4-14-2016

How Surprise Affects Decision-Making Behavior: An Adaptation of Prospect Theory

Edward Yonkers
Lake Forest College, yonkerseh@lakeforest.edu

Follow this and additional works at: http://publications.lakeforest.edu/seniortheses
Part of the Behavioral Economics Commons, and the Economic Theory Commons

Recommended Citation

This Thesis is brought to you for free and open access by the Student Publications at Lake Forest College Publications. It has been accepted for inclusion in Senior Theses by an authorized administrator of Lake Forest College Publications. For more information, please contact levinson@lakeforest.edu.
How Surprise Affects Decision-Making Behavior: An Adaptation of Prospect Theory

Abstract
Prospect theory describes how people evaluate decisions under risk. I modify prospect theory to account for how ex-post surprise affects an individual’s evaluation of subsequent prospects. Based on this adaptation of prospect theory, I hypothesize that unexpected outcomes yield greater utility or disutility compared to expected outcomes due to expectations-based reference points. The effect surprise has on utility should manifest itself in terms of risk preferences and ex-post reference point shift. Two experiments are conducted to measure the effect of surprise on utility, risk preferences, and reference point shift. Data is collected from undergraduate students at Lake Forest College. The results show evidence for expectations-based reference points, utility of surprise outcomes is greater than expected outcomes, and reference point shift is faster in surprise outcomes. Refinements to the experimental protocols are explored to inform future research. Policy implications concerning financial markets, marketing, and general decision-making are discussed.

Document Type
Thesis

Distinguished Thesis
Yes

Degree Name
Bachelor of Arts (BA)

Department or Program
Economics

First Advisor
Amanda J. Felkey

Second Advisor
Robert J. Lemke

Third Advisor
Matthew R. Kelley

Subject Categories
Behavioral Economics | Economic Theory

This thesis is available at Lake Forest College Publications: http://publications.lakeforest.edu/seniortheses/70
Your thesis will be deposited in the Lake Forest College Archives and the College’s online digital repository, Lake Forest College Publications. This agreement grants Lake Forest College the non-exclusive right to distribute your thesis to researchers and over the Internet and make it part of the Lake Forest College Publications site. You warrant:

- that you have the full power and authority to make this agreement;
- that you retain literary property rights (the copyright) to your work. Current U.S. law stipulates that you will retain these rights for your lifetime plus 70 years, at which point your thesis will enter common domain;
- that for as long you as you retain literary property rights, no one may sell your thesis without your permission;
- that the College will catalog, preserve, and provide access to your thesis;
- that the thesis does not infringe any copyright, nor violate any proprietary rights, nor contain any libelous matter, nor invade the privacy of any person or third party;
- If you request that your thesis be placed under embargo, approval from your thesis chairperson is required.

By signing below, you indicate that you have read, understand, and agree to the statements above.

**Printed Name:** Edward Yonkers

**Thesis Title:** How Surprise Affects Decision-Making Behavior: An Adaptation of Prospect Theory

*This thesis is available at Lake Forest College Publications: [http://publications.lakeforest.edu/seniortheses/70](http://publications.lakeforest.edu/seniortheses/70)*
LAKE FOREST COLLEGE
Senior Thesis

How Surprise Affects Decision-Making Behavior: An Adaptation of Prospect Theory

by

Edward Yonkers

April 14, 2016

The report of the investigation undertaken as a Senior Thesis, to carry two courses of credit in the Department of Economics

__________________________  __________________________
Michael T. Orr              Amanda J. Felkey, Chairperson
Krebs Provost and Dean of the Faculty

__________________________
Robert J. Lemke

__________________________
Matthew R. Kelley
Abstract: Prospect theory describes how people evaluate decisions under risk. I modify prospect theory to account for how ex-post surprise affects an individual’s evaluation of subsequent prospects. Based on this adaptation of prospect theory, I hypothesize that unexpected outcomes yield greater utility or disutility compared to expected outcomes due to expectations-based reference points. The effect surprise has on utility should manifest itself in terms of risk preferences and ex-post reference point shift. Two experiments are conducted to measure the effect of surprise on utility, risk preferences, and reference point shift. Data is collected from undergraduate students at Lake Forest College. The results show evidence for expectations-based reference points, utility of surprise outcomes is greater than expected outcomes, and reference point shift is faster in surprise outcomes. Refinements to the experimental protocols are explored to inform future research. Policy implications concerning financial markets, marketing, and general decision-making are discussed.
This thesis is dedicated to all of the professors who inspired me to work my hardest
during my time at Lake Forest College.
Acknowledgments

Thank you to Professor Carolyn Kent Grote, Professor Robert Lemke, Professor Susan Long, and Professor Carolyn Tuttle for sacrificing their class times to allow me to collect data for my research. Thank you to Artie Foster for guiding me through the early writing stages of my thesis. Thank you to Professor Matthew Kelley for his valuable input on the psychological aspects of my literature review, and for taking the time to be on my thesis committee. Thank you to Professor Scott Drewianka for giving me helpful critical insight on several aspects of my thesis. Thank you to Professor Robert Lemke for his advice on my methods of experimentation and analysis, as well as for being on my thesis committee. There are several aspects of my research that can be credited to his advice. Finally, my greatest thanks go to Professor Amanda Felkey. Professor Felkey has been my adviser, professor, and mentor since my freshman year. During my four years as an undergraduate, Professor Felkey has always given me the perfect balance of challenge and support, guiding me to the achievements of which I am most proud. I genuinely would not have the successes of my time as an undergraduate were it not for her.
# Table of Contents

I – Introduction: 1

II – Literature Review: 2
   A – Motivation: 2
   B – Models of decision-making behavior: 7
   C – Prospect theory: 11
   D – Expectations-based reference points: 17
   E – Adapting prospect theory to account for how surprises affect behavior: 21
   F – Testing for the effects of surprise on behavior: 25

III – Methods: 27
   A – Participants: 27
   B – Materials and incentive system: 27
   C – General procedures: 28

IV – Experiment 1: 31
   A – Design: 31
   B – Predictions: 36
   C – Results: 39
   D – Discussion: 42

V – Experiment 2: 44
   A – Design: 44
   B – Predictions: 48
   C – Results: 51
   D – Discussion: 63

VI – Conclusions: 66
   A – Considering the effectiveness of my adaptation to prospect theory: 66
   B – Potential improvements to methods: 69
   C – Suggestions for future research: 73
   D – Policy implications: 75
   E – Final statement: 77
I. Introduction

There is a reason why adding the word “surprisingly” to the words good or bad enhances their meanings. Surprising outcomes elicit greater responses than expected outcomes. That is why we wrap presents and hold surprise parties; the surprise makes the outcome better. The feeling of bad outcomes is also enhanced by surprise; if someone cannot make it to a party you are hosting, it feels much worse if they do not tell you ahead of time. In economic terms surprising outcomes generate more utility or disutility than expected outcomes.

Evidence that surprise increases the utility of an outcome in the direction of the surprise has been noted in several different fields (Vanhamme and Snelders 2001; Chang 2011). However, research into how surprise affects decision-making behavior after the surprise occurs is relatively limited. If surprise affects behavior to a large enough degree, there are important implications for corporate policy, public policy, and individual well-being. For example, several studies already suggest that surprise affects investor behavior in a variety of settings (Ball and Brown 1968; Kasznik and Lev 1995; Chang 2011). Therefore it is worthwhile to determine precisely how surprise may affect decision-making behavior.

The theoretical framework for my investigation into surprise is based on prospect theory (Kahneman and Tversky 1979). Prospect theory is one of the most widely accepted theories explaining how people make decisions under risk. In summary, prospect theory states that people are more risky when they face losses, less risky when they face gains, and that the perception of whether an outcome is a loss or gain depends on one’s reference point. I adapt this theory so that prior outcomes affect how people
evaluate future decisions, accounting for the effect surprise has on the utility of those prior outcomes. I argue that positive surprises cause future prospects to be evaluated further into the domain of gain, thereby reducing risk-seeking. Likewise, negative surprises cause future prospects to be evaluated further into the domain of loss, thereby increasing risk-seeking.

I will test for the validity of my claim using two experiments. The first is based on an experiment first performed by Arkes et al. (2008) during their investigation into how expectations affect reference point formation. The second is based on an experiment first performed by Holt and Laury (2002) during their investigation into what affects risk preferences. I modify the experiments in order to look specifically at how surprise outcomes affect behavior in subsequent decisions.

The structure of my thesis is the following. To begin, I discuss the motivation for this research. Then I summarize the development of theories about individual decision-making behavior. Next I explain the methods of how to test my claim in terms of what results will provide evidence supporting my theory. I then show how the two experiments I have chosen to conduct will prompt the behaviors that could support my theory. Next I describe how the experiments went in reality, and the results of those experiments. Finally, I discuss the results, make conclusions based on those results, discuss how my model and methods can be improved for future research, outline potential policy implications of my results, and make my concluding statements.

II. Literature Review

A. Motivation

In order to conceptualize how surprise affects behavior, it is easiest to begin by considering surprise on the personal scale. By studying purchase experience diaries and
questionnaires about purchase experiences, Vanhamme and Snelders (2001) show that surprise plays an important role in consumer satisfaction. In particular, products which give the consumer some sort of positive surprise yield customers the highest utility, and products which give the consumer some sort of negative surprise yield the lowest utility. Vanhamme and Snelders provide several explanations for why positive and negative surprises enhance or reduce respectively the satisfaction a consumer experiences. They argue that the initial arousal of surprise “contaminates” the emotions following the surprise, enhancing or diminishing the overall experience.

Surprises also have significant effects on financial markets. Not only are there several terms used in the world of finance that refer specifically to the unique behaviors which result from surprises, there are also strategies used by both firms and governments which blatantly take into account the fact that surprise is affecting behavior.

First, consider the phenomenon known as post-earnings-announcement drift, or PEAD. This effect, first documented by Ball and Brown (1968), causes stock prices to consistently drift in the direction of an earnings surprise. That is, if the earnings a company reports are larger than what was predicted, the price of that company’s stock will continue to go up for at least 60 days after the earnings announcement. If reported earnings are below what was predicted, the price of that company’s stock will continue to fall for at least 60 days (Bernard and Thomas 1989). In this case, an earnings surprise has a direct short term effect on investor behavior toward that company. Given that stock prices update with new information in a matter of minutes and even seconds, (Busse and Green 2002), it is unlikely that PEAD is a result of prices updating with new information. There has been significant discourse as to why PEAD occurs (Bernard and Thomas 1989; Shane and Brous 2001), but there is yet to be a general consensus.
Kasznik and Lev (1995) find that firms will strategically choose when to disclose earnings forecasts due to the effect of earnings surprises on investor behavior. In particular, Kasznik and Lev find that a company is more likely to release an earnings forecast if they are facing long term structural losses. One explanation for this behavior is that large, long-term structural losses are especially discouraging to investors if the losses are surprising, so it is better to warn investors of these losses ahead of time.

Chang (2011) shows that unexpected monetary policy changes affect financial markets more than expected monetary policy changes. In particular, Chang shows that unexpected contractionary policies have a larger negative effect on the returns to real estate investment trusts (REIT) as compared to expected changes. Because the money supply and interest rates play such a critical role in the global economy, surprise monetary policy changes may have an expanding ripple effect which affects other areas of the economy.

Several studies by psychologists and neurologists have also shown that surprises cause measurable changes in behavior. For example, Rescorla and Wagner (1972) find that conditioning speed, or the speed at which an individual is trained to respond to a given stimulus, is affected greatly by whether one was expecting that stimulus. The Rescorla-Wagner model is defined mathematically as the following. Let $V$ represent the agent’s associative value of the stimuli prior to an unconditioned stimulus. Let $\lambda$ represent the unconditioned stimulus itself. Therefore, $(\lambda-V)$ represents the difference between what happens and what one expected. Let $k$ equal a constant for the salience of the stimuli. Finally, let $\Delta V$ represent the change in the associative value of an unconditioned stimulus. Learning is the reduction of the difference between what one
expects will happen and what will actually happen. Therefore the amount one has learned in a certain trial is:

\[ \Delta V = k(\lambda - V) \]

The difference between \( \lambda \) and \( V \) will be very large at the beginning of the learning process, but that difference will become smaller and approach zero as one learns precisely the association between a given stimulus and its outcome. If surprise has an influence on how behaviors are learned and reinforced, then it is possible surprise could affect economic decision-making in games of repeated rounds with incomplete information, as the relationship between a certain choice and outcome may be reinforced at varying rates depending on the level of surprise.

Blanchard and Honig (1976) also investigate factors in the speed of conditioning behavior and find that a stimulus which is a surprise is more effective compared to non-surprising stimuli in reinforcing behaviors. They reach this conclusion after finding subjects who were surprised by their rewards exhibit conditioned behavior more readily than subjects who were not surprised by their rewards. A result found by Donchin (1981) not only supports the conclusion made by Blanchard and Honig concerning the impact surprise has on reinforcement of behavior, but goes further to make another conclusion. That is, learning only occurs if the behavior one is trying to learn is elicited by a surprising stimulus. In other words, one will only store the information of an event if that event is surprising, because it is through surprises that one is able to adjust models of the environment. In the context of economic decision-making, whether one can make sense of a surprise outcome may influence their next decision given the hindsight bias or lack thereof concerning the outcome of the previous surprise.
Pezzo (2003) makes a similar finding concerning the role that surprise has on behavior. Pezzo argues that surprises trigger a “sense-making” process whose outcome can affect hindsight bias, or the feeling that an unpredictable outcome was predictable after the outcome had passed. If one is successful in making sense of an unexpected outcome, then hindsight bias is increased as one can make the connections between the previous conditions and the outcome. If one is unsuccessful in making sense of the outcome then hindsight bias is decreased as one was unable to make the connections between previous conditions and the outcome. The result of the sense-making process and its subsequent effect on hindsight bias could potentially affect future decisions because hindsight bias may create a perception of lower uncertainty or risk. To illustrate this idea, consider an investor who decides to invest in what he believed to be a safe stock. Then, that stock unexpectedly crashes. If the investor is able to successfully make sense of why the stock crashed, he might try investing again as he believes to have a better understanding of why the stock crashed and could avoid the conditions which led to that outcome. If he is unsuccessful in explaining the crash, then he might not invest again (at least in the stock he originally invested in or ones similar to it) in order to avoid the risk of another unexpected loss.

The ways in which surprises can affect behavior are clearly numerous. On the small scale, surprise is shown to affect behavior, and specifically the way in which we learn and perceive the connections between certain conditions and certain outcomes. On the large scale, surprise affects behavior in financial markets whose outcomes can influence several aspects of life in modern industrialized societies. Considering both the small scale and large scale observed effects of surprise on behavior, it is important to have a model which can precisely describe behavior in the context of surprise. In order
to begin discussing a model which accounts for the effect that surprise has on decision-making behavior, it is necessary to first outline the development of prior pertinent models of decision-making behavior.
B. Models of decision-making behavior

Standard microeconomics, assumes two things: (1) economic agents are rational in that they make decisions to maximize utility based on personal preferences, and (2) people have full information of their environment and options when making decisions. Given these assumptions, decisions to consume adhere to four axioms (Autor, 2010).

1. **Completeness**: For every A and B either $A \succ B$, $B \succ A$ or $A \sim B$. Individuals have fully defined preferences.

2. **Transitivity**: If $A \succ B$, and $B \succ C$, then $A \succ C$. Individuals are consistent in their preferences.

3. **Strong Monotonicity**: In simpler terms, more is always better. If bundle A has more X and/or Y than bundle B, then A is preferred to B.

4. **Diminishing Marginal Utility**: Marginal utility of consumption decreases as total consumption increases for each good in any given bundle.

In situations of simply deciding to consume between two goods, standard microeconomics provides an effective model for explaining decision-making behavior. When it comes to decisions under uncertainty or decisions that involve risk, the model loses its predictive power. For example, one of the assumptions of the standard model is that people have full information of their environment. This is not always the case. The standard model also does not discuss how people analyze choices which involve risk. For example, the model cannot show why people decide to gamble or how they gamble when they are forced to do so. The inherent weakness of the standard model of rational behavior in its ability to more realistically explain decisions under risk or uncertainty has led to the development of several models which do account for risk and uncertainty.
Simply using expected value to represent the utility one receives from a gamble implies that people are neutral with regard to risk. For some people this may be true, but it can be plainly observed that some people are risk averse, and others are risk-seeking. Therefore, levels of risk may affect the utility one receives when faced with gambles. In other words, a risk averse person may get utility from the simple guarantee that their wealth will increase. A risk-seeking person may get utility simply from the potential to have a large increase in wealth. Expected utility theory takes the effects that levels of risk have on utility into account.

The assumptions of standard microeconomic theory also apply to expected utility theory (von Neumann and Morgenstern 1956). Additionally, expected utility theory requires two more axioms:

1. **Independence:** If A ≽ B and p∈(0,1), then p(A) + (1-p)C ≽ p(B) + (1-p)C. Introducing an independent gamble does not change the preference ordering of two things had the gamble not been there.

2. **Continuity:** If A ≽ B ≽ C, then there is a probability p such that p(B) ≈ p(A) + (1-p)(C). There is a lottery for B such that one is indifferent between the lottery for B and a mixed lottery of A and C.

If these axioms hold, then the mathematical representation of how risk levels affect utility according to expected utility theory is as follows. Let p represent the distribution of probabilities of outcomes, \( p_i \) represent the probability of \( x_i \) happening, \( u(x_i) \) represent the utility of \( x_i \), and \( U(p) \) represent the utility of the gamble as a whole.

\[
U(p) = \sum u(x_i) \cdot p_i
\]
Using this model, the differences in utility from levels of risk can be captured. For example, consider a situation where one has a 50/50 chance to win $100 or $0, or one can simply take a guaranteed $50. A risk-seeking individual would receive greater utility from taking the gamble. Mathematically, this is represented as $0.5[u(100)] + 0.5[u(0)] > u(50)$. A risk-averse individual would receive greater utility from taking the guaranteed $50, or $0.5[u(100)] + 0.5[u(0)] < u(50)$. The utility of risk as suggested by expected utility theory is represented graphically in Figure 1. Let $X$ represent a certain level of expected wealth gain, $U(x)$ represent the utility of the gamble, $E[U(x)]$ represent the expected utility of getting $X$, and CE represent the certainty equivalent, or the value of an outcome which yields the same expected utility as $X$.

**Figure 1: Expected Utility Theory Value Functions**

![Figure 1: Expected Utility Theory Value Functions](image)

Figure 1 shows the value functions of risk averse, risk neutral, and risk-seeking individuals as hypothesized by expected utility theory. According to the figure, the risk averse individual would receive relatively high utility from outcome $X$. However, the expected utility of outcome $X$ is lower than the utility of outcome $X$. An outcome which yields the same utility as the expected utility of $X$ is smaller than $X$, as denoted by the
blue “CE,” or certainty equivalent. In summary, risk averse individuals are willing to take relatively smaller gains. Therefore, in a decision under risk, the risk averse individual is willing to sacrifice possible larger gains for the guarantee of a smaller gain.

The risk-seeking individual shows the opposite effect. The utility of outcome X is lower than the expected utility of X. An outcome which yields the same utility as the expected utility of X is larger than X, as denoted by the red “CE.” In summary, risk-seeking individuals want only to have larger gains. In a decision under risk, the risk-seeking individual will be willing to take on more risk in order to get larger gains.

Expected utility theory provides a model for decisions under uncertainty and explains differences in risk preferences, but expected utility theory has also come under criticism, particularly concerning the axiom of independence. The independence axiom states that an individual’s preference ordering will not change if equal independent gambles are mixed with the original options one was considering. However, this axiom is systematically violated (Allais 1953). For example, consider a gamble where one has the option between winning $125 at .8 probability and winning $0 at .2 probability, or guarantee winning $100. In this situation, most people would choose the guaranteed $100 (Kahneman and Tversky 1979). If we mix in a 50% chance to win 0$, the payoffs can be rewritten as $125 at probability .4 and $0 at probability .6, or $100 at probability .5 and $0 at probability .5. In this case, most people would choose to gamble for $125 (Kahneman and Tversky 1979). The tendency to switch preferences when an equal gamble is mixed into one’s options is a direct violation of independence axiom of expected utility theory.

The functional form of expected utility theory also implies that the negative utility of losses are equal to the positive utility of gains assuming the magnitude of loss or gain
is equal. In other words, final states of wealth are the primary carriers of utility. There is also evidence that this is not true (Kahneman and Tversky 1979). For example, consider situation A in which you are first endowed with $1000, and then can choose to either take a gamble of even probabilities to win $200 or $0, or you can simply take a sure gain of $100. Now consider a situation B where you are first endowed with $1200 and can choose to either take a gamble of even probabilities to lose $200 or $0, or you can simply take a sure loss of $100. In both situations you are deciding to gamble for $1000 or $1200, or simply take $1100. But for the majority of people, taking the sure value of $100 is preferred in situation A, and the risky gamble of $200 or $0 is preferred in situation B. The consistently observed violations of axioms and implications of expected utility theory is what led to further investigation into more realistic decision-making models.

C. Prospect theory

Daniel Kahneman and Amos Tversky (KT) were the first to make a convincing argument that expected utility theory was making unreasonable assumptions. Through a series of questionnaire-style experiments, KT consistently reproduced the behaviors which expected utility theory could not explain. Their findings led to a new model of decision-making behavior which they called prospect theory (PT). The following paragraphs summarize the key aspects of PT which differentiate it from previous decision-making theories.

According to PT, value or utility is generated by changes in wealth rather than final states of wealth (Kahneman and Tversky 1979). For example, consider two people, A and B. Person A is significantly richer than person B. If person A loses a small amount of money and person B gains a small amount of money, person A does not have more
utility than person B simply because they are still richer than person B. Rather, person A experienced disutility from the loss and person B experienced utility from the gain.

Gains and losses of equal magnitude do not yield equal utility or disutility, respectively. PT reflects that losses loom heavier than gains (Kahneman and Tversky 1979). Therefore in a graphical representation of the PT value function there are two domains, the domain of gain and the domain of loss. The value function in the loss domain is characterized by a steep convex curve, and in the gain domain it is a shallower concave curve (see Figure 2).

Next, PT states that people tend to over-value small probabilities, under-value large probabilities, and perceive moderate probabilities as relatively equal. For example, if a given option has a 1% chance to lose, people overestimate the likelihood of losing. If a given option has an 80% chance to lose, people might underestimate the likelihood of losing. If a given option has approximately the same probability of winning and losing, then people will evaluate the probabilities as equal.

Finally, PT states that people place especially large utility on outcomes which are certain. This effect is also known as the certainty effect. The certainty effect explains why even when a gamble has a higher expected value than a sure increase of wealth, people will still tend to choose the sure increase of wealth.

PT is a superior model of decision-making behavior under risk compared to expected utility theory, because it explains two well documented behaviors that expected utility theory does not: changing risk preferences between gains and losses, and the violation of the independence axiom.
The distinction between losses and gains as put forth by PT implies that risk preferences change when in the domain of gain versus the domain of loss. According to PT, people are more risk-seeking in the domain of loss and more risk averse in the domain of gain. For example, consider an offer to gain $100 or flip a coin for $200 or $0. Most people would prefer to simply gain $100. But consider the offer again in terms of losses: lose $100, or flip a coin to lose $200 or $0. In this situation most people would prefer to gamble. One simple explanation for this is that a $100 loss is so bad, that the gamble option becomes relatively more attractive given the possibility of losing nothing. The difference in marginal utility between the domains of gain and loss explains why people’s risk preferences switch when questions are in terms of gains or losses.

The certainty effect and non-linear weighting of probabilities explain why people regularly violate the independence axiom of expected utility theory. When given two options and one is certain, people will over-value certainty and choose that option. When the options both entail some level of risk, the probabilities associated with each option get weighted non-linearly, and people’s preferences may switch depending on how heavily they over-value small probabilities or under-value large probabilities.

The behaviors that PT explains are largely captured by the PT value function. Let $V_i$ equal the overall utility of the decision an individual is making, $x_i$ equal potential outcomes in terms of wealth change, $v(x_i)$ equal value as a function of $x_i$, $p_i$ equal the probabilities associated with the potential outcomes $x_i$, and $\pi$ equal a probability weighting function.

$$V_i = \sum_{i=1}^{n} \pi(p_i) * v(x_i)$$

Because $x_i$ is defined as outcomes in terms of wealth change, it is changes in wealth which determine overall utility rather than final states. The $v$ function also causes
losses to yield more disutility than equal size gains yield utility. The $\pi$ function weights the probabilities associated with outcomes such that people overreact to small probabilities, underreact to large probabilities, and have increased value of sure outcomes. Therefore this model determines utility of a given prospect based on that prospect’s expected change in wealth, whether the change is negative or positive, the probability of that change, and the non-linear weighting of that probability.

Observing the graphical form of the PT value function also helps to understand several key features of the theory.

**Figure 2: Prospect Theory Value Function**

In the graphical representation of the PT value function, change in wealth is measured on the X-axis and the utility of a given wealth change is measured on the Y-axis. Everything to the right of the value function’s origin is the domain of gain, and everything to the left is the domain of loss.
The value function’s shape changes between the domain of gain and domain of loss. It is concave in the domain of gain and convex in the domain of loss. The value function in the domain of loss is also steeper than it is in the domain of gain. There are several things this shape implies. First, there is diminishing marginal utility for both losses and gains. Second, holding the magnitude of losses and gains equal, losses have a greater effect on utility than gains as is shown by the red lines in the figure. Because losses have a large negative effect on utility, one will try to avoid certain loss. If one is guaranteed to take a loss, a risk may seem attractive as one over-values the possibility of success should one take the risk. Therefore, one is risk averse in the domain of gain and risk-seeking in the domain of loss.

The origin of the PT value function is known as the reference point. The reference point is the level of wealth from which changes are coded as losses or gains. For example, consider two people, A and B. Person A’s current reference point is at $1200, and person B’s current reference point is at $1000. If person A goes from $1200 to $1100, then person A has entered the domain of loss and experienced disutility, or negative utility. If person B goes from $1000 to $1100, then person B has entered the domain of gain and experienced positive utility. Even though the final state of wealth is the same in both situations, utility was dependent on whether one was in the domain of gain or domain of loss, which was dependent on their reference point prior to the wealth change.

For an investigation into how surprise affects behavior, reference points are a key aspect of decision-making models because a surprise is an unexpected change from one’s reference point. Therefore, the reference point suggested by PT will be investigated thoroughly. This includes highlighting the effects of reference point on utility, how reference points are formed, and how reference points might change.
Both risk preferences and utility are dependent on being in the domain of gain or loss according to PT. Whether one is in the domain of gain or domain of loss is dependent on one’s reference point, but determining an individual’s actual reference point can be complicated. To put the idea of reference points into more relatable terms, KT use an example prompting the reader to consider a change in one’s upcoming paycheck. Say you receive $10,000 every month. This month, you received $8,000 instead. If one’s reference point is the expectation to receive $10,000, then one might see an $8,000 paycheck as a loss of $2,000 from what was going to be their expected income. If one’s reference point is simply the wealth one had prior to getting the paycheck, then one might see the $8,000 paycheck as a gain of $8,000 from their current status quo of wealth. Therefore, whether one’s reference point is based on expectations of future outcomes or the current status quo of wealth can affect if one perceives to be in the domain of gain or domain of loss, and subsequently affect that person’s risk preferences. Knowing how reference points are formed and how they might adjust is extremely important for creating a model which can accurately represent and predict behavior in decisions under risk.

In several experiments KT (1979) assumed that the reference point was one’s status quo level of wealth. The questions used to estimate participants’ risk preferences generally involved asking something along the lines of, “do you prefer getting $1,000 or flipping a coin to get $2,000 or nothing?” Questions like this have no prior outcomes from which one can form expectations, nor any subsequent rounds from which expectations could be made, so it must be that the status quo is the reference point. KT note that this may not be the case in every situation. In some situations, one’s reference point may depend more on the expectations of an outcome. KT refer back to the example
of the reduced paycheck and argue that most people would see this situation as a loss from the expectation of the paycheck staying the same value as it was in the past. They also provide an example whereby a businessman is in a slump market, but he takes a smaller loss than his competitors. In this case, the knowledge of the possibility of a larger loss makes his relatively smaller loss feel like a gain.

Reference point adaptation also affects behavior through the evaluation of prospects. KT (1979) offer the following example: consider a businessman who has lost $2,000, but now faces a choice between gaining $1,000 for sure or flipping a coin to gain $2,000 or nothing. If he has not adjusted to the prior loss, then he would see this choice not as gain $1,000 or flip a coin to gain $2,000. Rather, he would see it as a certain $1,000 loss or flip a coin to lose $2,000 or nothing. Someone who has not adjusted to the loss prior to the decision will be more willing to accept risk since they are viewing the problem in the domain of loss, whereas someone who adjusts quickly will be less willing to accept risk as they are viewing the problem in the domain of gain.

KT cite McGlothlin’s (1956) work about the efficiency of horse betting markets, saying that it is a lag of adjustment to losses which explains why people take more risky bets as the day goes on. In particular, gamblers who have lost perceive themselves to be in the domain of loss, and therefore they are already more likely to accept risk and continue betting. It is possible that gamblers do not adapt to losses and thus continue to bet as they remain in the domain of loss. If gamblers were able to immediately adapt to losses, then the propensity for risk-seeking in gamblers may decrease. Therefore, speed of reference point adaptation following outcomes is also an important factor in analyzing changes in behavior in decisions under risk.

D. Expectations-based reference points
Koszegi and Rabin (2006, 2007) provide a model which includes recent expectations about future outcomes as an important factor in reference point formation and adaptation. In summary, expectations shift the reference point towards those expectations, such that the true domains of gain and loss are on either side of the expectations-based reference point, as shown in Figure 3.

Figure 3: Domains of Gain and Loss with Expectations-Based Reference Points

Refer to Figure 3. An expectation can shift the reference point toward that expectation, changing how prospects are evaluated. To motivate expectations-based reference points, Koszegi and Rabin (2007) use the example of a homeowner who is paying attention to the value of their house. A homeowner who foresees a loss in their house’s value will not be risk-loving, because their reference point has already updated to the foreseen loss. Thus the homeowner may sell their house as they are not willing to take a risk to break even. In other words, the expectation of losses caused the reference point to shift such that the homeowner was more sensitive to further losses, and thus
became risk averse and sold the house. But a homeowner who was surprised by this loss will be risk-loving and feel compelled to stay in the market to break even, as the unexpected loss caused the home owner to stay in the domain of loss and be risky. This is illustrated in Figure 4.
Figure 4 compares the value functions of someone who does not expect to lose, and someone who expects to lose. Notice that the expectation causes the value function to shift to the right, as illustrated by a red value function. The person who was not expecting the loss moved along their value function into the domain of loss when the price she sold the house for was less than her reference point. Assuming the reference point fully updates with expectations, the curve shifts into the old domain of loss. Holding true that everything to the left of the value function is the domain of loss and everything to the right of the value function is the domain of gain, then as long as the home’s value does not exceed the maximum expectation of loss, the home’s value is in fact in the person’s domain of gain despite it having lost value.

Expectations-based reference points have been shown to exist in the lab using a variety of different experiments. Hack and Bieberstein (HB) (2014) used two experiments to test how expectations affect reference points. The first is a modification of an experiment originally performed by Arkes, et al. (2008) to test for differences in
reference point adaptation in the domains of gain and loss. Arkes et al.’s general form of the experiment was as follows: tell the subject that last month they bought a stock at $30. This month the stock’s price has either gone up or down $6. The subject is then asked at what price the stock would need to trade next month in order to make the subject feel equally sad or happy with this month. Assuming the subject is able to accurately submit two different wealth values that give him/her equal utility, the following equation can be used to calculate reference point adaptation. Let $P_1$ equal the previous stock price, $R_0$ equal the previous reference point, $P^*$ equal the new price given by the subject and $R^*$ equal the new reference point.

$$P^* - R^* = P_1 - R_0 \rightarrow \Delta R = R^* - R_0 = P^* - P_1$$

To see how this method works with numbers, consider buying a stock at $30, but it fell to $24 last month. $P_1$ equals $24$. The average price which generates equal disutility in the following month is $20$, making $P^*$ equal $20$. The calculation of reference point shift is as follows:

$$20 - 24 = -4$$

In the situation where going from $30$ to $24$ generates equal disutility as going from $24$ to $20$, the reference point must have shifted down by $4$, making reference point shift equal -$4$.

This method is modified by HB (2014) to highlight the effect of expectations on reference point formation. They divide the subjects into two groups. One group is simply told the stock price one month later. The other group is told that before the stock price initially changed, the price was predicted to be in a certain range. No matter the predictions given to the subjects, the real price change of the stock was constant. The
experiment showed that people who were given higher or lower expectations of the stock price would report higher or lower levels respectively at which the stock would need to trade in the following month. Thus, the expectations of a price level had an effect on how people felt about the final nominal price of the stock.

The second experiment in HB (2014) is a modification of an experiment first used by Holt and Laury (2002). In Holt and Laury’s version of the experiment, participants were presented with a table which contained several rows. Within each row there were two options, a risky bet and a safe bet. Participants then indicate at each row whether they would prefer the risky or the safe bet at that row. In order to show willingness-to-pay for risk, HB simplified the experiment such that the safe bet was simply a certain amount of points, and the risky bet was to flip a coin for a high amount of points. In order to show the effect of expectations on the reference point, participants were subjected to a preliminary round in which they were endowed with some points. In the control group, participants are simply endowed with 4 points. In the treatment groups, participants play a lottery. In treatment group A, participants have a 50% chance to get 4 points and a 50% chance to get 8 points. In treatment group B, participants have a 75% chance to get 4 points and a 25% chance to get 12 points. HB were particularly interested in comparing those who won 4 points in the lottery to those who were endowed with 4 points. They found those who won the 4 point lottery in round 1 became more risky in round 2, suggesting they were in the domain of loss, and their reference points were being affected by the expectation of getting more points.

E. **Adapting prospect theory to account for how surprises affect behavior**

According to PT, the equation by which people evaluate options in a decision is:

\[ V = \sum_{i=1}^{n} \pi(p_i) \ast v(x_i) \]
This model does well for modeling the value of prospects assuming previous outcomes do not affect the evaluation of future prospects. But if previous outcomes do affect the evaluation of future prospects, then this model is not sufficient to capture all the things which influence the evaluation of a prospect and therefore how people make decisions. For example, consider playing a game where the goal is to maximize points, and you gain points by choosing option A or option B. Option A allows you to simply gain a point. Option B allows you to gain 2 points or 0 points with equal probability. Now consider two identical people in every respect. One person chooses option B three times in a row and loses each time. The other person chooses option B three times and wins each time. When they evaluate the decision between A and B in the fourth round, their behaviors may be different (Thaler and Johnson 1990).

Given that prior outcomes affect decisions in future rounds, it must be that the utility from prior rounds is influencing prospect evaluations in future rounds. However, simply including prior utility into the evaluation of a future decision without considering the outcome in terms of its location relative to one’s reference point is an oversimplification. For example, if someone expected to lose $10, the effect of actually losing the $10 is greatly diminished, and the utility coded into the next decision is also diminished. If the $10 loss is a surprise, then the utility of loss is much larger, and the utility coded into the next decision is also larger. The effect of surprises on utility needs to be understood in order to appropriately edit prior outcomes into future prospects.

The definition of a surprise according to Rescorla and Wagner (1972) is the difference between what was expected and what actually happened. Based on Rescorla and Wagner’s definition, I constructed the following table which outlines all potential
outcomes and states whether the outcome was a surprise or not. A “+” indicates the surprise is positive, and a “-” indicates the surprise is negative.

**Table 1: Outcome Possibilities**

<table>
<thead>
<tr>
<th>Expectation</th>
<th>Reality</th>
<th>Big loss</th>
<th>Small loss</th>
<th>Maintain status quo</th>
<th>Small gain</th>
<th>Big gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big loss</td>
<td>Non-surprise</td>
<td>Surprise</td>
<td>Surprise +</td>
<td>Surprise +</td>
<td>Surprise +</td>
<td>Surprise +</td>
</tr>
<tr>
<td>Small loss</td>
<td>Surprise -</td>
<td>Non-surprise</td>
<td>Surprise +</td>
<td>Surprise +</td>
<td>Surprise +</td>
<td>Surprise +</td>
</tr>
<tr>
<td>Maintain status quo</td>
<td>Surprise -</td>
<td>Non-surprise</td>
<td>Surprise +</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small gain</td>
<td>Surprise -</td>
<td>Non-surprise</td>
<td>Non-surprise</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Big gain</td>
<td>Surprise -</td>
<td>Non-surprise</td>
<td>Non-surprise</td>
<td></td>
<td></td>
<td>Non-surprise</td>
</tr>
</tbody>
</table>

Table 1 provides a framework of outcomes categorized as surprising or not, negative or positive. The bold cells indicate the types of surprise I investigate in this study. In future investigations, all types of surprises according to this framework should be tested, but due to limited resources of time, incentives for play, and participants, I only test negative surprises when expecting to gain or maintain the status quo.

Following Koszegi and Rabin (2006, 2007), expectations shift the reference point in the direction of the expectation. The true domains of gain and loss are on either side of one’s expectations rather than relative to one’s current status quo. 1 If the domains of gain and loss exist around one’s expectations-based reference point, then surprise outcomes should have a significantly greater effect on utility both in the domains of gain and loss compared to expected outcomes. Refer to Figure 5 to see more clearly how surprise increases utility or expectations diminish utility.

---

1 Assuming one’s expectation is not to maintain the status quo
Figure 5: Comparing Utilities of Surprise and Expected Outcomes

Notice that in the image on the left, there is no reference point shift. Changes in wealth therefore yield utility, graphed on the Y axis. When there is a reference point shift based on the expectation to gain or lose, the utility of said gain or loss is diminished. Therefore, a positive outcome is enhanced if one was not expecting it, and a negative outcome is also enhanced if one was not expecting it. The greater magnitude of utility changes following surprise outcomes should be apparent based on how an individual’s risk preferences change after unexpected events compared expected events. In other words, a surprise loss should result in greater movement into the domain of loss, and therefore result in more risk-seeking compared to an expected loss. A surprise gain should result in a greater movement into the domain of gain and result in greater risk aversion compared to an expected gain.

To account for the effect that surprise has on future decisions, I add another feature to standard PT. Let $V_t$ represent the value of a given prospect in round $t$ of a multi-round round game, $x_t$ represent the given prospect in round $t$, $p_t$ represent the probability of $x_t$, $x_{t-1}$ represent the outcome of round $t-1$ in the game, $\psi_{t-1}$ represent the
location of the expectations-based reference point along the x-axis of the value function, and \( u_{t-1} \) represent the value function for the outcome of round \( t-1 \).

\[
V_t = \sum_{i=1}^{n} \pi(p_i) * v[x_i + u_{t-1}(x_{t-1} - \psi_{t-1})]
\]

According to this value function, when an outcome exactly meets one’s expectations, then the evaluation of one’s next prospect is simply prospect theory because \( x_{t-1} = \psi_{t-1} \). With a positive or negative surprise, the value of a prospect can increase or decrease respectively. Therefore even when considering a prospect in the domain of loss, a prior surprise gain can positively influence the expected value of future prospects.

**F. Testing for the effects of surprise on behavior**

There are several ways to test the effect surprise has on behavior. Based on PT with expectations-based reference points, surprise magnifies the utility of outcomes. Therefore, the effect of surprise on utility should be tested.

If surprise affects utility, then risk preferences will also be affected by surprise. For example, if a surprise loss is coded further into the domain of loss than the same loss had it been expected, then risk-seeking should be larger for surprise losses compared to expected losses. If a surprise gain is coded further into the domain of gain than the same gain had it been expected, then risk aversion should be larger for surprise gains compared to expected gains. The effect of surprise on risk preferences should be tested.

Finally, speed of ex-post reference point shift is another important consideration for how surprise affects behavior. There is relatively limited research on ex-post reference point shifts. Arkes et al. (2008) find that reference point shift is faster in the domain of gain than the domain of loss. The primary distinction between the domain of gain and the domain of loss is that marginal utility is smaller at all points in the domain of
gain compared to the domain of loss. If reference point shift and marginal utility are inversely related, then ex-post reference point shift for surprise outcomes should be larger than ex-post reference point shift for expected outcomes due to diminishing marginal utility. The effect of surprise on reference point adaptation should be tested.

The following is a summary of my hypotheses concerning the effect that surprise has on behavior based on PT and findings related to PT.

1. An unexpected loss should yield greater disutility than an expected loss.
2. An unexpected gain should yield greater utility than an expected gain.
3. Surprise gains should cause greater risk aversion than expected gains in subsequent time periods.
4. Surprise losses should cause greater risk-seeking than expected losses in subsequent time periods.
5. Ex-post reference point shift for surprise outcomes should be greater than ex-post reference point shift for expected outcomes in the domain of loss.
6. Ex-post reference point shift for surprise outcomes should be greater than ex-post reference point shift for expected outcomes in the domain of gain.

To fully test how surprises affect behavior, all six of these hypotheses should be tested. Because of limited resources in terms of research participants, adequate incentives for real play, and time to conduct research, I only test hypotheses 1, 4, and 5, the negative surprise hypotheses. In future investigations of this topic, the positive surprise hypotheses should also be tested.
III. Methods

The experiments I use to observe the effect of surprise on behavior are based on those used by HB (2014). HB use two distinct experiments to research reference point shifts. The first experiment is in the style of a questionnaire based on Arkes et al.’s (2008) experiments. The second experiment is in the style of a game based on Holt and Laury’s (2002) experiments. I first outline the source of my participants, materials used, and the general procedures of the experiment. Then I detail each experiment separately: the design of the experiment, the results, and discussion of results.

A. Participants

Participants in my experiment were all autumn 2015 to spring 2016 Lake Forest College students. All participants were students in classes where professors allowed me class time to conduct the experiment. These classes included Introduction to Economics, Intermediate Microeconomics, Intermediate Macroeconomics, and Cross-cultural Psychology classes. There were 100 females and 113 males, yielding 213 total observations. The average age of participants was 19.6 years old. Participation was voluntary, and no student decided to opt out of the experiment. The samples are not random because individuals selected into those particular courses. If the characteristics that affect selection of courses also affects the examined behaviors in my study, then the results will not be representative of the general population.

B. Materials and incentive system

All responses were recorded in packets of paper which included a consent form, instructions and questions, and a debriefing form at the end which participants were not
allowed to look at until their final responses were recorded and handed in. See Figures A and B in the appendix to see the full versions of each experimental packet.

Because this experiment was conducted by a human rather than a computer, I tried to minimize irregularities in how instructions were given. The experimenter used a pre-written script each time the experiment was conducted. To see the script, refer to Figure E in the appendix.

The second experiment was a game which included two elements of randomness, a random number between 1 and 17 and a coin flip. Two smart phone applications were used to generate random numbers and coin flips. Those applications are Random Number by Saranomy version gpv1.0.11 and Coin Flip, copyright 2015 by Richard Banasiak with contributions from Alex Baker, Ciaran Gultnieks, Spanti Nicola and Michael Riepen, version 6.4.

A chance to win a $50 gift card to Walgreens was used to encourage genuine play in the game stage of the experiment. The chance to win was determined in a raffle, whereby one’s point total at the end of the game would equal the amount of raffle tickets a participant would receive. If the participant had a negative score at the end of the experiment, they would still receive one ticket. The raffle tickets used were blue with two rows of tickets running parallel whose numbers were identical. This way, both the participant and experimenter would have a copy of the ticket number rather than a name associated with a ticket. This was done to preserve anonymity and elicit truthful behavior.

C. General procedures

The experiment was always conducted during class time under the supervision and assistance of the professor leading the class. The class times during which the
experiment took place ranged from 9 AM to 3:30 PM. The experimenter entered the classroom and with the help of the professor distributed experimental packets to all students in the classroom. Students were instructed not to look inside the packet. The front page was the participant consent form. Once all students in the class had a packet, the experimenter read the consent form aloud to the students. Students who agreed with the consent form signed it, removed it from the packet and submitted it to the experimenter.

The next page in the packet included instructions which gave an overview of what was going to occur during the experiment. After consent forms were handed in, the experimenter read the instructions aloud while participants followed along. Then after instructions were read, all participants flipped to the first page of experiment 1 together.

The experimenter read the script of experiment 1, read the first question, and gave time for the participants to answer. Once all participants had answered, the experimenter read the second question and gave the participants some time to answer. After all participants had answered the second question, the page was flipped.

The next page in the packet was the questionnaire of demographic information. The questionnaire asked participants to record age, sex, race/ethnicity one most closely identifies with, major(s) or field(s) of study, and whether one would go skydiving if given the opportunity. The purpose of the skydiving question is to obtain the most general form of baseline risk preferences that a person has under the assumption that someone who would like to skydive is also generally more risk-seeking.

The final pages of the packet were Experiment 2, the game. The experimenter read the initial explanation of the game and instructions of how to play to the participants. Participants then filled in a practice version of the game which had no impact on one’s
actual score in the real version of the game. Participants were also allowed to ask questions about how the game works, to which the experimenter responded with an ad-libbed answer. Once all participants were allowed to ask questions, the game began. For group A, the experimenter told all participants before the game started that after the conclusion of round one, everyone will have to take 12 points away from their scores, even if it made their scores negative. For group B, the game began with no warning of the points being taken away. The experimenter allowed the participants a duration of time to fill in the game table however they wished.

Once all participants had filled in their game tables, the experimenter used the random number generator to assign a random number between 1 and 17 to each participant. This number would correspond to a row in the game table which the participant just filled out. At whatever row a participant was assigned, he/she indicated a preference to gamble or not at that row. After each participant’s row was assigned, the experimenter asked all participants who gambled at their assigned rows to raise their hands. The experimenter then used the coin flip application to tell participants individually if they won or lost their gamble. The coin was flipped once for each person who took the gamble. Heads indicated a win, tails indicated a loss. Participants then wrote down the points earned after that round. Next, the experimenter told everyone in both groups A and B to take 12 points away from their scores. For group A, this announcement was expected, and for group B this announcement was a surprise.

After everyone had subtracted 12 points from their scores, round two of the game began. The experimenter told the participants that the table was exactly the same as before, and that they may fill it in however they like keeping in mind that they are trying to maximize points. The experimenter also told participants that no more points will be
taken away for the remainder of the game. Once everyone’s tables had been filled in, the experimenter assigned new random rows to each participant, gamblers were again asked to raise their hands, winners and losers were determined, and final scores were recorded. Raffle tickets were distributed as participants were handing in their answer sheets.

IV. Experiment 1

A. Design

Experiment 1 is based on Arkes et al.’s (2008) method for calculating reference point shift. I modify this experiment to measure the effect surprise has on reference point shift as well as utility.

Arkes et al.’s (2008) original method allows for calculation of ex-post reference point shift in the context of stock prices. The calculation is as follows: if $P_1$ equals the previous stock price, $R_0$ equals the previous reference point, $P^*$ equals the new price given by the subject, and $R^*$ equals the new reference point, then:

$$ P^* - R^* = P_1 - R_0 \rightarrow \Delta R = R^* - R_0 = P^* - P_1 $$

In words this equation states that if utility is equal between two changes in wealth, then the difference between the reference point and the final state of wealth must also be equal. This can then be rearranged to state that the difference in reference points is equal to the new state of wealth following the first wealth change and the new state of wealth following the second wealth change. In both Arkes et al.’s (2008) and HB’s (2014) version of this experiment, changes in the value of stock prices were used to elicit responses. The questions used by Arkes et al. are as follows:

_Say you bought a stock at the price $30. This month the price fell to $24. At what price would the stock have to trade to make you equally unhappy with last month?_
In this case, one would fill in the reference point adaptation equation as follows:

\[ P^* - R^* = 24 - 30 \rightarrow \Delta R = R^* - 30 = P^* - 24 \]

If the participant’s response was, for example, $20, then the equation would be filled in:

\[ P^* - R^* = 24 - 30 \rightarrow \Delta R = R^* - 30 = 20 - 24 \]

\[ \Delta R = -$4 \]

To see the effect surprise has on reference point adaptation, I used two different prompts to elicit responses. These prompts are the following:

Group A: You are the owner of a small business. All year every year your monthly profits are $100,000. This value fluctuates from time to time, but luckily your company has an incredibly skilled adviser. She is always able to predict when and how the company's profits will change. Last month your profits fell by $20,000. Your adviser did **not** predict this, so the change was totally unexpected.

Group B: You are the owner of a small business. All year every year your monthly profits are $100,000. This value fluctuates from time to time, but luckily your company has an incredibly skilled adviser. She is always able to predict when and how the company's profits will change. Last month your profits fell by $20,000. Your adviser **did** predict this, so the change was totally expected.

The two prompts are exactly the same, except the prompt for group A describes the change of profit as totally unexpected, and the prompt for group B describes the change as totally expected.

The context of the prompt has also changed in my version. Rather than look at changing stock prices, changes in profit were used. I made this decision for several
reasons. First, one group needed to feel as though a change of value could be genuinely expected. Based on the efficient market hypothesis, the stock market is unpredictable, and I did not want this fact influencing whether participants took the question seriously. I left the details of why profits fell ambiguous because this allows for participants to more easily accept whether the profit change was expected. For example, the expected profit loss could be due to seasonal changes, but the unexpected profit loss could be due to some exogenous shock.

After the participants in each group read their respective prompts, they were then asked the following question:

“On a scale of 1 to 10, how unhappy does this make you?

1 is little to no unhappiness, 10 is extreme unhappiness.”

There are two purposes of this question. The primary purpose is to get an estimation of the average disutility experienced between groups A and B. The secondary purpose is to give participants a reference point around which to determine values of profit loss that would yield equal disutility. Arkes et al. (2008) note that there is some concern about whether participants can accurately determine values of money in future time periods that yield equal levels of utility. By attributing a reference point around which to determine hypothetical disutility, participants may be more accurate in their responses of a value which would yield equal disutility in the future.

The next question given to the participants was:

“In the situation above your profits fell last month. How much money would you have to lose again this month to feel equally unhappy? Note that this is
not necessarily the same value of money lost last month, it is the value of money lost this month that would make you feel equally unhappy with last month.”

This question prompts the participant to record a loss of profit which yields equal disutility, or what I call an equal-utility-loss-value (EULV).

In Arkes et al.’s (2008) version of the experiment, participants are asked to record what final state of wealth would yield equal disutility. This value is then used to calculate reference point shift. My method eliminates the calculation step by simply asking what loss would yield equal disutility. To see the distinction more clearly, first consider Arkes et al.’s version of the experiment where reference point shift was calculated as follows: assume the original loss resulted in a final state of wealth of $24, and the average response as to what final state would yield equal disutility was $20, then the reference point shift would be calculated as:

\[ $20 - $24 = -$4 \]

This equation can be rewritten in terms of total value lost from the original price of $30:

\[ \text{Total amount lost} - \text{Initial amount lost} = \text{Reference point shift} \]

\[ (30-10) - (30-6) = -4 \]

\[-10 - (-6) = -4 \]

Given that the largest possible profits one could earn in the two month period in the prompt are $200,000, then the reference point shift calculation according to Arkes et al.’s (2008) method looks like this. Let X represent the EULV reported by subjects following the $20,000 loss.
\[ [200,000 - (X+20,000)] - [200,000 - 20,000] \]

Using distribution:
\[-(X+20,000)+20,000 \]
\[-X\]

Thus, the EULV reported is the amount by which the reference point has shifted for each group on average according to Arkes et al.’s (2008) methods.²

There are a couple advantages to having respondents report an EULV rather than a final state. First, having responses in terms of losses rather than final states makes interpretation of the results easier. Whatever the respondents report as the value of loss that makes them equally unhappy is simply their reference point shift.

The second advantage to asking the question in terms of losses is that an EULV provides information on people’s marginal reactiveness to loss. That is, if group A reports a larger EULV than group B, then group A is relatively less reactive to further losses than group B. If group A reports a smaller EULV than group B, then group A relatively more reactive to further loss than group B.

There are two necessary assumptions for proper interpretation of the data in this experiment. These assumptions are outlined below.

1. The average perception of the unhappiness scale was the same between the groups.

---

² It is possible that framing the question in terms of losses rather than final states of wealth will change how people respond. Kahneman and Tversky point out that it is changes in wealth which are the carriers of utility, not final states, so it is possible that focusing on final states rather than changes may underestimate reference point shift, as less disutility may be associated with a final state rather than a change. For now I will assume that the effect is negligible, and will allow further research to investigate this topic.
It is likely that each individual person had their own perception of what feeling justified what number on the unhappiness scale. We will assume that the average perception of the scale is the same between the groups. If there are differences in how the unhappiness scale is perceived between group A and group B, then it is impossible to tell if there are any differences in the real disutility experienced.

2. *The average EULVs accurately reflect the values of loss that would yield equal disutility in the following time period.*

Due to discounting of values over time, there may be a slight overestimation of EULVs, but the effect of time discounting should not affect a comparison of average EULVs between the groups assuming both groups face the same average levels of time discounting.

**B. Predictions**

**Prediction 1:** Group A, the surprised group, will report higher average unhappiness than group B, the group which expected the loss.

**Prediction 2:** Group A, the surprised group, will report a higher EULV (reference point shift) than group B, the group which expected the loss.

This prediction may seem counter-intuitive at first. Consider two people, 1 and 2. Both face a loss of \(-X\). Person 1 is very unhappy with the loss, while person 2 is only slightly unhappy with the loss. Because person 1 is very unhappy, her marginal disutility of loss is very high, so her tolerance of further loss must be very low. Because person 2 is
only slightly unhappy, his marginal disutility of loss is low relative to person 1’s, so his tolerance of further loss must be greater than person 1’s.

In the case of comparing individuals, we can assume that their reference point locations are the same prior to the loss. This way the difference in reaction to the loss between persons 1 and 2 is dependent on each individual’s marginal reactivity to wealth changes. This can be seen in Figure 6.

**Figure 6: Differences in Individual Reactions to an Outcome**

![Figure 6: Differences in Individual Reactions to an Outcome](image)

As you can see, person 1 is more reactive to wealth changes than person 2. Therefore person 1 is made more unhappy by \(-X\), and she is less tolerant of taking on more losses.

Now consider comparing two groups of randomly selected people, group A and group B. Group B knows that \(-X\) is going to happen in the next time period. For group A, \(-X\) is a surprise. If surprise increases utility magnitudes, it would be intuitive to think that the surprised group should report a relatively low EULV, as their marginal disutility of
loss appears to be greater, and so their tolerance of further loss should be smaller. However, this is not the case.

Group A should report higher unhappiness than group B because \(-X\) is surprising to group A. When comparing groups, the average value functions of each group should be the same assuming the groups are comprised of randomly selected people. This way, the difference in average reaction to loss between groups is based on the difference in the locations of the average reference points rather than the difference in marginal reactivity seen in individuals. Differences in group reactions can be seen in Figure 7.

**Figure 7: Differences in Group Reactions to an Outcome**

As you can see, group A, the surprised group, is made more unhappy by \(-X\) than group B, the group that had expectations of \(-X\). Despite group A having a greater level of disutility from \(-X\), group A’s marginal reactivity to loss at \(-X\) is smaller than group B’s marginal reactivity to loss. Therefore, group A should report a higher EULV than group B.
C. Results

Table 2: Summary Statistics for Experiment 1

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unhappiness</td>
<td>5.556</td>
<td>2.226</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Nominal EULV</td>
<td>14871.490</td>
<td>10747.960</td>
<td>1</td>
<td>50000</td>
</tr>
<tr>
<td>Logged EULV</td>
<td>8.799</td>
<td>2.488</td>
<td>0</td>
<td>10.820</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.474</td>
<td>0.469</td>
<td>0.235</td>
<td>0.362</td>
<td>0.155</td>
<td>5.552</td>
</tr>
<tr>
<td></td>
<td>0.500</td>
<td>0.500</td>
<td>0.425</td>
<td>0.482</td>
<td>0.363</td>
<td>2.237</td>
</tr>
</tbody>
</table>

Refer to Table 2. In the regression analysis, I use nominal unhappiness as opposed to logged unhappiness or another monotonic transformation of the data, as the distribution of unhappiness is relatively normal. Nominal EULV is simply what participants recorded as their EULVs. Logged EULV is the natural log of EULV. Both nominal and logged EULVs are included because there is a slight skew in both distributions.

Group A is a dummy variable which equals 1 if the participant was in group A and 0 if in group B. Female is a dummy variable which equals 1 if the participant was a female and 0 otherwise. Nonwhite is a dummy variable which equals 1 if the participant was not white and 0 otherwise. The female and nonwhite variables are then interacted with group, such that they equal 1 if they are both female and in group A or nonwhite and

---

3 Refer to Figure F in the appendix to see the distribution of unhappiness. Also it should be noted that although participants were prompted to record a value from 1 to 10, one participant reported unhappiness of 0. This participant was in group B, the group where the loss was expected, so it is possible their expectations fully adapted to the loss. Nonetheless, I recode this value as a 1.
in group A, and 0 otherwise. This is to see if the effects of surprise affect certain demographic variables differently.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unhappiness</th>
<th>Unhappiness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>0.849***</td>
<td>0.980**</td>
</tr>
<tr>
<td></td>
<td>(0.303)</td>
<td>(0.464)</td>
</tr>
<tr>
<td>Female</td>
<td>0.204</td>
<td>0.143</td>
</tr>
<tr>
<td></td>
<td>(0.303)</td>
<td>(0.419)</td>
</tr>
<tr>
<td>Group A Female</td>
<td>-</td>
<td>0.148</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>(0.609)</td>
</tr>
<tr>
<td>Non-white</td>
<td>0.089</td>
<td>0.342</td>
</tr>
<tr>
<td></td>
<td>(0.315)</td>
<td>(0.427)</td>
</tr>
<tr>
<td>Group A Non-white</td>
<td>-</td>
<td>-0.564</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>(0.635)</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.039</td>
<td>0.043</td>
</tr>
<tr>
<td>(n)</td>
<td>213</td>
<td>213</td>
</tr>
</tbody>
</table>

Standard deviations are in parentheses. *, **, and *** indicate significance to the 10%, 5% and 1% levels respectively.

**Prediction 1:** Refer to Table 3. Prediction 1 states that group A should report higher unhappiness than group B. According to the regressions, being in group A caused unhappiness to increase by almost a full point on the 1-10 unhappiness scale with significance at the 1% level in the first model and significance at the 5% level in the second model. No other variables were significant predictors of unhappiness. Given this result, prediction 1 is confirmed, and therefore there is strong evidence that surprise magnifies the utility of outcomes.
**Table 4: Regressions of Nominal andLogged EULVs**

<table>
<thead>
<tr>
<th>Variable</th>
<th>EULV</th>
<th>EULV</th>
<th>Log EULV</th>
<th>Log EULV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A</strong></td>
<td>2633.827*</td>
<td>2299.200</td>
<td>0.194</td>
<td>0.312</td>
</tr>
<tr>
<td></td>
<td>(1497.384)</td>
<td>(2278.878)</td>
<td>(0.352)</td>
<td>(0.535)</td>
</tr>
<tr>
<td>Female</td>
<td>1368.851</td>
<td>1792.547</td>
<td>-0.079</td>
<td>0.235</td>
</tr>
<tr>
<td></td>
<td>(1473.048)</td>
<td>(2038.472)</td>
<td>(0.346)</td>
<td>(0.478)</td>
</tr>
<tr>
<td><strong>Group A Female</strong></td>
<td>-</td>
<td>-970.533</td>
<td>-</td>
<td>-0.680</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2958.939)</td>
<td>-</td>
<td>(0.695)</td>
</tr>
<tr>
<td><strong>Non-white</strong></td>
<td>1640.663</td>
<td>661.639</td>
<td>-0.011</td>
<td>-0.255</td>
</tr>
<tr>
<td></td>
<td>(1530.614)</td>
<td>(2077.565)</td>
<td>(0.360)</td>
<td>(0.488)</td>
</tr>
<tr>
<td><strong>Group A non-white</strong></td>
<td>-</td>
<td>2192.183</td>
<td>-</td>
<td>0.561</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3092.935)</td>
<td>-</td>
<td>(0.726)</td>
</tr>
<tr>
<td><strong>Unhappiness</strong></td>
<td>-588.405*</td>
<td>-572.589*</td>
<td>-0.014</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(335.962)</td>
<td>(337.784)</td>
<td>(0.079)</td>
<td>(0.079)</td>
</tr>
<tr>
<td><strong>R^2</strong></td>
<td>0.033</td>
<td>0.036</td>
<td>0.002</td>
<td>0.009</td>
</tr>
<tr>
<td><strong>n</strong></td>
<td>213</td>
<td>213</td>
<td>213</td>
<td>213</td>
</tr>
</tbody>
</table>

*Standard deviations are in parentheses. *, **, and *** indicate significance to the 10%, 5% and 1% levels respectively.*

**Prediction 2:** Refer to Table 4. Prediction 2 states that group A should report higher EULV than group B. Only in the first model is the group dummy variable a statistically significant predictor of EULV. Moreover, group is only significant at the 10% level in this regression, so the result is not very robust. In all four regressions, the sign on group A is positive, indicating there is some evidence in support of prediction 2, that group A would report a higher EULV than group B. The coefficient on unhappiness is also negative in all four models and significant at the 10% level in the models of nominal EULV, indicating that for people in both groups, as marginal reactivity to loss increased, tolerance of loss decreased. Given these results, there is some evidence to support prediction 2. The effect of surprise on reference point shift should be investigated more in future research.
D. Discussion of results for experiment 1

Prediction 1 states that group A should report higher average unhappiness than group B because group A was told the loss of $20,000 was not expected. According to the results, group A did report higher average unhappiness than group B, and therefore there is strong evidence that surprise increases the disutility of loss. It is important to keep in mind that the unhappiness is scale has the potential for subjective interpretations. For example, the two groups may in fact experience almost identical feelings of disutility on average, but given the context from which they judge the scale, one group may report a 5 on average and the other group may report a 6 on average. One potential change to the methods in future experiments would be to use an explicitly ordinal prompt. For example, a question could be designed as the following.

Consider the following scenarios:

1. You were told by your boss last month you would get a $500 dollar raise this month. As expected, you get the raise this month.

2. This month your boss surprised you with a $500 dollar raise.

In which scenario does getting the $500 feel better to you?

By using explicitly ordinal prompts, you may be able to ascertain with more confidence whether surprise outcomes do yield more utility than expected outcomes.

Prediction 2 states that the ex-post reference point shift (EULV) for group A would be greater than the reference point shift for group B. Only in one regression at the 10% significance level was group a significant predictor of EULV. In all 4 regressions
with EULV as the dependent variable, the coefficient on the group A variable was positive. This result indicates some support for prediction 2.

Another important result is that in one regression at the 10% significance level, higher unhappiness is correlated with lower EULV. This result confirms the intuition that when comparing reactions overall, higher unhappiness indicates more marginal reactivity to loss, and therefore lower EULV or reference point shift.

The results of EULV and unhappiness also support the hypothesis that reference point shift and marginal reactivity are inversely related. There are now three scenarios in which this has been shown to be true.

First, Arkes et al.’s (2008) results showed that reference point shift is faster in the domain of gain. Marginal reactivity is lower in the domain of gain compared to the domain of loss.

Second, when comparing individuals who have equal reference points, someone who is more marginally reactive to loss will be less tolerant of further loss. Someone who is less marginally reactive will be more tolerant of further loss. This less reactive person will report a larger EULV, and thus a larger reference point shift.

Finally, when comparing groups with different reference points, the surprised group will be further into the domain of loss than the group which expected the loss. Due to diminishing marginal utility, the surprised group will be less reactive to further loss. The surprised group will report a higher EULV, and thus a larger reference point shift.

The apparent relationship between marginal utility of an outcome and reference point shift may be worth investigating more. Let us label the speed with which one’s
reference point changes as “adaptability”; how quickly you can adjust to changes. Second, let us label marginal utility as “reactiveness”: how much you react to changes in wealth. If adaptability and reactiveness are inversely related, then people who are more reactive are less adaptable, and people who are not very reactive are more adaptable. If people’s adaptability and reactiveness are also variable, times when you are very reactive will prevent you from adapting, and times when you are not reactive will help you adapt. This could be why in emergency situations people are told to stay calm; staying calm makes adjusting to the situation easier, thereby reducing risk-seeking.

Given the results of experiment 1, further research into how surprise affects utility and reference point shift is warranted.

V. Experiment 2

A. Design

The design of this experiment is based on HB’s (2012) experiments into the effect of expectations on reference point formation, which is based on Holt and Laury’s (2002) experiments. The game is designed to observe people’s risk preferences in terms of willingness-to-pay (WTP) for the risky prospect, which in this case is to gamble for points rather than take a sure value of points. The following table was used to gather participants’ WTP for a gamble in the game.
Table 5: Game Table

<table>
<thead>
<tr>
<th>Row Number</th>
<th>Gamble</th>
<th>Receive Sure Value</th>
<th>Choice (S or G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50/50 chance to win 20 points</td>
<td>0 points</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>50/50 chance to win 20 points</td>
<td>1 points</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>50/50 chance to win 20 points</td>
<td>2 points</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>50/50 chance to win 20 points</td>
<td>3 points</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>50/50 chance to win 20 points</td>
<td>4 points</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>50/50 chance to win 20 points</td>
<td>5 points</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>50/50 chance to win 20 points</td>
<td>6 points</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>50/50 chance to win 20 points</td>
<td>7 points</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>50/50 chance to win 20 points</td>
<td>8 points</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>50/50 chance to win 20 points</td>
<td>9 points</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>50/50 chance to win 20 points</td>
<td>10 points</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>50/50 chance to win 20 points</td>
<td>11 points</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>50/50 chance to win 20 points</td>
<td>12 points</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>50/50 chance to win 20 points</td>
<td>13 points</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>50/50 chance to win 20 points</td>
<td>14 points</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>50/50 chance to win 20 points</td>
<td>15 points</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>50/50 chance to win 20 points</td>
<td>16 points</td>
<td></td>
</tr>
</tbody>
</table>

Table 5 is the game table presented to participants in experiment 2. In each round of the game participants were told to write S or G in each row to indicate if they would prefer the sure value of points or the gamble, respectively. The rational strategy was to gamble starting at 0 points, then gamble for consecutive rows until one would prefer the sure value of points, then take sure value for the following consecutive rows. The WTP for the risky prospect therefore was the highest level of points at which one would prefer to gamble assuming all levels of points below that were also gambled upon.

Group A was told that after the conclusion of round 1 that 12 points would be taken away from their round 1 scores. If group A includes this new information in their

---

Note that now group B is the surprised group and group A is expecting a loss. In experiment 1, group A was the surprised group and group B expected a loss. The role of being the surprised group was switched between experiments 1 and 2 in order to prevent the surprised group in experiment 1 from anticipating a surprise in experiment 2.
evaluations of the potential payoffs, then the game table should resemble to them the following:

Table 6: Game Table as Perceived by Group A

<table>
<thead>
<tr>
<th>Row Number</th>
<th>Gamble</th>
<th>Receive Sure Value</th>
<th>Choice (S or G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50/50 chance to win 8/-12 points</td>
<td>-12 points</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>50/50 chance to win 8/-12 points</td>
<td>-11 points</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>50/50 chance to win 8/-12 points</td>
<td>-10 points</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>50/50 chance to win 8/-12 points</td>
<td>-9 points</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>50/50 chance to win 8/-12 points</td>
<td>-8 points</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>50/50 chance to win 8/-12 points</td>
<td>-7 points</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>50/50 chance to win 8/-12 points</td>
<td>-6 points</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>50/50 chance to win 8/-12 points</td>
<td>-5 points</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>50/50 chance to win 8/-12 points</td>
<td>-4 points</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>50/50 chance to win 8/-12 points</td>
<td>-3 points</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>50/50 chance to win 8/-12 points</td>
<td>-2 points</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>50/50 chance to win 8/-12 points</td>
<td>-1 points</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>50/50 chance to win 8/-12 points</td>
<td>0 points</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>50/50 chance to win 8/-12 points</td>
<td>1 point</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>50/50 chance to win 8/-12 points</td>
<td>2 points</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>50/50 chance to win 8/-12 points</td>
<td>3 points</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>50/50 chance to win 8/-12 points</td>
<td>4 points</td>
<td></td>
</tr>
</tbody>
</table>

Table 6 shows how the game table should be perceived by participants in group A, the group told about the 12 point loss ahead of time. Assuming group A’s reference point does not fully adapt to being inside the domain of loss, then the information of losing 12 points will cause the expected utility of round 1 to be coded in the domain of loss for group A. This will cause group A to have higher WTP for the risky prospect in round 1 compared to group B who will code all outcomes in the domain of gain.

In evaluating behaviors in the second round there are two layers of surprise that need to be considered. The first layer is the surprise 12 point loss for group B. This layer of the surprise is what we are most interested in. The experiment is designed to see if there is a difference in how the two groups react to an equal loss of points, the only
difference being whether or not a group expected the loss. Group B was not informed of the 12 point loss, so the average group B reference point is somewhere in the positive region of the points axis. Group A was informed of the loss, so their reference point will be lower on the points axis compared to group B. This means there is a range of points between the average reference points of the two groups where group A and group B could have the same exact outcome, but group A will be positively surprised and group B will be negatively surprised. I refer to this region as the opposite-surprise-region, or OSR. The OSR is highlighted in orange in the Figure 8. Recall, RP stands for reference point.

**Figure 8: Opposite-Surprise Range of Groups A and B**

Refer to Figure 8. Within the OSR, outcome X is in the domain of gain for person A, but X is in the domain of loss for person B. For the purpose of analyzing experiment 2, a precise definition of the OSR is not necessary. Because the 12 point loss happens following the initial distribution of points, any value of points following the conclusion of round 1 will be a negative surprise for group B. The effect of surprise on WTP for the risky prospect can be captured simply by the dummy variable for being in group A because any value for group B will be a negative surprise relative to group A’s perception of outcomes. Even a negative surprise for group A will be an even more negative surprise
for group B, and positive surprises for group A will still be negative surprises for group B. In summary, the first layer of surprise caused by the loss of points can be captured simply by the group A dummy variable.

The other layer of surprise which may affect behavior is the surprise each individual experiences relative to their own expectations. This layer of surprise is simply a byproduct of how the experiment is designed. When participants choose their individual utility-maximizing WTP for the risky prospect, they develop a belief about what amount of points they reasonably expect to have at the conclusion of the round. Then outcomes are evaluated relative to the expected level of points, causing an outcome to be considered a positive surprise, negative surprise, or expected outcome.

We can observe the effect of uncertainty resolution regarding round 1 outcomes on behavior by including variables which account for round 1 performance in the regressions of round 2 WTP. For example, the effects of winning or losing the gamble can be observed. Nominal score, negative or positive scores, and winning or losing the gamble following round 1 should all be observed to see the effects of uncertainty resolution on round 2 risk preferences.

B. Predictions

Because we are primarily concerned with the effect that the surprise loss has on behavior, predictions and data concerning the 12 point loss will be separate from predictions and data concerning general uncertainty resolution. The following are predictions concerning the effect of the 12 point loss, the primary layer of surprise we are concerned about.
Prediction 1: In round 1 of the game, group A should report a higher average WTP for risk than group B due to the information of a coming loss causing most outcomes to be coded into the domain of loss. This is assuming group A’s reference point does not fully adapt following the information of imminently losing 12 points.

Prediction 2: Group B should report a higher average WTP for the risky prospect than group A in round 2. After the 12 point loss has happened, both groups will have full information to the game. The total disutility of information and loss experienced by group A is less than group B’s disutility of the surprise loss. This idea is captured by the following expression. Let $U_A$ stand for disutility experienced by group A and $U_B$ stand for disutility experienced by group B.

\[
[U_A \text{ Information of Loss} + U_A \text{ Experience of Loss}] < [U_B \text{ Experience of Loss}]
\]

If this expression is true, then group B should be further into the domain of loss than group A at the conclusion of round 1, so group B should be more risky than group A in round 2.

Prediction 3: The WTP difference, or [round 2 WTP] - [round 1 WTP] should be greater for group B than group A. In other words, group B should become risky in round 2 faster than group A becomes risky in round 2 following the loss of points.

The following are predictions concerning general uncertainty resolution following the conclusion of round 1.

Prediction 4: For both groups, higher points in round 1 should cause lower WTP in round 2. It is possible that group B, the surprised group, will increase risk-seeking as round 1
score decreases faster than group A. This is because group B’s scores will be further in the domain of loss than group A’s scores.

**Prediction 5:** If 0 is a reference point around which participants determine whether they have won or lost, then a negative score in round 1 should lead to higher risk in round two. Also group B should increase WTP for the gamble in round 2 faster than group A, because negative scores will be further in the domain of loss for group B than group A.

**Prediction 6:** If a member of either group lost the gamble, they should seek more risk in round 2 because losing the gamble is undeniably in the domain of loss for both groups assuming participants in group A do not completely expect to lose the gamble.

**Prediction 7:** If a member of either group won the gamble, they should have lower WTP for the gamble in round 2 compared to WTP for risk in round 1. It is possible that group A will decrease riskiness faster than group B if they win the gamble because winning the gamble will be further into the domain of gain for a group A participant compared to a group B participant.
C. Results

Table 7: Summary Statistics for Experiment 2

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round 1 WTP</td>
<td>9.674</td>
<td>2.873</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>Round 2 WTP</td>
<td>10.230</td>
<td>3.368</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>Round 2 WTP, excluding Round 1 gamblers</td>
<td>9.850</td>
<td>3.282</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>WTP Difference</td>
<td>0.551</td>
<td>2.716</td>
<td>-8</td>
<td>9</td>
</tr>
<tr>
<td>Independent demographic variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group A</td>
<td>0.473</td>
<td>0.501</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Female</td>
<td>0.478</td>
<td>0.501</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>[Group A] X [Female]</td>
<td>0.237</td>
<td>0.426</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Nonwhite</td>
<td>0.367</td>
<td>0.483</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>[Group A] X [Nonwhite]</td>
<td>0.155</td>
<td>0.362</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Skydiver</td>
<td>0.778</td>
<td>0.417</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>[Group A] X [Skydiver]</td>
<td>0.343</td>
<td>0.476</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Independent round 1 outcome variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 1 Score</td>
<td>-1.620</td>
<td>8.058</td>
<td>-12</td>
<td>15</td>
</tr>
<tr>
<td>[Group A] X [Round 1 Score]</td>
<td>-0.729</td>
<td>5.680</td>
<td>-12</td>
<td>8</td>
</tr>
<tr>
<td>Lost gamble</td>
<td>0.300</td>
<td>0.459</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>[Group A] X [Lost gamble]</td>
<td>0.150</td>
<td>0.358</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Won gamble</td>
<td>0.261</td>
<td>0.440</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>[Group A] X [Won gamble]</td>
<td>0.140</td>
<td>0.348</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>[Neg. Score]</td>
<td>0.478</td>
<td>0.501</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>[Group A] X [Neg. Score]</td>
<td>0.227</td>
<td>0.420</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Refer to Table 7. Round 1 WTP and round 2 WTP are simply the nominal WTP for the coin flip in rounds 1 and 2. Participants who did not report a valid WTP are not included in the regressions.\(^5\) There was also one observation in round 1 where no gambles were taken, and five observations in round 2 where no gambles were taken. Because there is potentially a large difference in the true risk preferences of someone who did not take any gambles and someone who took at least one gamble, these

---

\(^5\) In other words, if subjects mixed gambles and sure values rather than beginning with gamble and then moving to sure values at some point, then they were not included in the regression. Several preliminary regressions were done using the number of gambles as one’s risk preference estimation, but this yielded no correlations. It is likely that people who did not understand the game did not report a valid willingness-to-pay for risk and therefore do not need to be included in the analysis.
observations are dropped. I investigate what changes risk preferences along a spectrum of risk rather than what makes someone go from totally risk averse to willing to take a risk. This resulted in 129 usable observations for round 1 of the game and 152 observations for round 2 of the game.

Round 2 WTP excluding round 1 gamblers equals WTP for the risky prospect in round 2 of the game, but all observations where the participant had to flip the coin in round 1 are dropped. The effect on behavior of being endowed a sure value of points may be different from winning or losing the coin flip. Given this difference in how outcomes may affect behavior, the results should be analyzed both including and not including those who had to gamble in round 1 of the game.

WTP difference is defined as [round 2 WTP] – [round 1 WTP]. This is analyzed to see how risk preferences changed between the rounds, rather than see differences in final states of WTP. Two participants recorded valid WTP values in round 1, but not round 2. Therefore, there were 127 usable observations for the WTP difference regressions.

Independent demographic variables are defined exactly the same as they were in experiment 1. In this experiment I include another demographic variable in the model: skydiver. In order to control for baseline risk preferences, I asked the participants “would you go skydiving if you had the opportunity?” under the assumption that people who like skydiving are generally more risk-seeking than those who do not.

---

6 It should be noted that doing this means that changes in WTP for the risky prospect may be over-estimated on average.
There are several independent round 1 outcome variables. Score after round 1 of the game, or round 1 score, is simply the final nominal outcome of round 1 including the 12 point loss. Lost the gamble is a dummy variable defined as round 1 score equal to -12, as only those who lost the gamble could have -12 points. Won the gamble is a dummy variable defined as round 1 score equal to 8, as only those who won the gamble could possibly have 8 points. Finally, negative score is a dummy variable defined as having a score lower than 0, and this again is interacted with the group A dummy variable in order to observe differences in how the groups may react to having a negative score.

### Table 8: Regressions of WTP in Experiment 2

<table>
<thead>
<tr>
<th></th>
<th>Round 1</th>
<th>Round 1 Difference</th>
<th>Round 2</th>
<th>Round 2 Difference</th>
<th>WTP</th>
<th>WTP Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A</strong></td>
<td>0.696</td>
<td>2.305**</td>
<td>0.641</td>
<td>1.723</td>
<td>-0.238</td>
<td>-0.852</td>
</tr>
<tr>
<td></td>
<td>(0.509)</td>
<td>(1.163)</td>
<td>(0.555)</td>
<td>(1.275)</td>
<td>(0.492)</td>
<td>(1.157)</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>-0.501</td>
<td>-0.764</td>
<td>-0.044</td>
<td>0.121</td>
<td>0.193</td>
<td>0.543</td>
</tr>
<tr>
<td></td>
<td>(0.519)</td>
<td>(0.680)</td>
<td>(0.559)</td>
<td>(0.769)</td>
<td>(0.499)</td>
<td>(0.667)</td>
</tr>
<tr>
<td><strong>[Group A] X [Female]</strong></td>
<td>-</td>
<td>0.923</td>
<td>-</td>
<td>-0.385</td>
<td>-</td>
<td>-0.953</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.050)</td>
<td></td>
<td>(1.126)</td>
<td>-</td>
<td>(1.020)</td>
</tr>
<tr>
<td><strong>Nonwhite</strong></td>
<td>-0.647</td>
<td>-1.068</td>
<td>-0.008</td>
<td>-0.479</td>
<td>0.102</td>
<td>0.274</td>
</tr>
<tr>
<td></td>
<td>(0.551)</td>
<td>(0.723)</td>
<td>(0.604)</td>
<td>(0.804)</td>
<td>(0.536)</td>
<td>(0.707)</td>
</tr>
<tr>
<td><strong>[Group A] X [Nonwhite]</strong></td>
<td>-</td>
<td>0.888</td>
<td>-</td>
<td>1.019</td>
<td>-</td>
<td>-0.432</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.111)</td>
<td></td>
<td>(1.229)</td>
<td>-</td>
<td>(1.095)</td>
</tr>
<tr>
<td><strong>Skydiver</strong></td>
<td>1.251*</td>
<td>2.607***</td>
<td>0.635</td>
<td>1.485</td>
<td>-0.779</td>
<td>-1.411</td>
</tr>
<tr>
<td></td>
<td>(0.655)</td>
<td>(0.896)</td>
<td>(0.675)</td>
<td>(0.987)</td>
<td>(0.626)</td>
<td>(0.888)</td>
</tr>
<tr>
<td><strong>[Group A] X [Skydiver]</strong></td>
<td>-</td>
<td>-2.818**</td>
<td>-</td>
<td>-1.559</td>
<td>-</td>
<td>1.412</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.278)</td>
<td></td>
<td>(1.359)</td>
<td>-</td>
<td>(1.268)</td>
</tr>
<tr>
<td><strong>R²</strong></td>
<td>0.053</td>
<td>0.092</td>
<td>0.014</td>
<td>0.028</td>
<td>0.015</td>
<td>0.030</td>
</tr>
<tr>
<td><strong>n</strong></td>
<td>129</td>
<td>129</td>
<td>152</td>
<td>152</td>
<td>127</td>
<td>127</td>
</tr>
</tbody>
</table>

Standard deviations are in parentheses. *, **, and *** indicate significance to the 10%, 5% and 1% levels respectively.

Refer to Table 8 for the discussion of predictions 1 through 3.

**Prediction 1:** Prediction 1 states that group A should be more risky than group B in round 1. In the model where demographics are interacted with the group A variable, group A reported higher WTP than group B at the 5% significance level. This significance disappears in my other model, so this finding is not robust. The coefficient
on group A is positive in both models, so there is evidence that group A tended to be slightly more risky than group B in round 1, supporting prediction 1.

**Prediction 2:** Prediction 2 states that group B should be more risky than group A in round 2. In neither models was the group A variable statistically significant. Moreover, in both models the coefficient on the group A variable is positive, which is directly contrary to my prediction. My results do not support prediction 2.

**Prediction 3:** Prediction 3 states that group B should become risky faster than group A becomes risky in round 2. In neither models of WTP differences was the group A variable statistically significant. The coefficient on group A in both models is negative, suggesting either group B become less risky slower than group A, or group B became more risky faster than group A, giving some support to prediction 3.

Another result worth commenting on is the effect of being a skydiver in round 1 of the experiment. The skydiver variable is included to see how being a generally risky person affects decision-making. To understand the overall effect of being a more risky person, non-skydivers in both groups should be compared, and skydivers in both groups should be compared. The comparison of skydivers in both groups is captured by adding the coefficient of the group A variable with the group A skydiver variable. An F-test reveals a 90% chance for the sum of the coefficients to be 0. The comparison of non-skydivers in both groups is captured by the coefficient on the group A variable, which is positive, although not conclusive, as to the magnitude of the effect. Based on these results, skydivers react to information of loss less than non-skydivers in terms of risk preferences.
Table 9: Regressions of Round 2 WTP in Experiment 2 Accounting for Uncertainty Resolution after Round 1

<table>
<thead>
<tr>
<th>R1 Outcome Variable</th>
<th>Score</th>
<th>Score</th>
<th>Score</th>
<th>Score</th>
<th>Neg. score</th>
<th>Neg. score</th>
<th>Neg. score</th>
<th>Neg. score</th>
<th>Lost</th>
<th>Lost</th>
<th>Won</th>
<th>Won</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group A</td>
<td>0.655</td>
<td>2.087*</td>
<td>1.412</td>
<td>4.758**</td>
<td>0.594</td>
<td>2.095</td>
<td>1.518*</td>
<td>4.123**</td>
<td>0.623</td>
<td>2.433*</td>
<td>0.704</td>
<td>1.626</td>
</tr>
<tr>
<td></td>
<td>(0.543)</td>
<td>(1.252)</td>
<td>(0.894)</td>
<td>(1.793)</td>
<td>(0.550)</td>
<td>(1.363)</td>
<td>(0.899)</td>
<td>(1.890)</td>
<td>(0.543)</td>
<td>(1.300)</td>
<td>(0.553)</td>
<td>(1.304)</td>
</tr>
<tr>
<td>Female</td>
<td>0.144</td>
<td>0.510</td>
<td>-0.852</td>
<td>0.044</td>
<td>0.068</td>
<td>0.359</td>
<td>-0.891</td>
<td>0.019</td>
<td>0.118</td>
<td>0.480</td>
<td>-0.012</td>
<td>0.148</td>
</tr>
<tr>
<td></td>
<td>(0.551)</td>
<td>(0.762)</td>
<td>(0.890)</td>
<td>(1.163)</td>
<td>(0.556)</td>
<td>(0.771)</td>
<td>(0.870)</td>
<td>(1.127)</td>
<td>(0.550)</td>
<td>(0.757)</td>
<td>(0.556)</td>
<td>(0.766)</td>
</tr>
<tr>
<td>[Group A] X [Female]</td>
<td>-</td>
<td>-0.718</td>
<td>-</td>
<td>-2.571</td>
<td>-</td>
<td>-0.596</td>
<td>-</td>
<td>-2.552</td>
<td>-</td>
<td>-0.706</td>
<td>-</td>
<td>-0.380</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>(1.106)</td>
<td></td>
<td>(1.736)</td>
<td>-</td>
<td>(1.121)</td>
<td>-</td>
<td>(1.719)</td>
<td>-</td>
<td>(1.101)</td>
<td>-</td>
<td>(1.120)</td>
</tr>
<tr>
<td>Nonwhite</td>
<td>-0.155</td>
<td>-0.760</td>
<td>0.511</td>
<td>-0.162</td>
<td>-0.158</td>
<td>-0.756</td>
<td>0.643</td>
<td>0.186</td>
<td>-0.114</td>
<td>-0.603</td>
<td>-0.097</td>
<td>-0.717</td>
</tr>
<tr>
<td></td>
<td>(0.593)</td>
<td>(0.790)</td>
<td>(0.960)</td>
<td>(1.162)</td>
<td>(0.602)</td>
<td>(0.808)</td>
<td>(0.968)</td>
<td>(1.208)</td>
<td>(0.592)</td>
<td>(0.783)</td>
<td>(0.603)</td>
<td>(0.814)</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>(1.202)</td>
<td></td>
<td>(1.994)</td>
<td>-</td>
<td>(1.225)</td>
<td>-</td>
<td>(2.031)</td>
<td>-</td>
<td>(1.197)</td>
<td>-</td>
<td>(1.231)</td>
</tr>
<tr>
<td>Skydiver</td>
<td>0.669</td>
<td>1.677*</td>
<td>0.577</td>
<td>2.310</td>
<td>0.665</td>
<td>1.598</td>
<td>0.524</td>
<td>2.179</td>
<td>0.587</td>
<td>1.506</td>
<td>0.694</td>
<td>1.606</td>
</tr>
<tr>
<td></td>
<td>(0.660)</td>
<td>(0.964)</td>
<td>(1.015)</td>
<td>(1.448)</td>
<td>(0.668)</td>
<td>(0.979)</td>
<td>(1.008)</td>
<td>(1.450)</td>
<td>(0.660)</td>
<td>(0.960)</td>
<td>(0.672)</td>
<td>(0.985)</td>
</tr>
<tr>
<td>[Group A] X [Skydiver]</td>
<td>-</td>
<td>-1.784</td>
<td>-</td>
<td>-3.397*</td>
<td>-</td>
<td>-1.680</td>
<td>-</td>
<td>-3.219</td>
<td>-</td>
<td>-1.629</td>
<td>-</td>
<td>-1.648</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>(1.326)</td>
<td></td>
<td>(1.990)</td>
<td>-</td>
<td>(1.346)</td>
<td>-</td>
<td>(1.998)</td>
<td>-</td>
<td>(1.322)</td>
<td>-</td>
<td>(1.354)</td>
</tr>
<tr>
<td>R1 score</td>
<td>-0.094***</td>
<td>-0.132***</td>
<td>-0.003</td>
<td>0.052</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
<td>(0.047)</td>
<td>(0.136)</td>
<td>(0.160)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[Group A] X [R1 score]</td>
<td>-</td>
<td>0.068</td>
<td>-</td>
<td>-0.405</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>(0.067)</td>
<td></td>
<td>(0.291)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neg. score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.137**</td>
<td>1.543**</td>
<td>-0.751</td>
<td>-1.616</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.556)</td>
<td>(0.781)</td>
<td>(0.970)</td>
<td>(1.355)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[Group A] X [Neg. score]</td>
<td>-</td>
<td>-</td>
<td></td>
<td>-0.696</td>
<td></td>
<td></td>
<td></td>
<td>2.081</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>(1.121)</td>
<td></td>
<td>(1.895)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.625***</td>
<td>2.468***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.580)</td>
<td>(0.798)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[Group A] X [Lost]</td>
<td>-</td>
<td>-</td>
<td>-0.165*</td>
<td>-1.712</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td></td>
<td>(0.615)</td>
<td>(0.888)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Won</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.050</td>
<td>-0.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- (1.243)</td>
<td>- (1.243)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.065</td>
<td>0.090</td>
<td>0.063</td>
<td>0.202</td>
<td>0.041</td>
<td>0.061</td>
<td>0.073</td>
<td>0.191</td>
<td>0.064</td>
<td>0.094</td>
<td>0.034</td>
<td>0.051</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>-</td>
<td>-</td>
<td>-0.058</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-0.046</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>n</td>
<td>152</td>
<td>152</td>
<td>60</td>
<td>152</td>
<td>152</td>
<td>60</td>
<td>152</td>
<td>152</td>
<td>152</td>
<td>152</td>
<td>152</td>
<td>152</td>
</tr>
</tbody>
</table>

Standard deviations are in parentheses. *, **, and *** indicate significance to the 10%, 5% and 1% levels respectively.
Refer to Table 9 for the discussion of predictions 4 through 7.

**Prediction 4**: Prediction 4 states that as participants’ scores increase in round 1, WTP should decrease in round 2. The results support this prediction at the 1% significance level in the models of round 2 WTP which include round 1 gamblers in the sample. This significance disappears when round 1 gamblers are removed from the sample. This result suggests that winning or losing the gamble may be the most impactful round 1 outcome on round 2 behavior.

**Prediction 5**: Prediction 5 states that if 0 is a reference point around which players determine whether they are in the domain of loss or domain of gain, then negative scores in round 1 should be correlated with higher WTP in round 2. The results support this prediction at the 5% significance level in the models of round 2 WTP which include round 1 gamblers in the sample. This significance also disappears when round 1 gamblers are removed from the sample. Based on this result, winning or losing the gamble may be the most impactful round 1 outcome on round 2 behavior, especially considering anyone who lost the gamble would have a negative score at the conclusion of round 1.

**Prediction 6**: Prediction 6 states that if a participant lost the gamble in round 1, then round 2 WTP should increase. The results support this prediction at the 1% significance level in both models of round 2 WTP.

**Prediction 7**: Prediction 7 states that if a participant won the gamble in round 1, then round 2 WTP should decrease. The results do not show strong support for this prediction. This may be due to the fact that gains do not generate utility at the same speed as losses according to PT. Therefore the effect of gains on behavior may not be as pronounced as the effect of losses on behavior.
D. Discussion of Results for Experiment 2

Overall, the predictions concerning uncertainty resolution tend to be supported by the results. Also, prediction 1 and prediction 3 have some evidence to support them. There are two results in experiment 2 that require more discussion. First, there is evidence that those who had to gamble in round 1 behaved significantly differently than those who did not have to gamble in round 1. Second, in many regressions the opposite of prediction 2 was true: group A had a higher WTP for the risky prospect than group B. I will address both of these results.

Those who had to gamble in round 1 seem to behave differently than those who did not have to gamble in round 1 with regards to the effect of the 12 point loss. First, notice that the coefficient on the group A variable has a higher significance level and a larger coefficient in the regressions excluding round 1 gamblers. This result suggests that the effect of the 12 point loss was greater among those who did not gamble. It is possible that when participants gambled, their focus became not their overall performances in the game, but rather their performances in the gamble. In this case a loss of points in the game is unrelated to the gamble outcome in the minds of gambling participants, and therefore the loss of points does not affect gamblers’ behaviors across groups.

Second, in the regressions which looked at the effect of score or negative score on round 2 WTP, any significant results disappear when round 1 gamblers are removed from the sample. It is possible that the effects of winning or losing the gamble in round 1 have skewed the results in the regressions which include gamblers. This result may be evidence for a difference between reactions to a random endowment of points and reactions to the outcome of a gamble which one took. It is important to keep in mind that
a significant amount of observations were dropped in the regressions not including round 1 gamblers, so it may be worth investigating the effects of prior outcomes in this type of experiment again with a larger sample size.

In every regression of round 2 WTP, group A has a positive coefficient, and several regressions report that this result is statistically significant. This result is totally contrary to my prediction about the effect of the 12 point loss. There may be several reasons for this.

First, it is possible that group B did not see the loss of points as an income loss, but rather as a change of rules. If group B is worried that there are other rules about which they do not know, they may become inherently more risk-averse to avoid losses in the face of another unknown rule.

Second, it is possible that respondents are exhibiting status quo bias with regards to their round 1 WTP for the risky prospect. In other words, they simply do not want to change their risk profiles between rounds. Kahneman, Knetsch, and Thaler (1991) perform an experiment where some people were given a stock portfolio of a certain risk level, and then were given the option to change that risk level. The majority of respondents did not change the risk level of their portfolios. Kahneman, Knetsch, and Thaler say that there is a status quo bias for risk in this situation. It is possible that the same effect is being observed here. The propensity for status quo bias to occur may have also been enhanced because the same exact game table was used between rounds 1 and 2. Using two different game types in future experiments may help to minimize the effects of status quo bias in risk preferences.
To further motivate the argument that status quo bias is affecting the results, consider the following. In round 1, group A was given information that put them in the domain of loss, and group B’s information put them almost exclusively in the domain of gain, save the possibility of losing the gamble. It is possible that only over one round, status quo bias is stronger than the effect of any other change. In order to investigate this possibility more closely, consider the following table which shows the difference in WTP for the risky prospect between rounds for both groups. WTP difference is calculated as WTP in round 2 minus WTP in round 1.

Table 10: Comparison of Willingness-to-Pay Differences Between Rounds 1 and 2 of Both Groups

<table>
<thead>
<tr>
<th>WTP Difference</th>
<th>Group A</th>
<th>Group B</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>-16</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>-10</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>-8</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>-7</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>-6</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>-5</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>-4</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>-3</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>-2</td>
<td>2</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>-1</td>
<td>6</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>0</td>
<td><strong>20</strong></td>
<td><strong>19</strong></td>
<td><strong>39</strong></td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td><strong>60</strong></td>
<td><strong>72</strong></td>
<td><strong>132</strong></td>
</tr>
</tbody>
</table>

Refer to Table 10. A significant amount of people in both groups did not change their WTP for the risky prospect between the rounds. There is a slight tendency in group B to increase risk between the rounds, but a regression of WTP difference including the
group dummy variable yielded no statistically significant results. Given this result, there is evidence that a status quo effect for risk preferences was present in my experiment, and this minimized the effect of the 12 point loss on behavior.

In summary, I can conclude that information regarding a coming change in points does affect the reference point, and the outcomes of prior gambles do affect behavior in future rounds. I find no evidence that the loss of points caused a change in behavior between groups A and B.

VI. Conclusions

A. Considering the effectiveness of my adaptation to prospect theory

My adaptation of PT accounts for the effect surprise has on the evaluations of future decisions in games with several rounds. The value function I originally proposed is written below. As a reminder, let $V_t$ represent the value of a given prospect in round $t$ of a multi-round round game, $x_i$ represent the given prospect in round $t$, $p_i$ represent the probability of $x_i$, $x_{t-1}$ represent the outcome of round $t-1$ in the game, $\psi_{t-1}$ represent the location of the expectations-based reference point along the x-axis of the value function, and $u_{t-1}$ represent the value function for the outcome of round $t-1$.

$$V_t=\sum_{i=1}^n \pi(p_i) \cdot v[x_i + u_{t-1}(x_{t-1} - \psi_{t-1})]$$

According to this model, negative surprises in time period 1 cause prospects to be evaluated more negatively in time period 2, and positive surprises in time period 1 cause prospects to be evaluated more positively in time period 2. Finally, surprises affect behavior in the second time period more as the surprise grows, and likewise the more one expects an outcome the less that outcome affects the evaluation of prospects in the second
round. I also hypothesized that surprises outcomes increase the utility one experiences for both negative and positive outcomes compared to expected outcomes.

Based on my results, there is strong evidence that surprise does increase the utility of outcomes, but I was unable to find any evidence that surprises are affecting the evaluation of future prospects differently than expected outcomes. There are still several variables influencing decision-making behavior that are unaccounted for by the variables I test in this paper.

Beyond just my experimental results, the theory is only valuable if it can sufficiently explain behavior in the real world. My findings support Vanhamme and Snelders’s (2001) conclusion that surprise is associated with increased consumer satisfaction. My theory also provides a reasonable explanation as to why PEAD, strategic earnings forecasts by firms, and non-linear reactions by investors to expected and unexpected monetary policy changes occur. Earnings surprises cause the value of a company to be greater than had that company’s earnings not been a surprise, increasing demand for their stocks. Warning of long-term structural losses reduces negative investor reactions to those losses. Unexpected monetary policy changes discourage investors more than expected monetary policy changes. In each situation, the theory that surprise outcomes increase the utility magnitude of outcomes can be applied to give a reasonable explanation for why these behaviors occur. But in none of these situations do the factors that influence the current decision result solely from the weighting of current prospects and the outcome of previous time period, as my theory suggests.

As it stands, the adaptation to PT I propose is only functional in two round games. This may not be the best model for decision-making behavior in real life, because there are countless scenarios in which more than just the immediately previous round may
affect behavior. Loewenstein and Elster (1992) use an example of seeing a movie to show that the effects of reference point shift following an event may be long lasting. If I see an incredibly good movie, 15 years from now I may not remember exactly what happens in the movie, but my tastes for movies will still be altered. Clearly, taste for movies is not only affected by how you felt about the one movie you had watched previous to the current one.

The effect of prior outcomes on future evaluations may be a ratio of the effect of the previous outcome over the average effects of all previous rounds, keeping in mind that utility of an outcome increases as surprise increases. A model fitting these characteristics looks like this:

$$V_t = \sum_{i=1}^{n} \pi(p_i) \cdot v[x_i + u_{t-1}(x_{t-1}) / \sum_{i=1}^{n} u(x_i)]$$

According to this model, surprise has the largest effect on behavior in early rounds, or in the round immediately following the surprise. As the game goes on, it takes either consistently different results or a very large surprise in order to influence behavior.7

Despite the fact that my findings show surprise increases reference point adaptation following an outcome, there are intuitive scenarios where this may not be true. For example, consider a game that has been repeating for a very long time where there is a safe option A and a risky option B. In each round, my prospects are exactly the same. I always choose the safe option, and always get the payoff associated with the safe option. If I choose the safe option and something else happens, my reference point may not shift as I perceive this surprise as an error rather than new information that needs to be

---

7 This model may explain behavior in games with relatively few rounds well. In truly infinitely repeating games, a more complex function which accounts for forgetting some outcomes over time may be even better at explaining behavior.
accounted for. In a game which has just started, a surprise outcome may be seen as new information that needs to be weighted heavily into the evaluation of prospects. More research into how surprise affects reference point shift must be done. Moreover, including reference point shift in the multi-round PT value function may provide a better model of behavior in multiple rounds.

In summary, my adaptation to PT brings us a step closer to explaining behavior in games with multiple rounds, but more research and adjustment of the theory must be done to have a truly comprehensive model of what influences decision-making. The theory can be applied to explain behaviors we observe to a limited degree, and the data from my experiments supports the theory’s predictions concerning utility. But the majority of situations in life are not simple two round games as the theory assumes. Therefore, my adaptation to PT is strongest in terms of explaining behavior in an experimental setting with two round games. A better model for behavior in games with multiple rounds will account for the effects that many rounds have on behavior, rates of forgetting distant outcomes, and varying levels of ex-post reference point shift.

B. Potential improvements to methods

If I were to perform this experiment again, I would consider the following changes to the methods:

At a small liberal arts college, I find that the most efficient way in terms of time for gathering responses to an experimental survey is to gather participants during class times. But rather than assign one class to one experimental group and another class to another experimental group as I did, each class could be split such that one half of the class is in one experimental group, and the other half of the class is in the other experimental group. This would be an improvement because the factors that influence the
time students decide to take a class, 8:00 AM, 11:00 AM, 2:30 PM, may also affect that person’s decision-making tendencies in general. For example, if all classes assigned to group A happened to be the earlier segment of that class, then the average risk profile of group A may be systematically different than the average risk profile of group B. It may take more time to run the experiment twice for each class, but it will help to ensure an representative distribution of decision-making profiles between the experimental groups.

Introduction level classes should be used to collect participants, and if not all introduction level classes are used, then classes should be selected randomly. It is possible that one’s major influences the way in which one makes decisions, or particular decision-makers self-select into certain majors. By only using introduction level classes, a wider variety of majors or decision-making profiles will be present in the data, making the sample better represent the population. Also the class which a participant was in or the major that class is related to should be recorded and the effects of class tested for so the analysis can control for those differences. I did not record data on which classes participants came from, so I cannot determine if class influenced decision-making.

If I had adequate resources, I would use laptop computers or tablets with the experiments and instructions pre-programmed to collect responses rather than individuals filling out papers. This would reduce the effect of inconsistencies in how instructions are given, and also prevents respondents from providing illegible or inappropriate answers.

In experiment 1, explicitly ordinal prompts which allow the participant to compare expected or surprise outcomes could be used. This type of question may give a more confident result as to how surprise affects utility. If a 1 to 10 point scale is used to approximate utility as I did, then ordered logits or ordered probits may be considered as analysis tools rather than ordinary least squares (OLS) regressions. These analysis tools
might better capture relationships on a 1-10 scale because there are likely non-linear differences between the intervals on such a scale, and OLS does not capture non-linear relationships as well as the other analysis methods.

When using Arkes et al.’s (2008) methods of determining reference point shift, we should consider the potential for a difference in how people respond to a question when it is asked in terms of final states of wealth versus changes in wealth. More research needs to be done into this topic before any claims can be made as to which way of framing a question is the “better” method.

In experiment 2, a third group which experiences no change in points should be included in the study. This would allow for more precise observation of how the effects of general uncertainty resolution affect behavior without the presence of income shocks.

Whether participants perform the game section of the experiment in the presence of other participants or by themselves may affect their responses. For example, knowing how many others gambled in round 1 may influence people’s WTP for the risky prospect in round 2 due to social pressure. Also if respondents all see each other facing the same loss, then the utility of that loss may be different compared to had each individual thought the loss only applied to them. The incentives for genuine play may also affect how a group setting affects behavior. For example, I used a raffle, so each individual’s success was also a function of everyone else’s success. If the incentive is simply a quantity of candy associated with points, then your success is independent of everyone else’s success. Future researchers should consider how the setting of an experiment may affect behavior given the incentive system that the experiment implements.

My incentive system could be improved to elicit more realistic behavior. I told respondents that everyone would receive at least one raffle ticket, even if their scores
were negative. This means that if you lost the gamble in round 1, it was very difficult to gain any more points in round 2. Respondents who lost the first gamble may have lost hope and only taken the risky options or simply gave up trying to make any rational decision. An initial endowment of points would have allowed the potential for marginal benefit to exist at every point-level. I chose not to do this in order to avoid the potential for either a house money effect or endowment effect affecting people’s risk preferences in the first round of the game. In the second round a significant amount of people exclusively chose the risky prospect, so it is possible that some people did lose hope. Therefore, using an initial endowment of points to ensure marginal benefit at all point levels following an income shock may be a better incentive system.

The surprise in the game portion of the experiment could also be refined. A totally unsolicited change in points may not be perceived as an income shock by participants, but rather as a change of rules. In this case, the surprise may actually inherently increase risk-aversion as participants adjust their strategies to account for unknown rules of the game. Rather than give participants absolutely no expectation of a point change, it may be better to tell participants something may happen, but that it is extremely unlikely. Then, the extremely unlikely thing ends up happening. Kahneman and Tversky (1979) note that very low probabilities tend to be weighted as being more likely than they actually are by people. Nonetheless, an outcome which had a conservative expectation is still more surprising than an outcome with a strong expectation, and so the effect of surprise in this case should still be observable.

---

8 This issue may shed light on why we are more risk-seeking in the domain of loss. It is possible that there are enough situations in life where if you want to earn any marginal benefit, you need to be above a certain threshold. If you are far enough below that threshold, then the only possible way to pass the threshold is by taking a risk, as a safe bet is essentially worthless at that point. This may also be evidence for the possibility of multiple reference points: where I am now, and where I want to be/expect to be.
The experiment can also easily be adjusted to test for the effects on behavior of all other surprise categories which are outlined in Table 1, such as positive surprises and surprises of varying magnitudes. I decided to test for negative surprises first, because as Kahneman and Tversky (1979) put it, losses loom larger than gains, and so the effect of losses on behavior would be easier to detect than the effect of gains on behavior. But the theory does not have full empirical support until all types of positive surprises are shown to increase utility more than equal expected positive outcomes. This could be done simply by adjusting the point surprise in experiment 2, but include 5 distinct groups rather than two. These groups would be designated as the large loss group, the small loss group, the no change group, the small gain group, and the large gain group. In this way, the full range of possible surprises is investigated.

C. Suggestions for future research

It is possible that a relatively small sample, unevenly distributed participants between the experimental groups, misplaced incentives in my experimental design, and other behavioral effects may have inhibited my detection of the effects surprise has on risk in experiment 2. Nonetheless, the strong evidence for the effect surprise has on utility found in experiment 1 is justification to study how surprise affects behavior more in general.

I have also mentioned throughout the paper other possibilities for future research which I encountered during this study. They are summarized in the list that follows.

1. Concerning Arkes et al.’s (2008) method for estimating reference point shift, there may be a difference in how people respond to the question when it is asked in terms of final states of wealth versus changes in wealth. This difference should
be investigated so that the optimal methods for determining reference point shift are established for future research.

2. I find significant evidence which points towards an inverse relationship between marginal utility of outcomes and ex-post reference point shift. This relationship should be investigated more. In particular, future research should consider if consciously deciding to react less to a particular outcome increases adaptation to that outcome, allowing one to make decisions differently than had one reacted rather than adapted. Such a result would provide theoretical and empirical support for the claim that staying calm in a crisis leads to “better,” or at least different evaluations of prospects.

3. It appears that winning or losing the gamble was the primary variable causing behavior to change in round 2 of experiment 2. There should be more research into how people react to outcomes which exist on a binomial scale compared to outcomes which exist on a continuous scale. This research may lead to policy implications of how to maximize the effect of income shocks: simply winning or losing may be what matters most, not how much you win or lose by.

4. The experiment should be performed using a game of more than two rounds to see how expected and unexpected income shocks change behavior differently over time. For example, several rounds could be played to see if people develop an equilibrium strategy. Once equilibrium strategies have been established, an income shock could be administered to see how strategies change. It could then be seen if people return to their original equilibrium strategies, and if so under what conditions or how long it takes. If people do not return to their original equilibrium strategies, then it would be of interest to compare their new equilibriums with their old equilibriums. One could also vary the timing of the
announcement of a loss or gain to see how earlier or later announcements affect
the utility of an outcome. For example, does an early announcement get forgotten,
causing ex-post utility to increase, or does it allow for more reference point
adaptation over time, causing ex-post utility to decrease? Can both of these effects
take place under different circumstances? These are questions that can be
answered by more research into how the timing of warnings affects behavior.

D. Policy implications

The specific implications on policy of how surprise outcomes affect behavior is
not very complicated. Simply put, if you want a policy to have a more pronounced effect,
then make the policy announcement or enactment surprising. If you want a policy to have
a less pronounced effect, then give people some expectation of the policy. I will show
several examples of how surprise is already used in policy and in other aspects of life.
Then I will discuss potential complications of using surprise for influencing the effect of
policy.

Consider again the Federal Reserve. The Fed will occasionally change interest
rates as a surprise, and Chang has shown that these surprise interest rate changes have a
significantly larger effect on the economy than announced changes. It is possible the Fed
is consciously deciding whether to use surprise to change the magnitude of the effects of
its policies. In this case, surprise affects aggregate behavior, but surprise is also used by
marketing agencies to affect individual decisions.

Consider any standard infomercial. The infomercial is trying its hardest to sell
you on the latest widget. The infomercial uses flashing lights, loud noises, an interesting
character, anything to catch your attention and increase the feeling of surprise. Perhaps
the most iconic tactic is simply the phrase, “but wait, there’s more!” Marketing agencies realize that people set values on offers as they receive them. If you break the offer into several parts and make each part seem surprising, then people set a marginally higher value on the widget as a whole when each surprising part is added. By making certain aspects of the widget surprising, you have effectively increased the value of the widget without actually changing the widget.

Perhaps the most ancient use of surprise in influencing behavior in the real world is in barter trade. A vendor will initially set an incredibly high price so that the “appropriate” price is perceived as surprisingly low, making what may still be a high price seem like a good deal. Thus the customer is more prone to make a purchase compared to if the vendor had not set an outrageously high price to begin with.

The main complication with using surprise to influence policy is that if it is used too often, then the surprise is no longer surprising. For example, if the Fed uses surprise interest rate changes too often, then people will begin to expect the changes, and the effect is diminished. After hearing thousands of infomercials, the “wait, there’s more!” line becomes tedious rather than surprising. If you spend enough time with barterers, you begin to learn that if they set the first price it is always outrageously high. Therefore, anyone who wants to use surprise to influence policy should keep in mind that surprise should be used sparingly if the effect of surprise is what makes the policy effective in the first place.

The other side to using surprise to enhance the effects of policy is that expectations can be used to reduce the effect of policy on behavior. This policy strategy should be used warily though. As I discussed with the finding of Kasznik and Lev (1995), it is possible that announcements aimed at giving people expectations can have just as
significant an effect as a surprise outcome itself. Therefore one must be strategic in how you set expectations. Making an announcement big, loud, and generally surprising will still have a surprise effect on behavior much like the outcome would have if it were a surprise. If you want to set expectations without creating a surprise effect with your announcement or warning, then it is best to quietly give just enough information for people to slowly formulate an expectation on their own.

E. Final statement

If expectations affect reference point formation, then prospect theory suggests that surprise outcomes will generate more utility than expected outcomes. If the utility of prior outcomes affects future decisions, then surprise outcomes may affect behavior differently than expected outcomes.

The results of my experiments suggest that reference points are affected by expectations, that surprise outcomes do generate more utility than expected outcomes, and that the outcomes of gambles do affect future evaluation of prospects. The results do not provide strong evidence that surprise outcomes are affecting behavior differently from expected outcomes in decisions under risk. There is reason to believe that I find no evidence of a difference in behavior following expected and unexpected outcomes due to other well-documented behavioral effects having a greater influence on behavior than what I test for.

There is also evidence for an inverse relationship between marginal utility of outcomes and reference point shift. If this relationship is confirmed in further studies, there may be policy implications concerning the ability to alter people’s reactiveness or adaptability toward outcomes.
Given my results, more research into how surprise affects utility, risk preferences, and reference point adaptation is warranted.
References


Appendix

Figure A: Group A Experimental Packet

Experimental Survey A

Hello,

Thank you for taking part in this study. This entire survey should take approximately 20 minutes for everyone to complete. It is divided into three sections as follows:

Section 1, Response to a Situation

In this section you will be presented with a hypothetical situation. You will then be asked to record your subjective responses to this situation.

Section 2, Basic Demographic Information

In this section you will simply answer questions about yourself.

Section 3, The Two-Round Game

In this section you will play a game. The goal of the game is to make as many points as you can. Those points will be converted into raffle tickets at the end of the experiment such that the more points you have the more raffle tickets you get. The rules of the game will be explained at the beginning of Section 3.
Section 1

Response to a Situation

Consider the following:

You are the owner of a small business. All year every year your monthly profits are $100,000. This value fluctuates from time to time, but luckily your company has an incredibly skilled adviser. She is always able to predict when and how the company's profits will change. Last month your profits fell by $20,000. Your adviser did not predict this, so the change was totally unexpected.

Question 1:

On a scale of 1 to 10, how unhappy does this make you?

1 is little to no unhappiness, 10 is extreme unhappiness.

Answer: _______

Question 2:

In the situation above your profits fell last month. How much money would you have to lose again this month to feel equally unhappy? Note that this is not necessarily the same value of money lost last month, it is the value of money lost this month that would make you feel equally unhappy with last month.

Answer: $_________
Section 2

Demographic Information

Answer the following questions based on your own situation.

Question 1:

What is your age?

Answer: ______

Question 2:

What is your sex?

Circle one: Female Male

Question 3:

What race or ethnic origin do you most closely identify with?

Circle one: Black/African American White Hispanic or Latino Asian/Pacific Islander Native American or American Indian Other Two or more

Question 4:

What is(are) your major(s) or field(s) of study?

Answer: __________________________

Question 5:

Would you ever going skydiving if you had the opportunity?

Circle one: Yes No
Section 3

The Two-Round Game

Description of the Game and Rules:

In this game your goal is to get as many points as you can. These points will then be converted into raffle tickets after the experiment is done such that the more points you have the more tickets you receive. Everyone will receive at least 1 ticket.

In the table below there are 17 rows. In each row you have the option to either gamble for points or take a sure value of points. You must indicate at each row whether you want to gamble, G, or take the sure value, S. After everyone has filled in their tables, a random number based on the number of rows in the game table will be drawn using a random number generator. Everyone will receive the payoff they chose associated with whatever row is chosen by the random number generator. For example in the practice table below, if the number drawn is 2 and I chose to gamble at row 2, then I would gamble. If I chose sure value, I would receive 2 points.

The researcher will flip a coin for each person who gambled. Heads is a win, tails is a loss.

To better understand the game, we will do a practice round. This round will not count towards your point total, it is simply to help you understand the game before we play for real.

<table>
<thead>
<tr>
<th>Row Number</th>
<th>Gamble</th>
<th>Receive Sure Value</th>
<th>Choice (S or G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50/50 chance to win 6 points</td>
<td>1 point</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>50/50 chance to win 6 points</td>
<td>2 points</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>50/50 chance to win 6 points</td>
<td>3 points</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>50/50 chance to win 6 points</td>
<td>4 points</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>50/50 chance to win 6 points</td>
<td>5 points</td>
<td></td>
</tr>
</tbody>
</table>

G = GAMBLE

S = SURE VALUE

Practice Round RESULT:
We will play the game all together round by round. **Take note that after the conclusion of round 1, I will take 12 points away from your earnings.** After that, we will begin round 2.

**Round 1**

<table>
<thead>
<tr>
<th>Row Number</th>
<th>Gamble</th>
<th>Receive Sure Value</th>
<th>Choice (S or G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50/50 chance to win 20 points</td>
<td>0 points</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>50/50 chance to win 20 points</td>
<td>1 points</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>50/50 chance to win 20 points</td>
<td>2 points</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>50/50 chance to win 20 points</td>
<td>3 points</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>50/50 chance to win 20 points</td>
<td>4 points</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>50/50 chance to win 20 points</td>
<td>5 points</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>50/50 chance to win 20 points</td>
<td>6 points</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>50/50 chance to win 20 points</td>
<td>7 points</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>50/50 chance to win 20 points</td>
<td>8 points</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>50/50 chance to win 20 points</td>
<td>9 points</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>50/50 chance to win 20 points</td>
<td>10 points</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>50/50 chance to win 20 points</td>
<td>11 points</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>50/50 chance to win 20 points</td>
<td>12 points</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>50/50 chance to win 20 points</td>
<td>13 points</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>50/50 chance to win 20 points</td>
<td>14 points</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>50/50 chance to win 20 points</td>
<td>15 points</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>50/50 chance to win 20 points</td>
<td>16 points</td>
<td></td>
</tr>
</tbody>
</table>

**G = GAMBLE**

**S = SURE VALUE**

Round 1 RESULT:_______
**Round 2**

<table>
<thead>
<tr>
<th>Row Number</th>
<th>Gamble</th>
<th>Receive Sure Value</th>
<th>Choice (S or G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50/50 chance to win 20 points</td>
<td>0 points</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>50/50 chance to win 20 points</td>
<td>1 points</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>50/50 chance to win 20 points</td>
<td>2 points</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>50/50 chance to win 20 points</td>
<td>3 points</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>50/50 chance to win 20 points</td>
<td>4 points</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>50/50 chance to win 20 points</td>
<td>5 points</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>50/50 chance to win 20 points</td>
<td>6 points</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>50/50 chance to win 20 points</td>
<td>7 points</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>50/50 chance to win 20 points</td>
<td>8 points</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>50/50 chance to win 20 points</td>
<td>9 points</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>50/50 chance to win 20 points</td>
<td>10 points</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>50/50 chance to win 20 points</td>
<td>11 points</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>50/50 chance to win 20 points</td>
<td>12 points</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>50/50 chance to win 20 points</td>
<td>13 points</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>50/50 chance to win 20 points</td>
<td>14 points</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>50/50 chance to win 20 points</td>
<td>15 points</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>50/50 chance to win 20 points</td>
<td>16 points</td>
<td></td>
</tr>
</tbody>
</table>

G = GAMBLE  
S = SURE VALUE  

Round 2 RESULT:_________  

Total Earnings:_________
Hello,

Thank you for taking part in this study. This entire survey should take approximately 10 minutes for everyone to complete. It is divided into three sections as follows:

**Section 1, Response to a Situation**

In this section you will be presented with a hypothetical situation. You will then be asked to record your subjective responses to this situation.

**Section 2, Basic Demographic Information**

In this section you will simply answer questions about yourself.

**Section 3, The Two Round Game**

In this section you will play a game. The goal of the game is to make as many points as you can. Those points will be converted into raffle tickets at the end of the experiment such that the more points you have the more raffle tickets you get. The rules of the game will be explained at the beginning of Section 3.
Section 1

Response to a Situation

Consider the following:

You are the owner of a small business. All year every year your monthly profits are $100,000. This value fluctuates from time to time, but luckily your company has an incredibly skilled adviser. She is always able to predict when and how the company's profits will change. Last month your profits fell by $20,000. Your adviser did predict this, so the change was totally expected.

Question 1:

On a scale of 1 to 10, how unhappy does this make you?

1 is little to no unhappiness, 10 is extreme unhappiness.

Answer: _______

Question 2:

In the situation above your profits fell last month. How much money would you have to lose again this month to feel equally unhappy? Note that this is not necessarily the same value of money lost last month, it is the value of money lost this month that would make you feel equally unhappy with last month.

Answer: $________
Section 2

Demographic Information

Answer the following questions based on your own situation.

Question 1:
What is your age?
Answer: ______

Question 2:
What is your sex?
Circle one: Female Male

Question 3:
What race or ethnic origin do you most closely identify with?
Circle one: Black/African American White Hispanic or Latino Asian/Pacific Islander Native American or American Indian Other Two or more

Question 4:
What is(are) your major(s) or field(s) of study?
Answer: __________________________

Question 5:
Would you ever going skydiving if you had the opportunity?
Circle one: Yes No
Section 3

The Two Round Game

Description of the Game and Rules:

In this game your goal is to get as many points as you can. These points will then be converted into raffle tickets after the experiment is done such that the more points you have the more raffle tickets you receive. Everyone will receive at least 1 ticket.

In the table below there are 17 rows. In each row you have the option to either gamble for points or take a sure value of points. You must indicate at each row whether you want to gamble, G, or take the sure value, S. After everyone has filled in their tables, a random number based on the number of rows in the game table will be drawn using a random number generator. Everyone will receive the payoff they chose associated with whatever row is chosen by the random number generator. For example in the practice table below, if the number drawn is 2 and I chose to gamble at row 2, then I would gamble. If I chose sure value, I would receive 2 points.

The researcher will flip a coin for each person who gambled. Heads is a win, tails is a loss.

To better understand the game, we will do a practice round. This round will not count towards your point total, it is simply to help you understand the game before we play for real.

<table>
<thead>
<tr>
<th>Row Number</th>
<th>Gamble</th>
<th>Receive Sure Value</th>
<th>Choice (G or S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50/50 chance to win 6 points</td>
<td>1 point</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>50/50 chance to win 6 points</td>
<td>2 points</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>50/50 chance to win 6 points</td>
<td>3 points</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>50/50 chance to win 6 points</td>
<td>4 points</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>50/50 chance to win 6 points</td>
<td>5 points</td>
<td></td>
</tr>
</tbody>
</table>

G = GAMBLE

S = SURE VALUE

Practice Round RESULT:
We will play the game all together round by round.

**Round 1**

<table>
<thead>
<tr>
<th>Row Number</th>
<th>Gamble</th>
<th>Receive Sure Value</th>
<th>Choice (S or G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50/50 chance to win 20 points</td>
<td>0 points</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>50/50 chance to win 20 points</td>
<td>1 points</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>50/50 chance to win 20 points</td>
<td>2 points</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>50/50 chance to win 20 points</td>
<td>3 points</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>50/50 chance to win 20 points</td>
<td>4 points</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>50/50 chance to win 20 points</td>
<td>5 points</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>50/50 chance to win 20 points</td>
<td>6 points</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>50/50 chance to win 20 points</td>
<td>7 points</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>50/50 chance to win 20 points</td>
<td>8 points</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>50/50 chance to win 20 points</td>
<td>9 points</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>50/50 chance to win 20 points</td>
<td>10 points</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>50/50 chance to win 20 points</td>
<td>11 points</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>50/50 chance to win 20 points</td>
<td>12 points</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>50/50 chance to win 20 points</td>
<td>13 points</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>50/50 chance to win 20 points</td>
<td>14 points</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>50/50 chance to win 20 points</td>
<td>15 points</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>50/50 chance to win 20 points</td>
<td>16 points</td>
<td></td>
</tr>
</tbody>
</table>

G = GAMBLE
S = SURE VALUE

Round 1 RESULT:_________
Round 2

<table>
<thead>
<tr>
<th>Row Number</th>
<th>Gamble</th>
<th>Receive Sure Value</th>
<th>Choice (S or G)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50/50 chance to win 20 points</td>
<td>0 points</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>50/50 chance to win 20 points</td>
<td>1 points</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>50/50 chance to win 20 points</td>
<td>2 points</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>50/50 chance to win 20 points</td>
<td>3 points</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>50/50 chance to win 20 points</td>
<td>4 points</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>50/50 chance to win 20 points</td>
<td>5 points</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>50/50 chance to win 20 points</td>
<td>6 points</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>50/50 chance to win 20 points</td>
<td>7 points</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>50/50 chance to win 20 points</td>
<td>8 points</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>50/50 chance to win 20 points</td>
<td>9 points</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>50/50 chance to win 20 points</td>
<td>10 points</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>50/50 chance to win 20 points</td>
<td>11 points</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>50/50 chance to win 20 points</td>
<td>12 points</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>50/50 chance to win 20 points</td>
<td>13 points</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>50/50 chance to win 20 points</td>
<td>14 points</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>50/50 chance to win 20 points</td>
<td>15 points</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>50/50 chance to win 20 points</td>
<td>16 points</td>
<td></td>
</tr>
</tbody>
</table>

G = GAMBLE
S = SURE VALUE

Round 2 RESULT:_________

Total Earnings:_________
RESEARCH PARTICIPANT CONSENT FORM

Researchers: Edward Yonkers, Professor Amanda Felkey (Adviser to thesis)

Purpose of Research: This study is designed to see how decision-making behavior changes.

Specific Procedures to Be Used: Participants will answer a series of questions in three distinct phases. The first phase will be to record a subjective response to a described situation. The second phase will be to record simple demographic data. The final phase will be a two round game in which participants try to maximize points. Points are earned by strategically choosing a level of risk the participant is willing to take on. Each round will be exactly the same. Points will be converted into raffle tickets at the end of the game.

Duration of Participation: The duration of the experiment is generally about 20 minutes.

Benefits to the Individual: Participants have a chance to win a raffle. The participants will also acquire knowledge concerning the developing field of Behavioral Economics.

Risks to the Individual: Participants may experience negative emotional responses from the game section of this survey if they perceive their performance poorly. These feelings are likely to be temporary, but if they become unpleasant you are encouraged to leave the experiment.

Compensation: Participants will be rewarded with raffle tickets based on how well they do. Raffle prize: $50 Walgreens gift card. Raffle winner will be announced before the end of the semester depending on when data collection is completed, and December 11th by the latest.

Confidentiality: Note that this study is not anonymous because the researcher knows who participated. However, no single participant’s data will be linked to any identifying characteristics such as name, student ID or other identifying numbers under any circumstances in the discussion of the results. Data analysis will focus on group averages rather than individuals’ performances. Before beginning the survey, you will hand in this consent form so that your data cannot be linked to your name.

Voluntary Nature of Participation: No one is required to take part in this study. If you agree to take part, you may leave the study at any time you wish without penalty.

Human Subject Statement: If you have any questions about this study, you may contact Edward Yonkers (603-717-2466, yonkerseh@mx.lakeforest.edu). If you have any questions about your rights as a research participant, please feel free to contact the co-chairs of the Human Subjects Review Committee, Dr. Sergio Guglielmi, at guglielmi@lakeforest.edu (847-735-5260), or Dr. Naomi Wentworth, at wentworth@lakeforest.edu (847-735-5256)

I HAVE FULLY READ THIS CONSENT FORM AND UNDERSTAND ITS CONTENTS. I HAVE ALSO HAD THE OPPORTUNITY TO ASK QUESTIONS ABOUT THE STUDY, AND I AGREE TO TAKE PART IN THIS STUDY.

Participant’s Signature _______________________________ Date _______________________________

Participant’s Name and email (to be contacted for raffle) _______________________________ _______________________________

Researcher’s Signature _______________________________ Date _______________________________
Debriefing: The Power of Information Experimental Survey

What is the general aim of this research?

The general aim of this research is to see how people respond differently to situations based on whether or not they were expecting that situation. There were two versions of this survey, A and B. In version A, the hypothetical situation says your adviser did not predict the change. In version B, the adviser did predict the change. In both versions the changes were of equal amount. In version A participants are told ahead of time that they will lose 12 points after round 1 in the game. In version B participants are not told ahead of time that they will lose 12 points after round 1 in the game. The hypothesis is that the responses that participants in groups A and B give to each question will not be the same.

What kind of research is this?

This is experimental research. The independent variable is whether or not one had prior information that a loss was going to occur.

What areas of Economics does this research expand on or illustrate?

This research would fall into the Behavioral Economics region of study as it is concerned primarily with how we make decisions, and specifically how risk preferences might change in response to new information. The theory driving this research is based primarily on prospect theory, a Nobel Prize winning theory which, among many other things, provides a model for why people’s risk preferences might change. This theory has led to an entire field of new and developing research. The goal of this study is to show that simply having prior knowledge of an event can change how we view and react to that event when it occurs as opposed to when it is a surprise.

Where can I learn more about this particular topic or research like it?

Prospect Theory: An Analysis of Decision under Risk
Daniel Kahneman and Amos Tversky
Econometrica
Vol. 47, No. 2 (Mar., 1979), pp. 263-292
Published by: The Econometric Society
Stable URL: http://www.jstor.org/stable/1914185

How expectations affect reference point formation: an experimental investigation
Andreas Hack and Frauke von Bieberstein
Review of Managerial Science
Vol. 9, Issue 1 (Jan., 2014), pp. 33-59
Who is supervising this research and how can I contact them?

Edward Yonkers, a senior at Lake Forest College, is conducting the research. You can contact him by email at yonkerseh@mx.lakeforest.edu or by phone at 603-717-2466. Dr. Amanda J Felkey is the adviser to Edward Yonkers’s thesis. You can reach her by email at felkey@lakeforest.edu. You can also contact the co-chairs of the Human Subjects Committee, Dr. Naomi Wentworth at wentworth@lakeforest.edu (847-735-5256) and Dr. Sergio Guglielmi, at guglielmi@lakeforest.edu (847-735-5260).

How long has the investigator been studying this specific topic?

Edward Yonkers has been an Economics major since his freshman year but began the preliminary research for his thesis and this topic in particular last semester. This is his first time conducting research of this sort.

Thank you very much for taking part in this survey. This type of research is not possible without your support, so we are truly grateful for your time and effort.
Figure E: Experimental Script

[Before beginning, split survey copies into two pile and give to either ends of the classroom. Tell the students: “Take one and pass it along. Do not look beyond the front page until instructed to do so.” Once everyone has a copy, begin:

Hello everyone,

My name is Ned Yonkers, and I am a senior currently writing a thesis for Economics. Your professor has been gracious enough to allow me some time to come into your class and collect responses for my survey. Participation in this survey is completely voluntary, but those who participate have a chance to win a $50 Walgreens gift card. If you wish to participate, please follow along as I read the consent form.

[Read consent form]

Are there any questions about the study so far?

If you agree to the following statement, please fill out the consent form and pass it forward.

[Read consent statement]

[After all consent forms are gathered, read the survey]

[Cue page flips throughout survey, and say “This concludes Section (x)” at the end of each section. Ask students “Is everyone done answering?” when it appears they are ready to move on]

SECTION 3: During practice round, explain any confusion about the rules or how to fill in the table. When announcing the result of gambles, start with front left corner and work rightwards, then go to the left side of the next row back when the last person of the current row has been reached. Have gamblers raise their hands after the conclusion of each round.]

FOR SURVEY B: “I did not tell you this before we began, but before we begin round two of the game, you must subtract 12 points from your point total, even if this gives you a negative score.

[At the conclusion of the survey, say: “Thank you to everyone who participated. The final paper is for you to take with you. It explains into more detail what this research is. Please do not discuss the contents of this study with your peers, as they may become participants as well! As you come to hand in your papers, show me your total at the end of the game, and I will distribute your raffle tickets.”]
Figure F: Unhappiness Distribution