both groups seemed to encourage subjects to take the risk free option, this advice was not followed by Group 2. An informal conversation after the experiment revealed that participants of Group 2 felt that they did not have the right to value two hundred lives that could be saved, over the other four hundred lives. Therefore, they felt that they should take the risk to try and save all lives, which is what one of the explanations that they had received implied. It is once again possible that the majority they may have found this explanation more convincing than others.
In the experimenter's explanation stage, it was found that framing had a nearly significant impact on choices. Group 1 moved significantly towards the option with risk, while Group 2 moved towards the safe option. This is the exact opposite of what theory predicts for choices in the Asian Disease Problem. Exposing participants to the other possible framing of the problem by giving them the experimenter's explanation, seems to have influenced subjects to shift their understanding of the problem completely to the new framing. Instead of understanding the frames as different phrasing of the same objective problem, they seem to have understood the true problem as having the framing that they did not receive, but was contained in the experimenter's explanation. Thus, though there were significant shifts in choice for both subgroups of the experimenter's explanation group from the corresponding subgroups of the control group, these shifts occurred in such a way that the framing effect was still prevalent in this stage.

The framing effect results could also have been surprising due to the addition of monetary incentives to the Asian Disease Problem. Kahneman and Tversky [15] state that monetary incentives do not impact outcomes for the framing effect. However, informal interviews after the experiment revealed that some subjects somewhat dissociated the moral connotations of the Asian Disease Problem with their decision making process, which they based purely on monetary incentives.

Ambiguity Aversion

The most surprising result when testing this effect was that the control group already had a large proportion of subjects who picked the normatively optimal choice for this test.
The exposition stage had a smaller proportion of participants who chose Urn B\(^{10}\), than the control group. This shift in the negative direction was not significant. For some reason, writing out their thoughts made subjects more ambiguity averse, and they chose to take known risks over unknown risks. Some subjects later informally revealed that despite completely understanding that the expected probability of picking a red ball from Urn B was 50%, while that of picking a red ball from Urn A was known to be 49%, they still preferred Urn A since they knew for certain that they would have at least an almost 50% chance of picking a red ball. This may not turn out to be the case if Urn B is chosen. This reveals a strong attitude of ambiguity aversion.

The multiple explanation stage had the same proportion of participants who chose Urn B as the control group. Thus, overall, subjects were found to be ambiguity averse to the same degree as subjects in the control group. Therefore there was obviously no significant shift. The subjects may have been influenced by ambiguity averse explanations, which encouraged them to pick Urn A over Urn B.

The experimenter’s explanation stage had an extremely large proportion of subjects who picked Urn B, at 86.67%. However, the shift in the normative direction was not statistically significant. Subjects seemed to understand the experimenter, and pick the option that maximized their chances of winning. However, this may also have been due to experimenter’s bias.

---

\(^{10}\) Remember that Urn A contained 49 red balls and 51 black balls. Urn B contained an unknown proportion of red and black balls, but had a hundred balls in total.
CONCLUSION
The results for this experiment did not comply with expectations for two out of three of the effects being tested. Moreover, the multiple explanation stage did not prove to be an effective “nudge” [13] to subjects. Though it did provide a shift towards the normatively optional choices in two out of three of the effects under consideration, it did not lead to statistically significant results for any of the effects. In hindsight, it may have been worthwhile to make subjects rate how convincing they thought each explanation was in the multiple explanation group so that it could be discerned whether their decisions were dictated by particular biased explanations.

Having said this, it is important to note that the small size of the sample can be held partly responsible for the non-significant results. When one observes the data, it is not difficult to see a general pattern of movement towards normatively optimal choices through the treatments. We can say, then, that the treatments generally performed their parts ably, in that they mostly led to lessening of the biases.

The exposition stage certainly seemed to help participants, except in the ambiguity aversion test. Therefore it cannot be said that exposition is helpful in mitigating all biases, from the results of this study.

The experimenter’s explanation stage seemed to significantly eliminate biases, except in the framing effect. However, the framing effect is not an individual bias, but is judged for each treatment group as a whole. The explanation worked, but seemed to work to a larger
extent than necessary. Therefore, it can be discerned from the experiment that subjects certainly do not prefer irrationality. With influence they moved towards the correct answer, and with the experimenter’s influence, this happened to a large extent. Even though the shift in the ambiguity aversion test was not statistically significant, it is important to remember that thirteen out of fifteen subjects chose the normatively optimal option, which is a very large number.

In conclusion, it is fair to say that once a bias is explained to subjects, most of them shift their choices towards the normatively optimal option. This was found to a large extent in the effects analyzed in this experiment. However, it may be worthwhile to repeat these experiments with a larger sample to see if results still hold, and whether more significant results can be obtained.
References:


**TABLES AND FIGURES**

**Table 1**

Test for balanced data*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Control group</th>
<th>Treatment group</th>
<th>MW Probability**</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exposition</strong>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>0.6</td>
<td>0.67</td>
<td>0.71</td>
</tr>
<tr>
<td>Analytical conc.****</td>
<td>0.4</td>
<td>0.67</td>
<td>0.15</td>
</tr>
<tr>
<td>Upperclassmen****</td>
<td>0.6</td>
<td>0.93</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Multiple Explanation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>0.6</td>
<td>0.6</td>
<td>1.00</td>
</tr>
<tr>
<td>Analytical conc.</td>
<td>0.4</td>
<td>0.53</td>
<td>0.47</td>
</tr>
<tr>
<td>Upperclassmen</td>
<td>0.4</td>
<td>0.4</td>
<td>0.28</td>
</tr>
<tr>
<td><strong>Experimenter’s Explanation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>0.6</td>
<td>0.53</td>
<td>0.71</td>
</tr>
<tr>
<td>Analytical conc.</td>
<td>0.4</td>
<td>0.53</td>
<td>0.47</td>
</tr>
<tr>
<td>Upperclassmen</td>
<td>0.6</td>
<td>0.6</td>
<td>1.00</td>
</tr>
</tbody>
</table>

*The numbers in the first two columns represent the proportion of people in a treatment group, with a particular characteristic. For example, the number in the top left indicates that 0.6 of the control group consisted of male participants.

**Mann Whitney probability. The Mann Whitney U test was run on the treatment group mentioned in the subheading versus the control group to see if they vary significantly with regard to the variable in the left hand column.

***The subheading indicates the treatment group under consideration.

****Upperclassmen are students currently enrolled in a semester level higher than 4.

*****The list of analytical versus non analytical concentrations of participants is given below.

**Analytical Concentrations:**
1. Economics
2. Mathematics
3. Neuroscience
4. Biology
5. Engineering
6. Computer Science

**Non Analytical Concentrations:**
1. Music
2. International Relations
3. Political Science
4. Development Studies
5. Art
6. Comparative Literature
7. Environmental Science
8. Education
9. Anthropology
10. Undeclared
Table 2

Sunk Cost Bias: Signs of the estimated coefficients, individual regressions for subject responses across treatments.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Negative*</th>
<th>Negative</th>
<th>0**</th>
<th>Positive</th>
<th>Positive**</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Exposition Group</td>
<td>2</td>
<td>0</td>
<td>7</td>
<td>1</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>M. Explanation Group</td>
<td>5</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>E. Explanation Group</td>
<td>3</td>
<td>0</td>
<td>11</td>
<td>0</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>14</td>
<td>0</td>
<td>30</td>
<td>1</td>
<td>15</td>
<td>60</td>
</tr>
</tbody>
</table>

*Significant at the 0.05 level

**These subjects placed the same value on every ticket.

Table 3

Fisher Exact Test for Control group versus Exposition group

<table>
<thead>
<tr>
<th>Choice</th>
<th>Control Group</th>
<th>Exposition Group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non Normative</td>
<td>11</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>Normative</td>
<td>4</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
<td><strong>15</strong></td>
<td><strong>30</strong></td>
</tr>
</tbody>
</table>

Fisher exact = 0.450

1-sided Fisher’s exact = 0.225
Table 4

Fisher Exact Test for Control group versus Multiple Explanation group

<table>
<thead>
<tr>
<th>Choice</th>
<th>Control Group</th>
<th>M. Explanation Group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non Normative</td>
<td>11</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>Normative</td>
<td>4</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
<td><strong>15</strong></td>
<td><strong>30</strong></td>
</tr>
</tbody>
</table>

Fisher exact = 0.264  
1-sided Fisher’s exact = 0.132

Table 5

Fisher Exact Test for Control group versus Experimenter’s explanation group

<table>
<thead>
<tr>
<th>Choice</th>
<th>Control Group</th>
<th>Exposition Group</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non Normative</td>
<td>11</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>Normative</td>
<td>4</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
<td><strong>15</strong></td>
<td><strong>30</strong></td>
</tr>
</tbody>
</table>

Fisher exact = 0.027  
1-sided Fisher’s exact = 0.013
Table 6 a)  
Control group 1: Framing effect test

<table>
<thead>
<tr>
<th>Choice</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>2</td>
<td>28.57</td>
</tr>
<tr>
<td>Safe</td>
<td>5</td>
<td>71.43</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Table 6 b)  
Control group 2: Framing effect test

<table>
<thead>
<tr>
<th>Choice</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>4</td>
<td>50</td>
</tr>
<tr>
<td>Safe</td>
<td>4</td>
<td>50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Table 6c)  
Control Group: Fisher exact test to see if framing has an effect on choice.

<table>
<thead>
<tr>
<th>Choice</th>
<th>“Die” Framing</th>
<th>“Save” Framing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Safe</td>
<td>4</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8</strong></td>
<td><strong>7</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>

Fisher exact = 0.608  
1-sided Fisher’s exact = 0.378
### Table 7 a)

Exposition Group: Fisher exact test to see if framing has an effect on choice.

<table>
<thead>
<tr>
<th>Choice</th>
<th>“Die” Framing</th>
<th>“Save” Framing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Safe</td>
<td>6</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>7</td>
<td>15</td>
</tr>
</tbody>
</table>

Fisher exact = 1.000

1-sided Fisher’s exact = 0.662

### Table 7 b)

Exposition Group 1: Chi Square Goodness of Fit Test

<table>
<thead>
<tr>
<th>Choice</th>
<th>Expected %</th>
<th>Expected Frequency</th>
<th>Observed Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>28.57</td>
<td>1.9999</td>
<td>2</td>
</tr>
<tr>
<td>Safe</td>
<td>71.43</td>
<td>5.0001</td>
<td>5</td>
</tr>
</tbody>
</table>

Chisq(1) = 0

p = 0.9999
Table 7 c)

Exposition Group 2: Chi Square Goodness of Fit Test

<table>
<thead>
<tr>
<th>Choice</th>
<th>Expected %</th>
<th>Expected Frequency</th>
<th>Observed Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>50</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Safe</td>
<td>50</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

\[ \text{Chisq}(1) = 2 \]

\[ p = 0.1573 \]

Table 8a)

Multiple Explanation Group: Fisher exact test to see if framing has an effect on choice.

<table>
<thead>
<tr>
<th>Choice</th>
<th>“Die” Framing</th>
<th>“Save” Framing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>7</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Safe</td>
<td>1</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>7</td>
<td>15</td>
</tr>
</tbody>
</table>

\[ \text{Fisher exact} = 0.010 \]

\[ 1\text{-sided Fisher’s exact} = 0.009 \]
Table 8 b)

Multiple Explanation Group 1: Chi Square Goodness of Fit Test

<table>
<thead>
<tr>
<th>Choice</th>
<th>Expected %</th>
<th>Expected Frequency</th>
<th>Observed Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>28.57</td>
<td>1.9999</td>
<td>1</td>
</tr>
<tr>
<td>Safe</td>
<td>71.43</td>
<td>5.0001</td>
<td>6</td>
</tr>
</tbody>
</table>

Chisq(1) = 0.7
p = 0.4028

Table 8 c)

Multiple Explanation Group 2: Chi Square Goodness of Fit Test

<table>
<thead>
<tr>
<th>Choice</th>
<th>Expected %</th>
<th>Expected Frequency</th>
<th>Observed Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>50</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Safe</td>
<td>50</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

Chisq(1) = 4.5
p = 0.0339
Table 9a)

Experimenter’s Explanation Group: Fisher exact test to see if framing has an effect on choice.

<table>
<thead>
<tr>
<th>Choice</th>
<th>“Die” Framing</th>
<th>“Save” Framing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Safe</td>
<td>7</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>7</td>
<td>15</td>
</tr>
</tbody>
</table>

Fisher exact = 0.119
1-sided Fisher’s exact = 0.100

Table 9 b)

Experimenter’s Explanation Group 1: Chi Square Goodness of Fit Test

<table>
<thead>
<tr>
<th>Choice</th>
<th>Expected %</th>
<th>Expected Frequency</th>
<th>Observed Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>28.57</td>
<td>1.9999</td>
<td>4</td>
</tr>
<tr>
<td>Safe</td>
<td>71.43</td>
<td>5.0001</td>
<td>3</td>
</tr>
</tbody>
</table>

Chisq(1) = 2.8
p = 0.0942
**Table 9 c)**

Experimenter’s Explanation Group 2: Chi Square Goodness of Fit Test

<table>
<thead>
<tr>
<th>Choice</th>
<th>Expected %</th>
<th>Expected Frequency</th>
<th>Observed Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk</td>
<td>50</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Safe</td>
<td>50</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>

Chisq(1) = 4.5

p = 0.0339

**Figure 1**

Fig. 1. A hypothetical value function.
Figure 2

![Bar Chart]

- Control Group
- Exposition Group
- Multiple Explanation Group
- Experimenter's explanation group

"Save" framing % safe

"Die" Framing % safe
Appendix IA

Name:

Concentration:

Semester level:

Mailbox number:

Instructions:
This is an experiment in the economics of decision making conducted by Rohan Thakur, senior economics concentrator at Brown University, and to be used for his honors thesis. Funds for this experiment have been provided by the Brown University Dean’s office.

The experiment has three stages, and in each stage, you will be paid based on your decisions. Your earnings will be put in your mailbox within a week from the day the experiment was conducted.

During the experiment, you will not be allowed to talk to anyone with the exception of the experimenter. If you have any questions, or need any clarifications, please raise your hand and the experimenter will come to you. Please do not begin a new stage of the experiment, until the experimenter has instructed you to do so. We will proceed to the next stage once everyone has completed the current stage of the experiment. The entire experiment should take not more than an hour to finish.

We will now begin Stage 1 of the experiment. Please switch off your cellphones. Good luck!

Note: Your completion and return of the questionnaire indicates your consent to participate in this study.

Signature: Date:
Welcome to Stage 1 of today’s experiment. Please make the choice that represents your preferences.

**List of experimental steps:**

**Step 1: Six tickets offered**

You have a beginning balance of $2.50. Six tickets (A1 – A6) are offered to you at gradually increasing prices. One of these tickets will be randomly picked for payment at the end of the experiment. The tickets are represented by the following table.

<table>
<thead>
<tr>
<th>Name</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ticket 1</td>
<td>$0.00</td>
</tr>
<tr>
<td>Ticket 2</td>
<td>$0.50</td>
</tr>
<tr>
<td>Ticket 3</td>
<td>$1.00</td>
</tr>
<tr>
<td>Ticket 4</td>
<td>$1.50</td>
</tr>
<tr>
<td>Ticket 5</td>
<td>$2.00</td>
</tr>
<tr>
<td>Ticket 6</td>
<td>$2.50</td>
</tr>
</tbody>
</table>

**Step 2: The payment table**

All tickets entitle the owner to a payment decided by the roll of a six-sided die. For all tickets, the same payment table describes the amount paid for each number on the die.

<table>
<thead>
<tr>
<th>Number on die</th>
<th>Payment received</th>
<th>Probability of receiving corresponding payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$2</td>
<td>1/6</td>
</tr>
<tr>
<td>2</td>
<td>$3</td>
<td>1/6</td>
</tr>
<tr>
<td>3</td>
<td>$4</td>
<td>1/6</td>
</tr>
<tr>
<td>4</td>
<td>$5</td>
<td>1/6</td>
</tr>
<tr>
<td>5</td>
<td>$6</td>
<td>1/6</td>
</tr>
<tr>
<td>6</td>
<td>$7</td>
<td>1/6</td>
</tr>
</tbody>
</table>

**Step 3: The decision to hold tickets**

You must now decide whether or not you wish to hold any of the tickets. If you hold the ticket which is randomly chosen for payment, the price of the ticket will be subtracted from your beginning balance.
Step 4: The value scale

You will be asked to indicate the value of any tickets you hold on a scale from $0.00 to $10.00. To indicate the value of a ticket to you, think of whether you would prefer a certain dollar and cents amount or the ticket. We assume you would prefer the ticket to $0.00. Now move up the scale and ask yourself the same question for increasing dollar amounts. The amount at which you are indifferent between dollar payment and the ticket is your valuation.

Step 5: The ticket selected for payment

A ticket will randomly be selected for payment. This will be done by rolling a die. If 1 comes up, the ticket chosen will be A1, if 2 comes up it will be A2, and so on. A random valuation will also be generated. This is the experimenter’s valuation of the chosen ticket.

Step 6: Your earnings

If you do not hold the chosen ticket, you will only have your beginning balance.

If you hold the chosen ticket, its price will be deducted from your beginning balance. Then, your valuation of the ticket (V) will be compared with that of the experimenter’s valuation (V1).

Case 1: V≥V1. In this case you will play the lottery represented by the ticket.

Case 2: V< V1. In this case you will be paid V1 for the ticket.

Before we begin, if you have any questions, please ask the experimenter now. We will not begin, until everyone understands the experiment.

Note: The chosen ticket, V1, and your earnings will be decided later by a computer program, and your earnings will be calculated by the experimenter. You will know your earnings within a week’s time.

Some examples are provided to explain the experiment more clearly. The experimenter will go through each example. Think about what the outcome should be in each scenario. Make sure you understand all examples before we begin the experiment.

1. Michael chooses to hold only ticket 4. The ticket randomly selected for payment is ticket 5.
2. John chooses to hold tickets 3, 5, and 6. He values the tickets at $3, $5, and $6 respectively. The ticket selected for payment is ticket 3. The experimenter’s valuation is $7.
3. Same example as above, but now the experimenter’s valuation is $1.
1. Please circle the tickets you would like to hold.
   A1   A2   A3   A4   A5   A6

2. For each ticket that you have chosen to hold, please provide a valuation.
   I.    A1 –
   II.   A2 –
   III.  A3 –
   IV.   A4 –
   V.    A5 –
   VI.   A6 –
Welcome to stage two of today’s experiment. Please make the choice that represents your preferences.

Consider the following hypothetical scenario. Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which without any intervention is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume the exact scientific estimates of the consequences of the programs are as follows.

Circle the program that you would choose to be implemented.

Note:

1. You will be paid according to the number of people that are saved. (The higher the number of people saved, the higher your payoff.)

<table>
<thead>
<tr>
<th>Earnings</th>
<th>Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>0 people saved</td>
</tr>
<tr>
<td>$2</td>
<td>200 people saved</td>
</tr>
<tr>
<td>$6</td>
<td>600 people saved</td>
</tr>
</tbody>
</table>

2. According to your choices, an actual scenario will be generated by the computer using a randomizing function based on the probabilities indicated.

In the group of 600 people,

A. Program A: If this program is followed, 200 people will be saved with certainty.
B. Program B: If this program is followed, there is a one-third probability that 600 people will be saved, and a two-thirds probability that no people will be saved.
Welcome to Stage 3 of today’s experiment. Please make the choice that represents your preferences.

You have two urns, urn A and urn B. Urn A contains 49 red balls and 51 black balls. Urn B contains an unknown proportion of red and black balls, but we know that the total number of balls in Urn B is also 100. In other words Urn B contains x red balls and (100-x) black balls, where 0 ≤ x ≤ 100.

Your aim is to pick a red ball from an urn of your choice. If you successfully pick a red ball, you will receive $2, otherwise you will receive nothing.

Note:

1. The contents of Urn B have been generated uniquely for each participant using a randomizing function, so the chances of having 0 red balls, 100 red balls, or any other number of red balls between 0 and 100 are equal. This proportion will become known to the experimenter only after the experiment is complete.
2. When you choose an urn, a ball will be randomly picked for you by the computer. The probability of picking a red ball is therefore equal to the number of red balls in the chosen urn divided by the total number of balls in the urn.

Please indicate your choice by circling one of the following options.

Urn A  Urn B
Appendix IB

Name: 

Concentration: 

Semester level: 

Mailbox number: 

Instructions:
This is an experiment in the economics of decision making conducted by Rohan Thakur, senior economics concentrator at Brown University, and to be used for his honors thesis. Funds for this experiment have been provided by the Brown University Dean’s office.

The experiment has three stages, and in each stage, you will be paid based on your decisions. Your earnings will be put in your mailbox within a week from the day the experiment was conducted.

During the experiment, you will not be allowed to talk to anyone with the exception of the experimenter. If you have any questions, or need any clarifications, please raise your hand and the experimenter will come to you. Please do not begin a new stage of the experiment, until the experimenter has instructed you to do so. We will proceed to the next stage once everyone has completed the current stage of the experiment. The entire experiment should take not more than an hour to finish.

We will now begin Stage 1 of the experiment. Please switch off your cellphones. Good luck!

Note: Your completion and return of the questionnaire indicates your consent to participate in this study.

Signature: 

Date:
Welcome to Stage 1 of today’s experiment. Please make the choice that represents your preferences.

**List of experimental steps:**

**Step 1: Six tickets offered**

You have a beginning balance of $2.50. Six tickets (A1 – A6) are offered to you at gradually increasing prices. One of these tickets will be randomly picked for payment at the end of the experiment. The tickets are represented by the following table.

<table>
<thead>
<tr>
<th>Name</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ticket 1</td>
<td>$0.00</td>
</tr>
<tr>
<td>Ticket 2</td>
<td>$0.50</td>
</tr>
<tr>
<td>Ticket 3</td>
<td>$1.00</td>
</tr>
<tr>
<td>Ticket 4</td>
<td>$1.50</td>
</tr>
<tr>
<td>Ticket 5</td>
<td>$2.00</td>
</tr>
<tr>
<td>Ticket 6</td>
<td>$2.50</td>
</tr>
</tbody>
</table>

**Step 2: The payment table**

All tickets entitle the owner to a payment decided by the roll of a six-sided die. For all tickets, the same payment table describes the amount paid for each number on the die.

<table>
<thead>
<tr>
<th>Number on die</th>
<th>Payment received</th>
<th>Probability of receiving corresponding payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$2</td>
<td>1/6</td>
</tr>
<tr>
<td>2</td>
<td>$3</td>
<td>1/6</td>
</tr>
<tr>
<td>3</td>
<td>$4</td>
<td>1/6</td>
</tr>
<tr>
<td>4</td>
<td>$5</td>
<td>1/6</td>
</tr>
<tr>
<td>5</td>
<td>$6</td>
<td>1/6</td>
</tr>
<tr>
<td>6</td>
<td>$7</td>
<td>1/6</td>
</tr>
</tbody>
</table>

**Step 3: The decision to hold tickets**

You must now decide whether or not you wish to hold any of the tickets. If you hold the ticket which is randomly chosen for payment, the price of the ticket will be subtracted from your beginning balance.
Step 4: The value scale

You will be asked to indicate the value of any tickets you hold on a scale from $0.00 to $10.00. To indicate the value of a ticket to you, think of whether you would prefer a certain dollar and cents amount or the ticket. We assume you would prefer the ticket to $0.00. Now move up the scale and ask yourself the same question for increasing dollar amounts. The amount at which you are indifferent between dollar payment and the ticket is your valuation.

Step 5: The ticket selected for payment

A ticket will randomly be selected for payment. This will be done by rolling a die. If 1 comes up, the ticket chosen will be A1, if 2 comes up it will be A2, and so on. A random valuation will also be generated. This is the experimenter’s valuation of the chosen ticket.

Step 6: Your earnings

If you do not hold the chosen ticket, you will only have your beginning balance.

If you hold the chosen ticket, its price will be deducted from your beginning balance. Then, your valuation of the ticket (V) will be compared with that of the experimenter’s valuation (V1).

Case 1: \( V \geq V_1 \). In this case you will play the lottery represented by the ticket.

Case 2: \( V < V_1 \). In this case you will be paid \( V_1 \) for the ticket.

Before we begin, if you have any questions, please ask the experimenter now. We will not begin, until everyone understands the experiment.

Note: The chosen ticket, \( V_1 \), and your earnings will be decided later by a computer program, and your earnings will be calculated by the experimenter. You will know your earnings within a week’s time.

Some examples are provided to explain the experiment more clearly. The experimenter will go through each example. Think about what the outcome should be in each scenario. Make sure you understand all examples before we begin the experiment.

1. Michael chooses to hold only ticket 4. The ticket randomly selected for payment is ticket 5.
2. John chooses to hold tickets 3, 5, and 6. He values the tickets at $3, $5, and $6 respectively. The ticket selected for payment is ticket 3. The experimenter’s valuation is $7.
3. Same example as above, but now the experimenter’s valuation is $1.
1. Please circle the tickets you would like to hold.
   A1   A2   A3   A4   A5   A6

2. For each ticket that you have chosen to hold, please provide a valuation.
   I.  A1 –
   II. A2 –
   III. A3 –
   IV.  A4 –
   V.   A5 –
   VI.  A6 –
Welcome to stage two of today’s experiment. Please make the choice that represents your preferences.

Consider the following hypothetical scenario. Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which without any intervention is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume the exact scientific estimates of the consequences of the programs are as follows.

Circle the program that you would choose to be implemented.

Note:

1. You will be paid according to the number of people that die. (The lower the number of people that die, the higher your payoff.)

<table>
<thead>
<tr>
<th>Earnings</th>
<th>Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>600 people dead</td>
</tr>
<tr>
<td>$2</td>
<td>400 people dead</td>
</tr>
<tr>
<td>$6</td>
<td>0 people dead</td>
</tr>
</tbody>
</table>

2. According to your choices, an actual scenario will be generated by the computer using a randomizing function based on the probabilities indicated.

In the group of 600 people,

C. Program C: If this program is followed, 400 people will die with certainty.
D. Program D: If this program is followed, there is a one-third probability that nobody will die, and a two-third probability that 600 people will die.
Welcome to Stage 3 of today’s experiment. Please make the choice that represents your preferences.

You have two urns, urn A and urn B. Urn A contains 49 red balls and 51 black balls. Urn B contains an unknown proportion of red and black balls, but we know that the total number of balls in Urn B is also 100. In other words Urn B contains x red balls and (100-x) black balls, where 0 ≤ x ≤ 100.

Your aim is to pick a red ball from an urn of your choice. If you successfully pick a red ball, you will receive $2, otherwise you will receive nothing.

Note:

1. The contents of Urn B have been generated uniquely for each participant using a randomizing function, so the chances of having 0 red balls, 100 red balls, or any other number of red balls between 0 and 100 are equal. This proportion will become known to the experimenter only after the experiment is complete.
2. When you choose an urn, a ball will be randomly picked for you by the computer. The probability of picking a red ball is therefore equal to the number of red balls in the chosen urn divided by the total number of balls in the urn.

Please indicate your choice by circling one of the following options.

Urn A  Urn B
Appendix IIA

Name:
Concentration:
Semester level:
Mailbox number:

Instructions:
This is an experiment in the economics of decision making conducted by Rohan Thakur, senior economics concentrator at Brown University, and to be used for his honors thesis. Funds for this experiment have been provided by the Brown University Dean’s office.

The experiment has three stages, and in each stage, you will be paid based on your decisions. Your earnings will be put in your mailbox within a week from the day the experiment was conducted.

During the experiment, you will not be allowed to talk to anyone with the exception of the experimenter. If you have any questions, or need any clarifications, please raise your hand and the experimenter will come to you. Please do not begin a new stage of the experiment, until the experimenter has instructed you to do so. We will proceed to the next stage once everyone has completed the current stage of the experiment. The entire experiment should take not more than an hour to finish.

We will now begin Stage 1 of the experiment. Please switch off your cellphones. Good luck!

Note: Your completion and return of the questionnaire indicates your consent to participate in this study.

Signature:            Date:
Welcome to Stage 1 of today’s experiment. Please make the choice that represents your preferences.

After you view the question, you will be asked to provide reasons for your choice before you make it. Please state clearly why you are making the choice that you are making.

**List of experimental steps:**

**Step 1: Six tickets offered**

You have a beginning balance of $2.50. Six tickets (A1 – A6) are offered to you at gradually increasing prices. One of these tickets will be randomly picked for payment at the end of the experiment. The tickets are represented by the following table.

<table>
<thead>
<tr>
<th>Name</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ticket 1</td>
<td>$0.00</td>
</tr>
<tr>
<td>Ticket 2</td>
<td>$0.50</td>
</tr>
<tr>
<td>Ticket 3</td>
<td>$1.00</td>
</tr>
<tr>
<td>Ticket 4</td>
<td>$1.50</td>
</tr>
<tr>
<td>Ticket 5</td>
<td>$2.00</td>
</tr>
<tr>
<td>Ticket 6</td>
<td>$2.50</td>
</tr>
</tbody>
</table>

**Step 2: The payment table**

All tickets entitle the owner to a payment decided by the roll of a six-sided die. For all tickets, the same payment table describes the amount paid for each number on the die.

<table>
<thead>
<tr>
<th>Number on die</th>
<th>Payment received</th>
<th>Probability of receiving corresponding payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$2</td>
<td>1/6</td>
</tr>
<tr>
<td>2</td>
<td>$3</td>
<td>1/6</td>
</tr>
<tr>
<td>3</td>
<td>$4</td>
<td>1/6</td>
</tr>
<tr>
<td>4</td>
<td>$5</td>
<td>1/6</td>
</tr>
<tr>
<td>5</td>
<td>$6</td>
<td>1/6</td>
</tr>
<tr>
<td>6</td>
<td>$7</td>
<td>1/6</td>
</tr>
</tbody>
</table>

**Step 3: The decision to hold tickets**

You must now decide whether or not you wish to hold any of the tickets. If you hold the ticket which is randomly chosen for payment, the price of the ticket will be subtracted from your beginning balance.
Step 4: The value scale

You will be asked to indicate the value of any tickets you hold on a scale from $0.00 to $10.00. To indicate the value of a ticket to you, think of whether you would prefer a certain dollar and cents amount or the ticket. We assume you would prefer the ticket to $0.00. Now move up the scale and ask yourself the same question for increasing dollar amounts. The amount at which you are indifferent between dollar payment and the ticket is your valuation.

Step 5: The ticket selected for payment

A ticket will randomly be selected for payment. This will be done by rolling a die. If 1 comes up, the ticket chosen will be A1, if 2 comes up it will be A2, and so on. A random valuation will also be generated. This is the experimenter’s valuation of the chosen ticket.

Step 6: Your earnings

If you do not hold the chosen ticket, you will only have your beginning balance.

If you hold the chosen ticket, its price will be deducted from your beginning balance. Then, your valuation of the ticket (V) will be compared with that of the experimenter’s valuation (V1).

   Case 1: \( V \geq V_1 \). In this case you will play the lottery represented by the ticket.

   Case 2: \( V < V_1 \). In this case you will be paid \( V_1 \) for the ticket.

Before we begin, if you have any questions, please ask the experimenter now. We will not begin, until everyone understands the experiment.

Note: The chosen ticket, \( V_1 \), and your earnings will be decided later by a computer program, and your earnings will be calculated by the experimenter. You will know your earnings within a week’s time.

Some examples are provided to explain the experiment more clearly. The experimenter will go through each example. Think about what the outcome should be in each scenario. Make sure you understand all examples before we begin the experiment.

1. Michael chooses to hold only ticket 4. The ticket randomly selected for payment is ticket 5.

2. John chooses to hold tickets 3, 5, and 6. He values the tickets at $3, $5, and $6 respectively. The ticket selected for payment is ticket 3. The experimenter’s valuation is $7.

3. Same example as above, but now the experimenter’s valuation is $1.
Please write down your thoughts about which ticket you would like to hold. Please provide reasons.

1. Please circle the tickets you would like to hold.
   A1  A2  A3  A4  A5  A6

   Now for each ticket you hold, you will be asked to provide a valuation. Please think about what your valuations will be. In the space provided below, please provide the rationale for your valuations.

2. For each ticket that you have chosen to hold, please provide a valuation.
   I.  A1 –
   II. A2 –
   III. A3 –
   IV.  A4 –
   V.   A5 –
   VI.  A6 –
Welcome to stage two of today’s experiment. Please make the choice that represents your preferences.

After you view the question, you will be asked to provide reasons for your choice before you make it. Please state clearly why you are making the choice that you are making.

Consider the following hypothetical scenario. Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which without any intervention is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume the exact scientific estimates of the consequences of the programs are as follows.

In the group of 600 people,

A. Program A: If this program is followed, 200 people will be saved with certainty.
B. Program B: If this program is followed, there is a one-third probability that 600 people will be saved, and a two-thirds probability that no people will be saved

Note:

1. You will be paid according to the number of people that are saved. (The higher the number of people saved, the higher your payoff.)

<table>
<thead>
<tr>
<th>Earnings</th>
<th>Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>0 people saved</td>
</tr>
<tr>
<td>$2</td>
<td>200 people saved</td>
</tr>
<tr>
<td>$6</td>
<td>600 people saved</td>
</tr>
</tbody>
</table>

2. According to your choices, an actual scenario will be generated by the computer using a randomizing function based on the probabilities indicated.

Which program would you choose? Please write down your thoughts regarding the answer to the question, and the reasons for the choice you are about to make. Your explanations for your choices are confidential, and your name will never be associated with what you have written down, so please provide honest reasons.

Please indicate your choice by circling one of the following options.

A  B
Welcome to Stage 3 of today’s experiment. Please make the choice that represents your preferences.

After you view the question, you will be asked to provide reasons for your choice before you make it. Please state clearly why you are making the choice that you are making.

You have two urns, urn A and urn B. Urn A contains 49 red balls and 51 black balls. Urn B contains an unknown proportion of red and black balls, but we know that the total number of balls in Urn B is also 100. In other words Urn B contains x red balls and (100-x) black balls, where 0 ≤ x ≤ 100.

Your aim is to pick a red ball from an urn of your choice. If you successfully pick a red ball, you will receive $2, otherwise you will receive nothing. Which urn would make a better choice?

Note:

1. The contents of Urn B have been generated uniquely for each participant using a randomizing function, so the chances of having 0 red balls, 100 red balls, or any other number of red balls between 0 and 100 are equal. This proportion will become known to the experimenter only after the experiment is complete.
2. When you choose an urn, a ball will be randomly picked for you by the computer. The probability of picking a red ball is therefore equal to the number of red balls in the chosen urn divided by the total number of balls in the urn.
3. Your explanations for your choices are confidential, and your name will never be associated with what you have written down, so please provide honest reasons.

Please write down your thoughts regarding the answer to the question, and the reasons for the choice you are about to make in the space provided below.

Please indicate your choice by circling one of the following options.

Urn A  Urn B
Appendix IIB

Name:

Concentration:

Semester level:

Mailbox number:

Instructions:
This is an experiment in the economics of decision making conducted by Rohan Thakur, senior economics concentrator at Brown University, and to be used for his honors thesis. Funds for this experiment have been provided by the Brown University Dean’s office.

The experiment has three stages, and in each stage, you will be paid based on your decisions. Your earnings will be put in your mailbox within a week from the day the experiment was conducted.

During the experiment, you will not be allowed to talk to anyone with the exception of the experimenter. If you have any questions, or need any clarifications, please raise your hand and the experimenter will come to you. Please do not begin a new stage of the experiment, until the experimenter has instructed you to do so. We will proceed to the next stage once everyone has completed the current stage of the experiment. The entire experiment should take not more than an hour to finish.

We will now begin Stage 1 of the experiment. Please switch off your cellphones. Good luck!

Note: Your completion and return of the questionnaire indicates your consent to participate in this study.

Signature: ___________________________ Date: ________________
Welcome to Stage 1 of today’s experiment. Please make the choice that represents your preferences.

After you view the question, you will be asked to provide reasons for your choice before you make it. Please state clearly why you are making the choice that you are making.

**List of experimental steps:**

**Step 1: Six tickets offered**

You have a beginning balance of $2.50. Six tickets (A1 – A6) are offered to you at gradually increasing prices. One of these tickets will be randomly picked for payment at the end of the experiment. The tickets are represented by the following table.

<table>
<thead>
<tr>
<th>Name</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ticket 1</td>
<td>$0.00</td>
</tr>
<tr>
<td>Ticket 2</td>
<td>$0.50</td>
</tr>
<tr>
<td>Ticket 3</td>
<td>$1.00</td>
</tr>
<tr>
<td>Ticket 4</td>
<td>$1.50</td>
</tr>
<tr>
<td>Ticket 5</td>
<td>$2.00</td>
</tr>
<tr>
<td>Ticket 6</td>
<td>$2.50</td>
</tr>
</tbody>
</table>

**Step 2: The payment table**

All tickets entitle the owner to a payment decided by the roll of a six-sided die. For all tickets, the same payment table describes the amount paid for each number on the die.

<table>
<thead>
<tr>
<th>Number on die</th>
<th>Payment received</th>
<th>Probability of receiving corresponding payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$2</td>
<td>1/6</td>
</tr>
<tr>
<td>2</td>
<td>$3</td>
<td>1/6</td>
</tr>
<tr>
<td>3</td>
<td>$4</td>
<td>1/6</td>
</tr>
<tr>
<td>4</td>
<td>$5</td>
<td>1/6</td>
</tr>
<tr>
<td>5</td>
<td>$6</td>
<td>1/6</td>
</tr>
<tr>
<td>6</td>
<td>$7</td>
<td>1/6</td>
</tr>
</tbody>
</table>

**Step 3: The decision to hold tickets**

You must now decide whether or not you wish to hold any of the tickets. If you hold the ticket which is randomly chosen for payment, the price of the ticket will be subtracted from your beginning balance.
Step 4: The value scale

You will be asked to indicate the value of any tickets you hold on a scale from $0.00 to $10.00. To indicate the value of a ticket to you, think of whether you would prefer a certain dollar and cents amount or he ticket. We assume you would prefer the ticket to $0.00. Now move up the scale and ask yourself the same question for increasing dollar amounts. The amount at which you are indifferent between dollar payment and the ticket is your valuation.

Step 5: The ticket selected for payment

A ticket will randomly be selected for payment. This will be done by rolling a die. If 1 comes up, the ticket chosen will be A1, if 2 comes up it will be A2, and so on. A random valuation will also be generated. This is the experimenter’s valuation of the chosen ticket.

Step 6: Your earnings

If you do not hold the chosen ticket, you will only have your beginning balance.

If you hold the chosen ticket, its price will be deducted from your beginning balance. Then, your valuation of the ticket (V) will be compared with that of the experimenter’s valuation (V1).

Case 1: V≥V1. In this case you will play the lottery represented by the ticket.

Case 2: V< V1. In this case you will be paid V1 for the ticket.

Before we begin, if you have any questions, please ask the experimenter now. We will not begin, until everyone understands the experiment.

Note: The chosen ticket, V1, and your earnings will be decided later by a computer program, and your earnings will be calculated by the experimenter. You will know your earnings within a week’s time.

Some examples are provided to explain the experiment more clearly. The experimenter will go through each example. Think about what the outcome should be in each scenario. Make sure you understand all examples before we begin the experiment.

1. Michael chooses to hold only ticket 4. The ticket randomly selected for payment is ticket 5.
2. John chooses to hold tickets 3, 5, and 6. He values the tickets at $3, $5, and $6 respectively. The ticket selected for payment is ticket 3. The experimenter’s valuation is $7.
3. Same example as above, but now the experimenter’s valuation is $1.
Please write down your thoughts about which ticket you would like to hold. Please provide reasons.

1. Please circle the tickets you would like to hold.
   A1    A2    A3    A4    A5    A6

   Now for each ticket you hold, you will be asked to provide a valuation. Please think about what your valuations will be. In the space provided below, please provide the rationale for your valuations.

2. For each ticket that you have chosen to hold, please provide a valuation.
   I.   A1 –
   II.  A2 –
   III. A3 –
   IV.  A4 –
   V.   A5 –
   VI.  A6 –
Welcome to Stage 2 of today’s experiment. Please make the choice that represents your preferences.

After you view the question, you will be asked to provide reasons for your choice before you make it. Please state clearly why you are making the choice that you are making.

Consider the following hypothetical scenario. Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which without any intervention is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume the exact scientific estimates of the consequences of the programs are as follows.

In the group of 600 people,

C. Program C: If this program is followed, 400 people will die with certainty.
D. Program D: If this program is followed, there is a one-third probability that nobody will die, and a two-third probability that 600 people will die.

Note:

1. You will be paid according to the number of people that die. (The lower the number of people that die, the higher your payoff.)

<table>
<thead>
<tr>
<th>Earnings</th>
<th>Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>600 people dead</td>
</tr>
<tr>
<td>$2</td>
<td>400 people dead</td>
</tr>
<tr>
<td>$6</td>
<td>0 people dead</td>
</tr>
</tbody>
</table>

2. According to your choices, an actual scenario will be generated by the computer using a randomizing function based on the probabilities indicated.

Which program would you choose? Please write down your thoughts regarding the answer to the question, and the reasons for the choice you are about to make. Your explanations for your choices are confidential, and your name will never be associated with what you have written down, so please provide honest reasons.

Please indicate your choice by circling one of the following options.

C  D
Welcome to Stage 3 of today’s experiment. Please make the choice that represents your preferences.

After you view the question, you will be asked to provide reasons for your choice before you make it. Please state clearly why you are making the choice that you are making.

You have two urns, urn A and urn B. Urn A contains 49 red balls and 51 black balls. Urn B contains an unknown proportion of red and black balls, but we know that the total number of balls in Urn B is also 100. In other words Urn B contains x red balls and (100-x) black balls, where 0 ≤ x ≤ 100.

Your aim is to pick a red ball from an urn of your choice. If you successfully pick a red ball, you will receive $2, otherwise you will receive nothing. Which urn would make a better choice?

Note:

1. The contents of Urn B have been generated uniquely for each participant using a randomizing function, so the chances of having 0 red balls, 100 red balls, or any other number of red balls between 0 and 100 are equal. This proportion will become known to the experimenter only after the experiment is complete.
2. When you choose an urn, a ball will be randomly picked for you by the computer. The probability of picking a red ball is therefore equal to the number of red balls in the chosen urn divided by the total number of balls in the urn.
3. Your explanations for your choices are confidential, and your name will never be associated with what you have written down, so please provide honest reasons.

Please write down your thoughts regarding the answer to the question, and the reasons for the choice you are about to make in the space provided below.

Please indicate your choice by circling one of the following options.

Urn A  Urn B
Appendix IIIA

Name:

Concentration:

Semester level:

Mailbox number:

Instructions:
This is an experiment in the economics of decision making conducted by Rohan Thakur, senior economics concentrator at Brown University, and to be used for his honors thesis. Funds for this experiment have been provided by the Brown University Dean’s office.

The experiment has three stages, and in each stage, you will be paid based on your decisions. Your earnings will be put in your mailbox within a week from the day the experiment was conducted.

During the experiment, you will not be allowed to talk to anyone with the exception of the experimenter. If you have any questions, or need any clarifications, please raise your hand and the experimenter will come to you. Please do not begin a new stage of the experiment, until the experimenter has instructed you to do so. We will proceed to the next stage once everyone has completed the current stage of the experiment. The entire experiment should take not more than an hour to finish.

We will now begin Stage 1 of the experiment. Please switch off your cellphones. Good luck!

Note: Your completion and return of the questionnaire indicates your consent to participate in this study.

Signature: 

Date:
Welcome to Stage 1 of today’s experiment. Please make the choice that represents your preferences.

**List of experimental steps:**

**Step 1: Six tickets offered**

You have a beginning balance of $2.50. Six tickets (A1 – A6) are offered to you at gradually increasing prices. One of these tickets will be randomly picked for payment at the end of the experiment. The tickets are represented by the following table.

<table>
<thead>
<tr>
<th>Name</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ticket 1</td>
<td>$0.00</td>
</tr>
<tr>
<td>Ticket 2</td>
<td>$0.50</td>
</tr>
<tr>
<td>Ticket 3</td>
<td>$1.00</td>
</tr>
<tr>
<td>Ticket 4</td>
<td>$1.50</td>
</tr>
<tr>
<td>Ticket 5</td>
<td>$2.00</td>
</tr>
<tr>
<td>Ticket 6</td>
<td>$2.50</td>
</tr>
</tbody>
</table>

**Step 2: The payment table**

All tickets entitle the owner to a payment decided by the roll of a six-sided die. For all tickets, the same payment table describes the amount paid for each number on the die.

<table>
<thead>
<tr>
<th>Number on die</th>
<th>Payment received</th>
<th>Probability of receiving corresponding payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$2</td>
<td>1/6</td>
</tr>
<tr>
<td>2</td>
<td>$3</td>
<td>1/6</td>
</tr>
<tr>
<td>3</td>
<td>$4</td>
<td>1/6</td>
</tr>
<tr>
<td>4</td>
<td>$5</td>
<td>1/6</td>
</tr>
<tr>
<td>5</td>
<td>$6</td>
<td>1/6</td>
</tr>
<tr>
<td>6</td>
<td>$7</td>
<td>1/6</td>
</tr>
</tbody>
</table>

**Step 3: The decision to hold tickets**

You must now decide whether or not you wish to hold any of the tickets. If you hold the ticket which is randomly chosen for payment, the price of the ticket will be subtracted from your beginning balance.
Step 4: The value scale

You will be asked to indicate the value of any tickets you hold on a scale from $0.00 to $10.00. To indicate the value of a ticket to you, think of whether you would prefer a certain dollar and cents amount or the ticket. We assume you would prefer the ticket to $0.00. Now move up the scale and ask yourself the same question for increasing dollar amounts. The amount at which you are indifferent between dollar payment and the ticket is your valuation.

Step 5: The ticket selected for payment

A ticket will randomly be selected for payment. This will be done by rolling a die. If 1 comes up, the ticket chosen will be A1, if 2 comes up it will be A2, and so on. A random valuation will also be generated. This is the experimenter’s valuation of the chosen ticket.

Step 6: Your earnings

If you do not hold the chosen ticket, you will only have your beginning balance.

If you hold the chosen ticket, its price will be deducted from your beginning balance. Then, your valuation of the ticket (V) will be compared with that of the experimenter’s valuation (V1).

Case 1: V≥V1. In this case you will play the lottery represented by the ticket.

Case 2: V< V1. In this case you will be paid V1 for the ticket.

Before we begin, if you have any questions, please ask the experimenter now. We will not begin, until everyone understands the experiment.

Note: The chosen ticket, V1, and your earnings will be decided later by a computer program, and your earnings will be calculated by the experimenter. You will know your earnings within a week’s time.

Some examples are provided to explain the experiment more clearly. The experimenter will go through each example. Think about what the outcome should be in each scenario. Make sure you understand all examples before we begin the experiment.

1. Michael chooses to hold only ticket 4. The ticket randomly selected for payment is ticket 5.
2. John chooses to hold tickets 3, 5, and 6. He values the tickets at $3, $5, and $6 respectively. The ticket selected for payment is ticket 3. The experimenter’s valuation is $7.
3. Same example as above, but now the experimenter’s valuation is $1.

You will now be asked which tickets you would like to hold. The following are the thoughts of some previous subjects who faced the same question. Note, the answers have been selected randomly, and may have led to good or bad outcomes for the subject. It is up to you to decide if you find any of these arguments convincing. They are simply provided to help you.
1. “I would like to hold all tickets with the exception of ticket 6. I can ensure that if a ticket is chosen, I can get at least $2.50 back. E.g. Ticket 5 = (2.50 - 2) = $0.50 + any valuation > 2.50 with or without lottery. I hold A6 as well because I am not risk averse in this case.”

2. “Expected value of each ticket is approximately $4.50, I think... so all tickets are worth it.”

3. “I would like to hold all tickets to maximize my chances of both playing the lottery and the possibility of having my tickets bought by the experimenter. The possibility of having more money is worth losing some.”

4. “I would choose to hold all tickets because the maximum amount I could lose is $2.50 seeing as if I’m holding ticket 6 and it gets selected, then 2.50 will be deducted from my initial balance and if my valuation is greater than the experimenter’s, I choose to gain.”

5. “Low cost ones, several so that ticket is chosen. Low cost means that I can value lower which gives a better chance of getting paid.”

6. “I’m going to hold all the tickets because for any one of them I think the payoff is higher than the cost.”

1. Please circle the tickets you would like to hold.
   A1  A2  A3  A4  A5  A6

Now you will be asked to value the tickets that you have chosen to hold. The following are the thoughts of some previous subjects who faced the same question. Note, the answers have been selected randomly, and may have led to good or bad outcomes for the subject. It is up to you to decide if you find any of these arguments convincing. They are simply provided to help you.

1. “Valuation = Expected value – price

<table>
<thead>
<tr>
<th>Ticket</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>4.50</td>
</tr>
<tr>
<td>T2</td>
<td>4.00</td>
</tr>
<tr>
<td>T3</td>
<td>3.50</td>
</tr>
<tr>
<td>T4</td>
<td>3.00</td>
</tr>
<tr>
<td>T5</td>
<td>2.50</td>
</tr>
<tr>
<td>T6</td>
<td>2.00</td>
</tr>
</tbody>
</table>

2. “Valuation at which indifferent, same as payment schedule. Each ticket valued at $4.50”

3. “I choose $4.50 for all tickets because that’s the expected value of the lottery. If V1 > 4.50, then there is only upside for me.”

4. “I would choose to value all tickets at $10 because this is the highest valuation so is likely to be the same, if not higher than the experimenters so I know one ticket will always be deducted from my initial balance but I will also always get to play the lottery and stand to gain.”

5. “Cost doesn’t matter. Average price of lottery is about $4.5”

6. For low cost tickets I don’t have much to lose at lottery, so I give myself a 50% chance to at least make my valuation.
2. For each ticket that you have chosen to hold, please provide a valuation.
   I.  A1 –
   II. A2 –
   III. A3 –
   IV. A4 –
   V.  A5 –
   VI. A6 –
Welcome to Stage 2 of today’s experiment. Please make the choice that represents your preferences.

After you view the question, you will be shown a series of statements from previous subjects, regarding the question. These are their explanations for the choices they made. After this, you will be asked to make your choice.

Consider the following hypothetical scenario. Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which without any intervention is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume the exact scientific estimates of the consequences of the programs are as follows.

In the group of 600 people,

A. Program A: If this program is followed, 200 people will be saved with certainty.
B. Program B: If this program is followed, there is a one-third probability that 600 people will be saved, and a two-thirds probability that no people will be saved

Note:
1. You will be paid according to the number of people that are saved. (The higher the number of people saved, the higher your payoff.)

<table>
<thead>
<tr>
<th>Earnings</th>
<th>Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>0 people saved</td>
</tr>
<tr>
<td>$2</td>
<td>200 people saved</td>
</tr>
<tr>
<td>$6</td>
<td>600 people saved</td>
</tr>
</tbody>
</table>

2. According to your choices, an actual scenario will be generated by the computer using a randomizing function based on the probabilities indicated.

**Previous subjects’ thoughts and explanations**

1. “I prefer the certainty of knowing that at least some people will be saved and that I will be paid money.”
2. “I’d choose A because I would rather not risk no one being saved.”
3. “While A is sure money, B is a significantly larger reward which is worth the 1/3 chance.”
4. “Expected value is not a good measure here. Take the risk free option!”
5. “I would choose program A because it guarantees lives saved and $2. With program B, I may end up with nothing.”

Please indicate your choice by circling one of the following options.

A        B
Welcome to Stage 3 of today’s experiment. Please make the choice that represents your preferences.

After you view the question, you will be shown a series of statements from previous subjects, regarding the question. These are their explanations for the choices they made. After this, you will be asked to make your choice.

You have two urns, urn A and urn B. Urn A contains 49 red balls and 51 black balls. Urn B contains an unknown proportion of red and black balls, but we know that the total number of balls in Urn B is also 100. In other words, Urn B contains x red balls and (100-x) black balls, where 0 <= x <= 100.

Your aim is to pick a red ball from an urn of your choice. If you successfully pick a red ball, you will receive $2, otherwise you will receive nothing. Which urn would you pick from?

Note:

1. The contents of Urn B have been generated uniquely for each participant using a randomizing function, so the chances of having 0 red balls, 100 red balls, or any other number of red balls between 0 and 100 are equal. This proportion will become known to the experimenter only after the experiment is complete.
2. When you choose an urn, a ball will be randomly picked for you by the computer. The probability of picking a red ball is therefore equal to the number of red balls in the chosen urn divided by the total number of balls in the urn.

Previous subjects’ thoughts and explanations

1. “Urn A is essentially 49% of picking a red ball. However, Urn B, has a 51% chance of the urn having 49 or more red balls so overall greater chance of picking a red ball.”
2. “B because on average there should be more red balls in it (higher payoff).”
3. “I think there is a near 50/50 chance of choosing a red ball from Urn A, while there is a 50/50 chance that there are more red balls than black in Urn B. I think it almost doesn’t matter which Urn is chosen.”
4. “The overall probability of red ball for Urn B is 50%, and that of Urn A is 49%.”
5. “Urn B has the probability of having 0 red balls or 100. It’s definitely a riskier choice. I think I would be better off choosing Urn A because I at least know it actually contains red balls.”
6. “I prefer the larger degree of certainty of Urn A rather than the risk of Urn B, so I choose Urn A. Choosing Urn B involves two levels of risk, whereas Urn A only has one variable. Therefore I choose Urn A.”

Please indicate your choice by circling one of the following options.

Urn A  Urn B
Appendix IIIB

Name:

Concentration:

Semester level:

Mailbox number:

Instructions:
This is an experiment in the economics of decision making conducted by Rohan Thakur, senior economics concentrator at Brown University, and to be used for his honors thesis. Funds for this experiment have been provided by the Brown University Dean’s office.

The experiment has three stages, and in each stage, you will be paid based on your decisions. Your earnings will be put in your mailbox within a week from the day the experiment was conducted.

During the experiment, you will not be allowed to talk to anyone with the exception of the experimenter. If you have any questions, or need any clarifications, please raise your hand and the experimenter will come to you. Please do not begin a new stage of the experiment, until the experimenter has instructed you to do so. We will proceed to the next stage once everyone has completed the current stage of the experiment. The entire experiment should take not more than an hour to finish.

We will now begin Stage 1 of the experiment. Please switch off your cellphones. Good luck!

Note: Your completion and return of the questionnaire indicates your consent to participate in this study.

Signature: Date:
Welcome to Stage 1 of today’s experiment. Please make the choice that represents your preferences.

**List of experimental steps:**

**Step 1: Six tickets offered**

You have a beginning balance of $2.50. Six tickets (A1 – A6) are offered to you at gradually increasing prices. One of these tickets will be randomly picked for payment at the end of the experiment. The tickets are represented by the following table.

<table>
<thead>
<tr>
<th>Name</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ticket 1</td>
<td>$0.00</td>
</tr>
<tr>
<td>Ticket 2</td>
<td>$0.50</td>
</tr>
<tr>
<td>Ticket 3</td>
<td>$1.00</td>
</tr>
<tr>
<td>Ticket 4</td>
<td>$1.50</td>
</tr>
<tr>
<td>Ticket 5</td>
<td>$2.00</td>
</tr>
<tr>
<td>Ticket 6</td>
<td>$2.50</td>
</tr>
</tbody>
</table>

**Step 2: The payment table**

All tickets entitle the owner to a payment decided by the roll of a six-sided die. For all tickets, the same payment table describes the amount paid for each number on the die.

<table>
<thead>
<tr>
<th>Number on die</th>
<th>Payment received</th>
<th>Probability of receiving corresponding payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$2</td>
<td>1/6</td>
</tr>
<tr>
<td>2</td>
<td>$3</td>
<td>1/6</td>
</tr>
<tr>
<td>3</td>
<td>$4</td>
<td>1/6</td>
</tr>
<tr>
<td>4</td>
<td>$5</td>
<td>1/6</td>
</tr>
<tr>
<td>5</td>
<td>$6</td>
<td>1/6</td>
</tr>
<tr>
<td>6</td>
<td>$7</td>
<td>1/6</td>
</tr>
</tbody>
</table>

**Step 3: The decision to hold tickets**

You must now decide whether or not you wish to hold any of the tickets. If you hold the ticket which is randomly chosen for payment, the price of the ticket will be subtracted from your beginning balance.
Step 4: The value scale

You will be asked to indicate the value of any tickets you hold on a scale from $0.00 to $10.00. To indicate the value of a ticket to you, think of whether you would prefer a certain dollar and cents amount or the ticket. We assume you would prefer the ticket to $0.00. Now move up the scale and ask yourself the same question for increasing dollar amounts. The amount at which you are indifferent between dollar payment and the ticket is your valuation.

Step 5: The ticket selected for payment

A ticket will randomly be selected for payment. This will be done by rolling a die. If 1 comes up, the ticket chosen will be A1, if 2 comes up it will be A2, and so on. A random valuation will also be generated. This is the experimenter’s valuation of the chosen ticket.

Step 6: Your earnings

If you do not hold the chosen ticket, you will only have your beginning balance.

If you hold the chosen ticket, its price will be deducted from your beginning balance. Then, your valuation of the ticket ($V$) will be compared with that of the experimenter’s valuation ($V_1$).

Case 1: $V \geq V_1$. In this case you will play the lottery represented by the ticket.

Case 2: $V < V_1$. In this case you will be paid $V_1$ for the ticket.

Before we begin, if you have any questions, please ask the experimenter now. We will not begin, until everyone understands the experiment.

Note: The chosen ticket, $V_1$, and your earnings will be decided later by a computer program, and your earnings will be calculated by the experimenter. You will know your earnings within a week’s time.

Some examples are provided to explain the experiment more clearly. The experimenter will go through each example. Think about what the outcome should be in each scenario. Make sure you understand all examples before we begin the experiment.

1. Michael chooses to hold only ticket 4. The ticket randomly selected for payment is ticket 5.
2. John chooses to hold tickets 3, 5, and 6. He values the tickets at $3, $5, and $6 respectively. The ticket selected for payment is ticket 3. The experimenter’s valuation is $7.
3. Same example as above, but now the experimenter’s valuation is $1.

You will now be asked which tickets you would like to hold. The following are the thoughts of some previous subjects who faced the same question. Note, the answers have been selected randomly, and may have led to good or bad outcomes for the subject. It is up to you to decide if you find any of these arguments convincing. They are simply provided to help you.
1. “I would like to hold all tickets with the exception of ticket 6. I can ensure that if a ticket is chosen, I can get at least $2.50 back. E.g. Ticket 5 = (2.50 – 2) = $0.50 + any valuation > 2.50 with or without lottery. I hold A6 as well because I am not risk averse in this case.”

2. “Expected value of each ticket is approximately $4.50, I think... so all tickets are worth it.”

3. “I would like to hold all tickets to maximize my chances of both playing the lottery and the possibility of having my tickets bought by the experimenter. The possibility of having more money is worth losing some.”

4. “I would choose to hold all tickets because the maximum amount I could lose is $2.50 seeing as if I’m holding ticket 6 and it gets selected, then 2.50 will be deducted from my initial balance and if my valuation is greater than the experimenter’s, I choose to gain.”

5. “Low cost ones, several so that ticket is chosen. Low cost means that I can value lower which gives a better chance of getting paid.”

6. “I’m going to hold all the tickets because for any one of them I think the payoff is higher than the cost.”

1. Please circle the tickets you would like to hold.
   A1    A2    A3    A4    A5    A6

Now you will be asked to value the tickets that you have chosen to hold. The following are the thoughts of some previous subjects who faced the same question. Note, the answers have been selected randomly, and may have led to good or bad outcomes for the subject. It is up to you to decide if you find any of these arguments convincing. They are simply provided to help you.

1. “Valuation = Expected value – price

<table>
<thead>
<tr>
<th>Ticket</th>
<th>Valuation</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>4.50</td>
</tr>
<tr>
<td>T2</td>
<td>4.00</td>
</tr>
<tr>
<td>T3</td>
<td>3.50</td>
</tr>
<tr>
<td>T4</td>
<td>3.00</td>
</tr>
<tr>
<td>T5</td>
<td>2.50</td>
</tr>
<tr>
<td>T6</td>
<td>2.00</td>
</tr>
</tbody>
</table>

2. “Valuation at which indifferent, same as payment schedule. Each ticket valued at $4.50”

3. “I choose $4.50 for all tickets because that’s the expected value of the lottery. If V1 > 4.50, then there is only upside for me.”

4. “I would choose to value all tickets at $10 because this is the highest valuation so is likely to be the same, if not higher than the experimenters so I know one ticket will always be deducted from my initial balance but I will also always get to play the lottery and stand to gain.”

5. “Cost doesn’t matter. Average price of lottery is about $4.5”

6. For low cost tickets I don’t have much to lose at lottery, so I give myself a 50% chance to at least make my valuation.”
2. For each ticket that you have chosen to hold, please provide a valuation.
   I. A1 –
   II. A2 –
   III. A3 –
   IV. A4 –
   V. A5 –
   VI. A6 –
Welcome to Stage 2 of today’s experiment. Please make the choice that represents your preferences.

After you view the question, you will be shown a series of statements from previous subjects, regarding the question. These are their explanations for the choices they made. After this, you will be asked to make your choice.

Consider the following hypothetical scenario. Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which without any intervention is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume the exact scientific estimates of the consequences of the programs are as follows.

In the group of 600 people,

C. Program C: If this program is followed, 400 people will die with certainty.
D. Program D: If this program is followed, there is a one-third probability that nobody will die, and a two-third probability that 600 people will die.

Note:

1. You will be paid according to the number of people that die. (The lower the number of people that die, the higher your payoff.)

<table>
<thead>
<tr>
<th>Earnings</th>
<th>Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>600 people dead</td>
</tr>
<tr>
<td>$2</td>
<td>400 people dead</td>
</tr>
<tr>
<td>$6</td>
<td>0 people dead</td>
</tr>
</tbody>
</table>

2. According to your choices, an actual scenario will be generated by the computer using a randomizing function based on the probabilities indicated.

Previous subjects’ thoughts and explanations

1. “I’m risky, therefore D.”
2. “If C is followed, I know 200 people will survive with certainty. I would have to choose C because I would have a guaranteed $2.”
3. “It looks like the least risky option is to save 200 lives with certainty.”
4. “C because it lets you definitely save 200 people.”
5. “D because if all these people will be dying why not take the risk to save all of them? That’s what Batman would do.”
6. “Expected values are equal. I choose C to guarantee that 200 people live.”

Please indicate your choice by circling one of the following options.

A          B
Welcome to Stage 3 of today’s experiment. Please make the choice that represents your preferences.

After you view the question, you will be shown a series of statements from previous subjects, regarding the question. These are their explanations for the choices they made. After this, you will be asked to make your choice.

You have two urns, urn A and urn B. Urn A contains 49 red balls and 51 black balls. Urn B contains an unknown proportion of red and black balls, but we know that the total number of balls in Urn B is also 100. In other words Urn B contains x red balls and (100-x) black balls, where 0 <= x <= 100.

Your aim is to pick a red ball from an urn of your choice. If you successfully pick a red ball, you will receive $2, otherwise you will receive nothing. Which urn would you pick from?

Note:

1. The contents of Urn B have been generated uniquely for each participant using a randomizing function, so the chances of having 0 red balls, 100 red balls, or any other number of red balls between 0 and 100 are equal. This proportion will become known to the experimenter only after the experiment is complete.
2. When you choose an urn, a ball will be randomly picked for you by the computer. The probability of picking a red ball is therefore equal to the number of red balls in the chosen urn divided by the total number of balls in the urn.

**Previous subjects’ thoughts and explanations**

1. “Urn A is essentially 49% of picking a red ball. However, Urn B, has a 51% chance of the urn having 49 or more red balls so overall greater chance of picking a red ball.”
2. “B because on average there should be more red balls in it (higher payoff).”
3. “I think there is a near 50/50 chance of choosing a red ball from Urn A, while there is a 50/50 chance that there are more red balls than black in Urn B. I think it almost doesn’t matter which Urn is chosen.”
4. “The overall probability of red ball for Urn B is 50%, and that of Urn A is 49%.”
5. “Urn B has the probability of having 0 red balls or 100. It’s definitely a riskier choice. I think I would be better off choosing Urn A because I at least know it actually contains red balls.”
6. “I prefer the larger degree of certainty of Urn A rather than the risk of Urn B, so I choose Urn A. Choosing Urn B involves two levels of risk, whereas Urn A only has one variable. Therefore I choose Urn A.”

Please indicate your choice by circling one of the following options.

Urn A    Urn B
Appendix IVA

Name:

Concentration:

Semester level:

Mailbox number:

Instructions:
This is an experiment in the economics of decision making conducted by Rohan Thakur, senior economics concentrator at Brown University, and to be used for his honors thesis. Funds for this experiment have been provided by the Brown University Dean’s office.

The experiment has three stages, and in each stage, you will be paid based on your decisions. Your earnings will be put in your mailbox within a week from the day the experiment was conducted.

During the experiment, you will not be allowed to talk to anyone with the exception of the experimenter. If you have any questions, or need any clarifications, please raise your hand and the experimenter will come to you. Please do not begin a new stage of the experiment, until the experimenter has instructed you to do so. We will proceed to the next stage once everyone has completed the current stage of the experiment. The entire experiment should take not more than an hour to finish.

We will now begin Stage 1 of the experiment. Please switch off your cellphones. Good luck!

Note: Your completion and return of the questionnaire indicates your consent to participate in this study.

Signature: Date:
Welcome to Stage 1 of today’s experiment. Please make the choice that represents your preferences.

**List of experimental steps:**

**Step 1: Six tickets offered**

You have a beginning balance of $2.50. Six tickets (A1 – A6) are offered to you at gradually increasing prices. One of these tickets will be randomly picked for payment at the end of the experiment. The tickets are represented by the following table.

<table>
<thead>
<tr>
<th>Name</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ticket 1</td>
<td>$0.00</td>
</tr>
<tr>
<td>Ticket 2</td>
<td>$0.50</td>
</tr>
<tr>
<td>Ticket 3</td>
<td>$1.00</td>
</tr>
<tr>
<td>Ticket 4</td>
<td>$1.50</td>
</tr>
<tr>
<td>Ticket 5</td>
<td>$2.00</td>
</tr>
<tr>
<td>Ticket 6</td>
<td>$2.50</td>
</tr>
</tbody>
</table>

**Step 2: The payment table**

All tickets entitle the owner to a payment decided by the roll of a six-sided die. For all tickets, the same payment table describes the amount paid for each number on the die.

<table>
<thead>
<tr>
<th>Number on die</th>
<th>Payment received</th>
<th>Probability of receiving corresponding payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$2</td>
<td>1/6</td>
</tr>
<tr>
<td>2</td>
<td>$3</td>
<td>1/6</td>
</tr>
<tr>
<td>3</td>
<td>$4</td>
<td>1/6</td>
</tr>
<tr>
<td>4</td>
<td>$5</td>
<td>1/6</td>
</tr>
<tr>
<td>5</td>
<td>$6</td>
<td>1/6</td>
</tr>
<tr>
<td>6</td>
<td>$7</td>
<td>1/6</td>
</tr>
</tbody>
</table>

**Step 3: The decision to hold tickets**

You must now decide whether or not you wish to hold any of the tickets. If you hold the ticket which is randomly chosen for payment, the price of the ticket will be subtracted from your beginning balance.
Step 4: The value scale

You will be asked to indicate the value of any tickets you hold on a scale from $0.00 to $10.00. To indicate the value of a ticket to you, think of whether you would prefer a certain dollar and cents amount or the ticket. We assume you would prefer the ticket to $0.00. Now move up the scale and ask yourself the same question for increasing dollar amounts. The amount at which you are indifferent between dollar payment and the ticket is your valuation.

Step 5: The ticket selected for payment

A ticket will randomly be selected for payment. This will be done by rolling a die. If 1 comes up, the ticket chosen will be A1, if 2 comes up it will be A2, and so on. A random valuation will also be generated. This is the experimenter’s valuation of the chosen ticket.

Step 6: Your earnings

If you do not hold the chosen ticket, you will only have your beginning balance.

If you hold the chosen ticket, its price will be deducted from your beginning balance. Then, your valuation of the ticket (V) will be compared with that of the experimenter’s valuation (V1).

Case 1: V ≥ V1. In this case you will play the lottery represented by the ticket.

Case 2: V < V1. In this case you will be paid V1 for the ticket.

Before we begin, if you have any questions, please ask the experimenter now. We will not begin, until everyone understands the experiment.

Note: The chosen ticket, V1, and your earnings will be decided later by a computer program, and your earnings will be calculated by the experimenter. You will know your earnings within a week’s time.

Some examples are provided to explain the experiment more clearly. The experimenter will go through each example. Think about what the outcome should be in each scenario. Make sure you understand all examples before we begin the experiment.

1. Michael chooses to hold only ticket 4. The ticket randomly selected for payment is ticket 5.
2. John chooses to hold tickets 3, 5, and 6. He values the tickets at $3, $5, and $6 respectively. The ticket selected for payment is ticket 3. The experimenter’s valuation is $7.
3. Same example as above, but now the experimenter’s valuation is $1.

You will now be asked which tickets you would like to hold. The following is the experimenter’s answer to the problem. It is up to you to decide if you find his argument convincing. If you do not find it convincing, you should not let it influence you.

The expected value of a die roll is 3.50. Since each lottery is identical, and gives you the outcome of a die roll plus a dollar, the expected value of each lottery is $4.50. Thus, for each lottery, price is less than expected value. Therefore, all tickets should be held.
1. Please circle the tickets you would like to hold.
   A1  A2  A3  A4  A5  A6

Now you will be asked to value the tickets that you have chosen to hold. The following is the experimenter’s answer to the problem. It is up to you to decide if you find his argument convincing. If you do not find it convincing, you should not let it influence you.

Once a ticket is held, its price is irrelevant to the outcome it will give you, and should be treated as a sunk cost. Thus, valuation should depend simply on the expected value of the ticket. Since the expected value of every ticket is $4.50, one should ideally value each ticket identically at $4.50. However, it is also optimal to value each ticket more or less than the expected value, depending on risk preference, as long as all tickets are valued identically.

2. For each ticket that you have chosen to hold, please provide a valuation.
   I.  A1 –
   II. A2 –
   III. A3 –
   IV. A4 –
   V.  A5 –
   VI. A6 –
Welcome to Stage 2 of today’s experiment. Please make the choice that represents your preferences.

After you view the question, you will be provided with the experimenter’s explanation about the question. After this, you will be asked to make your choice.

Consider the following hypothetical scenario. Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which without any intervention is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume the exact scientific estimates of the consequences of the programs are as follows.

In the group of 600 people,

A. Program A: If this program is followed, 200 people will be saved with certainty.
B. Program B: If this program is followed, there is a one-third probability that 600 people will be saved, and a two-thirds probability that no people will be saved

Note:
1. You will be paid according to the number of people that are saved. (The higher the number of people saved, the higher your payoff.)

<table>
<thead>
<tr>
<th>Earnings</th>
<th>Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>0 people saved</td>
</tr>
<tr>
<td>$2</td>
<td>200 people saved</td>
</tr>
<tr>
<td>$6</td>
<td>600 people saved</td>
</tr>
</tbody>
</table>

2. According to your choices, an actual scenario will be generated by the computer using a randomizing function based on the probabilities indicated.

**Experimenter’s explanation:**

*The framing effect is a common bias found in behavioral economics, where the same question or task framed differently, elicits different responses from subjects.*

*In this example, realize that your options could have been framed as the following:*

- B. Program C: If this program is followed, 400 people will die with certainty.
- C. Program D: If this program is followed, there is a one-third probability that nobody will die, and a two-third probability that 600 people will die.

You should now be able to see that there is no difference in the outcomes between options a. and c., and options b. and d. Therefore, regardless of the framing of the question, your answer should be the same. Remember to only choose your true preferences no matter how a question is framed.

Please indicate your choice by circling one of the following options.

A  B
Welcome to Stage 3 of today’s experiment. Please make the choice that represents your preferences.

After you view the question, you will be provided with the experimenter’s explanation about the question. After this, you will be asked to make your choice.

You have two urns, urn A and urn B. Urn A contains 49 red balls and 51 black balls. Urn B contains an unknown proportion of red and black balls, but we know that the total number of balls in Urn B is also 100. In other words Urn B contains x red balls and (100-x) black balls, where 0 <= x <= 100.

Your aim is to pick a red ball from an urn of your choice. If you successfully pick a red ball, you will receive $2, otherwise you will receive nothing. Which urn would you pick from?

Note:

1. The contents of Urn B have been generated uniquely for each participant using a randomizing function, so the chances of having 0 red balls, 100 red balls, or any other number of red balls between 0 and 100 are equal. This proportion will become known to the experimenter only after the experiment is complete.
2. When you choose an urn, a ball will be randomly picked for you by the computer. The probability of picking a red ball is therefore equal to the number of red balls in the chosen urn divided by the total number of balls in the urn.

**Experimenter’s explanation**

In decision theory and economics, ambiguity aversion (also known as uncertainty aversion) describes an attitude of preference for known risks over unknown risks. However, if one is to maximize utility, one should choose the risk with higher expected value, regardless of whether the risk is ambiguous or not.

In this experiment, you should realize that if you pick urn A, the probability of obtaining a red ball is 49%. If you pick urn B, the expected probability of obtaining a red ball is 50%. This is because the share of red balls may be any share from 0% to 100% with equal probability, so on average the share of red balls is 50%. Thus, if you want to maximize your chances of winning, you should pick urn B even though the true probabilities of picking red and black balls from this urn are ambiguous.

Please indicate your choice by circling one of the following options.

Urn A          Urn B
Appendix IVB

Name:

Concentration:

Semester level:

Mailbox number:

Instructions:
This is an experiment in the economics of decision making conducted by Rohan Thakur, senior economics concentrator at Brown University, and to be used for his honors thesis. Funds for this experiment have been provided by the Brown University Dean’s office.

The experiment has three stages, and in each stage, you will be paid based on your decisions. Your earnings will be put in your mailbox within a week from the day the experiment was conducted.

During the experiment, you will not be allowed to talk to anyone with the exception of the experimenter. If you have any questions, or need any clarifications, please raise your hand and the experimenter will come to you. Please do not begin a new stage of the experiment, until the experimenter has instructed you to do so. We will proceed to the next stage once everyone has completed the current stage of the experiment. The entire experiment should take not more than an hour to finish.

We will now begin Stage 1 of the experiment. Please switch off your cellphones. Good luck!

Note: Your completion and return of the questionnaire indicates your consent to participate in this study.

Signature: ___________________________ Date: ___________________________
Welcome to Stage 1 of today’s experiment. Please make the choice that represents your preferences.

**List of experimental steps:**

**Step 1: Six tickets offered**

You have a beginning balance of $2.50. Six tickets (A1 – A6) are offered to you at gradually increasing prices. One of these tickets will be randomly picked for payment at the end of the experiment. The tickets are represented by the following table.

<table>
<thead>
<tr>
<th>Name</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ticket 1</td>
<td>$0.00</td>
</tr>
<tr>
<td>Ticket 2</td>
<td>$0.50</td>
</tr>
<tr>
<td>Ticket 3</td>
<td>$1.00</td>
</tr>
<tr>
<td>Ticket 4</td>
<td>$1.50</td>
</tr>
<tr>
<td>Ticket 5</td>
<td>$2.00</td>
</tr>
<tr>
<td>Ticket 6</td>
<td>$2.50</td>
</tr>
</tbody>
</table>

**Step 2: The payment table**

All tickets entitle the owner to a payment decided by the roll of a six-sided die. For all tickets, the same payment table describes the amount paid for each number on the die.

<table>
<thead>
<tr>
<th>Number on die</th>
<th>Payment received</th>
<th>Probability of receiving corresponding payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$2</td>
<td>1/6</td>
</tr>
<tr>
<td>2</td>
<td>$3</td>
<td>1/6</td>
</tr>
<tr>
<td>3</td>
<td>$4</td>
<td>1/6</td>
</tr>
<tr>
<td>4</td>
<td>$5</td>
<td>1/6</td>
</tr>
<tr>
<td>5</td>
<td>$6</td>
<td>1/6</td>
</tr>
<tr>
<td>6</td>
<td>$7</td>
<td>1/6</td>
</tr>
</tbody>
</table>

**Step 3: The decision to hold tickets**

You must now decide whether or not you wish to hold any of the tickets. If you hold the ticket which is randomly chosen for payment, the price of the ticket will be subtracted from your beginning balance.
Step 4: The value scale

You will be asked to indicate the value of any tickets you hold on a scale from $0.00 to $10.00. To indicate the value of a ticket to you, think of whether you would prefer a certain dollar and cents amount or the ticket. We assume you would prefer the ticket to $0.00. Now move up the scale and ask yourself the same question for increasing dollar amounts. The amount at which you are indifferent between dollar payment and the ticket is your valuation.

Step 5: The ticket selected for payment

A ticket will randomly be selected for payment. This will be done by rolling a die. If 1 comes up, the ticket chosen will be A1, if 2 comes up it will be A2, and so on. A random valuation will also be generated. This is the experimenter’s valuation of the chosen ticket.

Step 6: Your earnings

If you do not hold the chosen ticket, you will only have your beginning balance.

If you hold the chosen ticket, its price will be deducted from your beginning balance. Then, your valuation of the ticket (V) will be compared with that of the experimenter’s valuation (V1).

Case 1: V≥V1. In this case you will play the lottery represented by the ticket.

Case 2: V< V1. In this case you will be paid V1 for the ticket.

Before we begin, if you have any questions, please ask the experimenter now. We will not begin, until everyone understands the experiment.

Note: The chosen ticket, V1, and your earnings will be decided later by a computer program, and your earnings will be calculated by the experimenter. You will know your earnings within a week’s time.

Some examples are provided to explain the experiment more clearly. The experimenter will go through each example. Think about what the outcome should be in each scenario. Make sure you understand all examples before we begin the experiment.

1. Michael chooses to hold only ticket 4. The ticket randomly selected for payment is ticket 5.
2. John chooses to hold tickets 3, 5, and 6. He values the tickets at $3, $5, and $6 respectively. The ticket selected for payment is ticket 3. The experimenter’s valuation is $7.
3. Same example as above, but now the experimenter’s valuation is $1.

You will now be asked which tickets you would like to hold. The following is the experimenter’s answer to the problem. It is up to you to decide if you find his argument convincing. If you do not find it convincing, you should not let it influence you.

The expected value of a die roll is 3.50. Since each lottery is identical, and gives you the outcome of a die roll plus a dollar, the expected value of each lottery is $4.50. Thus, for each lottery, price is less than expected value. Therefore, all tickets should be held.
1. Please circle the tickets you would like to hold.

A1   A2   A3   A4   A5   A6

Now you will be asked to value the tickets that you have chosen to hold. The following is the experimenter’s answer to the problem. It is up to you to decide if you find his argument convincing. If you do not find it convincing, you should not let it influence you.

*Once a ticket is held, its price is irrelevant to the outcome it will give you, and should be treated as a sunk cost. Thus, valuation should depend simply on the expected value of the ticket. Since the expected value of every ticket is $4.50, one should ideally value each ticket identically at $4.50. However, it is also optimal to value each ticket more or less than the expected value, depending on risk preference, as long as all tickets are valued identically.*

2. For each ticket that you have chosen to hold, please provide a valuation.

   I. A1 –
   II. A2 –
   III. A3 –
   IV. A4 –
   V. A5 –
   VI. A6 –
Welcome to Stage 2 of today’s experiment. Please make the choice that represents your preferences.

After you view the question, you will be provided with the experimenter’s explanation about the question. After this, you will be asked to make your choice.

Consider the following hypothetical scenario. Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which without any intervention is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume the exact scientific estimates of the consequences of the programs are as follows.

In the group of 600 people,

C. Program C: If this program is followed, 400 people will die with certainty.
D. Program D: If this program is followed, there is a one-third probability that nobody will die, and a two-thirds probability that 600 people will die.

Note:

1. You will be paid according to the number of people that die. (The lower the number of people that die, the higher your payoff.)

<table>
<thead>
<tr>
<th>Earnings</th>
<th>Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0</td>
<td>600 people dead</td>
</tr>
<tr>
<td>$2</td>
<td>400 people dead</td>
</tr>
<tr>
<td>$6</td>
<td>0 people dead</td>
</tr>
</tbody>
</table>

2. According to your choices, an actual scenario will be generated by the computer using a randomizing function based on the probabilities indicated.

**Experimenter’s explanation**

The framing effect is a common bias found in behavioral economics, where the same question or task framed differently, elicits different responses from subjects. Remember to only choose your true preferences no matter how a question is framed.

In this example, realize that your options could have been framed as the following:

a. Program A: If this program is followed, 200 people will be saved with certainty.
b. Program B: If this program is followed, there is a one-third probability that 600 people will be saved, and a two-thirds probability that no people will be saved.

You should now be able to see that there is no difference in the outcomes between options a. and c., and options b. and d. Therefore, regardless of the framing of the question, your answer should be the same. Remember to only choose your true preferences no matter how a question is framed.

Please indicate your choice by circling one of the following options. A B
Welcome to Stage 3 of today’s experiment. Please make the choice that represents your preferences.

After you view the question, you will be provided with the experimenter’s explanation about the question. After this, you will be asked to make your choice.

You have two urns, urn A and urn B. Urn A contains 49 red balls and 51 black balls. Urn B contains an unknown proportion of red and black balls, but we know that the total number of balls in Urn B is also 100. In other words Urn B contains x red balls and (100-x) black balls, where 0 <= x <= 100.

Your aim is to pick a red ball from an urn of your choice. If you successfully pick a red ball, you will receive $2, otherwise you will receive nothing. Which urn would you pick from?

Note:

1. The contents of Urn B have been generated uniquely for each participant using a randomizing function, so the chances of having 0 red balls, 100 red balls, or any other number of red balls between 0 and 100 are equal. This proportion will become known to the experimenter only after the experiment is complete.
2. When you choose an urn, a ball will be randomly picked for you by the computer. The probability of picking a red ball is therefore equal to the number of red balls in the chosen urn divided by the total number of balls in the urn.

**Experimenter’s explanation**

In decision theory and economics, ambiguity aversion (also known as uncertainty aversion) describes an attitude of preference for known risks over unknown risks. However, if one is to maximize utility, one should choose the risk with higher expected value, regardless of whether the risk is ambiguous or not.

In this experiment, you should realize that if you pick urn A, the probability of obtaining a red ball is 49%. If you pick urn B, the expected probability of obtaining a red ball is 50%. This is because the share of red balls may be any share from 0% to 100% with equal probability, so on average the share of red balls is 50%. Thus, if you want to maximize your chances of winning, you should pick urn B even though the true probabilities of picking red and black balls from this urn are ambiguous.

Please indicate your choice by circling one of the following options.

Urn A   Urn B