

Core Knowledge Area Module II:
Theories of Human Development
Theories of Human Decision Making

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BREADTH ABSTRACT

Since Daniel Bernoulli proposed a solution to the famous St. Petersburg Paradox in 1731, researchers have proposed a number of models to describe decisions under risk and uncertainty. The first of these models was expected utility theory, and two of the most famous to follow were prospect theory, which was proposed by Kahneman and Tversky in 1979, and regret theory, proposed independently by Bell (1982) and by Loomes and Sugden (1982, 1983, 1987). The Breadth essay defines and then introduces some basic findings from hedonic psychology. Each of the three theories describing risky decision making are compared and contrasted and integrated with findings from hedonic psychology. Several famous experimental problems are discussed, and several biases in decision making are explored. The essay concludes by examining issues that illuminate the need for new theories or refinements to the existing ones.

DEPTH ABSTRACT

Prospect theory has emerged as the leading theory to describe decision under risk. In the depth section, risky decisions are carefully defined and recent research in prospect theory, including strengths and weaknesses of various research efforts is discussed. Various experimental results are examined from the perspective of their relationships to prospect theory, and the discussion weaves in important points that were demonstrated in the breadth section. The section concludes with an analysis of several applications to prospect theory in the realm of social behavior, political science, deterrence and compellence, and the way that the 9/11 terrorist attacks may have affected risk preferences.

APPLICATION ABSTRACT

Applications of decision theory are literally apparent in the average person's daily life. In fact, the models described in the Breadth and Depth sections of this paper describe what happens every time someone makes a choice where the outcome is not certain. Adolescents are especially prone to take careless risks (Johnson, McCaul, & Klein, 2002). In an effort to educate a group of adolescents about the subconscious mechanisms that influence their choices, two seminars were conducted at Roy Cloud School in Redwood City, California. The seminars were highly interactive, and students responded to certain classic research questions via a show of hands. The students who attended were also required to write a short paper as a take-home assignment after the seminar. This section describes the seminar in detail, including a comparison of previous results from prospect theory research with aggregate student answers to some classic research questions that were asked during the seminars.

Learning Agreement
Core Knowledge Area Module II:
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Overview

This learning agreement applies to my doctoral study in AMDS/Operations Research. I will use KAM2 to gain an understanding of how decisions are made from the perspective of social psychology, and how decisions affect human happiness.

I will critically examine theories of decision making throughout this study. This will include the study of major theories of how humans value various options in decision making, how “framing” can change perceptions, and how decisions are made. Framing specifically deals with the idea that different ways of formulating problems can have powerful effects on the choices made. Someone who designs the questions for a survey with a knowledge of framing effects can have great influence over the ultimate answers obtained from respondents. Values, contentment and risk will be examined using the disciplines of general psychology, social psychology, and philosophy and integrated with theories about human happiness.

There are three specific theories to be studied in this KAM. The first is Bernoulli’s utility theory, which was the first major contribution to contemporary decision theory. Bernoulli’s utility theory attempted to describe how individuals *would* behave if they followed certain rational rules of decision making, not how people actually *do* behave. Two hundred and fifty years later, Kahneman and Tversky developed prospect theory, which uses the idea of “value” rather than “utility” to evaluate decisions. Prospect theory attempts to explain the way people *actually* behave, and therefore prospect theory has many applications in a wide range of fields. A few short years after prospect theory first emerged, Dunning and Parpal, David Bell, and Loomes and Sugden, developed regret theory. Regret theory posits that decision makers look at their decisions

relative to what might have happened if they had made a different choice rather than evaluating options relative to a reference point.

During the depth phase of the KAM, a specific study will be made of more recent trends and theories in decision making and how they relate to human contentedness. These theories will then be applied by conducting a seminar with middle school students from Roy Cloud School, Redwood City School District, CA. Certain tenets of prospect theory will be tested using a few classic research questions and an informal poll during the seminar.

Breadth Objectives

Compare and contrast, and synthesize and integrate major theorists of human decision making from the perspective of social psychology, including Kahneman & Tversky's prospect theory, Bernoulli's utility theory, and Dunning and Parpal's, David Bell's, and Loomes and Sugden's regret theory in relation to the way humans develop rationales for their choices, Integrate the study with theories about how choices relate to human contentment.

Preliminary Breadth Reference List

Books:

Kahneman, D. (1999). *The foundations of hedonic psychology*. New York: Russell Sage Foundation.

Kahneman, D. & Tversky, A. (2000). *Choices, values, and frames*. Cambridge, United Kingdom: Cambridge University Press.

Myers, D. (1992). *The pursuit of happiness*. New York: Harper Collins Publishers.

Plous, S. (1993). *The psychology of judgment and decision making*. New York: McGraw Hill.

Articles:

Bell, D. (1982). Regret in decision making under uncertainty. *Operations Research*, 30, 961–981.

Bell, D. (1985). Disappointment in decision making under uncertainty. *Operations Research*, 33, 1–27.

Bernoulli, D. (1738/1954). Exposition of a new theory on the measurement of risk, translated by Louise Sommer. *Econometrica*, 22, 22–36.

Carlin, P. (1992). Violations of the reduction and independence axioms in Allais-type and common-ratio effect experiments. *Journal of Economic Behavior & Organization*, 19(2), 213–235.

- Dunning, D. & Parpal, M. (1989). Mental addition versus subtraction in counterfactual reasoning: On assessing the impact of personal actions and life events. *Journal of Personality and Social Psychology*, 57, 5–15.
- Gul, F. (1991). A theory of disappointment aversion. *Econometrica*, 59(3), 667–686.
- Loomes, G. & Sugden, R. (1982). Regret theory: An alternative theory of rational choice under uncertainty. *Economic Journal*, 92, 805–824.
- Loomes, G. & Sugden, R. (1983). A rationale for preference reversal. *American Economic Review*, 73, 428–432.
- Loomes, G. & Sugden, R. (1987). Some implications of a more general form of regret theory. *Journal of Economic Theory*, 42, 270–287.
- Quiggin, J. (1985). Subjective utility, anticipated utility, and the Allais paradox. *Organizational Behavior and Human Decision Processes*, 35(1), 94–101.

Breadth Demonstration

In a scholarly paper of about 30 pages, I will compare and contrast the major theories from social psychology related to how humans make decisions, how various choices are valued, and how these decisions affect contentment. The paper will lay the foundation for the detailed depth examination of recent discoveries in prospect theory.

Depth Objectives

Examine prospect theory in depth, including recent findings and schools of thought on prospect theory. Prospect theory deals with specific ways that humans actually make decisions. Some of the major tenets of prospect theory are the effects of framing on decision makers, the tendency for people to value items more once they possess them, (the endowment effect), and the propensity for decision makers to avoid loss even when doing so lowers expected utility. This theory will be analyzed for strengths, weaknesses and applicability to human contentment. The focus will be on recent research conducted in the last 5 to 15 years, and the analysis will be built upon the foundation laid in the Breadth section of the KAM.

Preliminary Depth References

Books:

Kahneman, D. (1999), *Judgment under uncertainty: Heuristics and biases*. Cambridge, UK: Cambridge University Press.

Articles:

Ariely, D., Huber, J., & Wertenbroch, K. (2005). When do losses loom larger than gains? *Journal of Marketing Research*, 42(2), 134–138.

Camerer, C. (2005). Three cheers—psychological, theoretical, empirical—for loss aversion. *Journal of Marketing Research*, 42(2), 129–133.

González-Vallejo, C., Reid, A. A., & Schiltz, J. (2003). Context effects: The proportional difference model and the reflection of preference. *Journal of Experimental Psychology/Learning*. 29(5), 942–953.

Hertwig, R., Barron G., Weber, G., Elke, U. & Erev. I. (2004). Decisions from experience and the effect of rare events in risky choice. *Psychological Science*, 15(8), 534–539.

Jervis, R. (2004). The implications of prospect theory for human nature and values. *Political Psychology*, 25(2), 163–176.

- Kahneman, D. (2003). A perspective on judgment and choice. *American Psychologist*, 58(9), 697–720.
- Kahneman, D. (1991). Judgment and decision making: A personal view. *Psychological Science*, 2, 142–145.
- Kahneman, D., Knetsch, J. L. & Thaler, R. H. (1990). Experimental tests of the endowment effect and the Coase theorem. *Journal of Political Economy*, 98, 1325–1348.
- Kahneman, D., & Tversky, A. (1972). Subjective probability: A judgment of representativeness, *Cognitive Psychology*, 3, 430–454.
- Kahneman, D., & Tversky, A. (1973). On the psychology of prediction. *Psychological Review*, 80, 237–251.
- Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, 47, 263–291.
- Kerr, N. L. & Tindale, R. S. (2004). Group performance and decision making. *Annual Review of Psychology*. 55(1), 623–652.
- Lo, K. C. (2005). More likely than unlikely. *Mathematical Social Sciences*, 49(1), 39–54.
- Mazur, J. E. (2004). Risky choice: Selecting between certain and uncertain outcomes. *Behavior Analyst Today*, 5(2), 190–203.
- Mercer, J. (2005). Prospect theory and political science. *Annual Review of Political Science*, 8(1), 1–21.
- Milburn, T. & Isaac, P. (1995). Prospect theory: Implications for international mediation. *Peace & Conflict*, 1(4), 333–342.
- Novemsky, N. & Kahneman, D. (2005). How do intentions affect loss aversion? *Journal of Marketing Research*, 42(2), 139–140.
- Novemsky, N. & Kahneman, D. (2005). The boundaries of loss aversion. *Journal of Marketing Research*, 42(2), 119–128.
- Rottenstreich, Y., Hsee, C. K. (2001). Money, kisses, and electric shocks: On the affective psychology of risk. *Psychological Science*, 12(3), 185–190.
- Sacco, K. Galletto, V., & Blanzeiri, E. (2003). How has the 9/11 terrorist attack influenced decision making? *Applied Cognitive Psychology*, 17(9), 1113–1127.

- Sasaki, H. (2005). The effects of trial repetition and individual characteristics on decision making under uncertainty, *Journal of Psychology*, 139(3), 233–246.
- Schaub, G. Jr. (2004). Deterrence, compellence and prospect theory. *Political Psychology*, 25(3), 389–410.
- Thorngate, W., & Tavakoli, M. (2005). In the long run: Biological versus economic rationality. *Simulation & Gaming*, 36(1), 9–26.
- Wakker, P. P. (2004). On the composition of risk preference and belief. *Psychological Review*, 111(1), 236–241.
- Weber, B., & Chapman, G. (2005). Playing for peanuts: Why is risk seeking more common for low-stakes gambles? *Organizational Behavior & Human Decision Processes*, 97(1), 31–46.

Depth Demonstration

In a scholarly paper of about 30 pages including annotated bibliography, I will integrate the theories from the Breadth component of the KAM with recent findings and thoughts regarding prospect theory, its strengths and weaknesses, and its applicability to human happiness. The annotated bibliography will include at least 15 current journal articles relevant to prospect theory. The bibliography will also contain some older, major foundational papers written by Kahneman and Tversky, the fathers of prospect theory.

Application Objectives

By means of a seminar for middle school students at Roy Cloud School in the Redwood City School District, CA, educate the students about the subconscious underlying mechanisms that drive risky decisions and determine the applicability of a few aspects of prospect theory to junior high school students' preferences. Study will build upon the foundation laid in the Breadth and Depth sections of the KAM, and use the theories studied in these sections.

Preliminary Application References Materials

Books:

Thomas, S. (1999). *Designing surveys that work!: A step-by-step guide*. Thousand Oaks, CA: Corwin Press.

Rea, L. (1997). *Designing and conducting survey research: A comprehensive guide (Jossey Bass Public Administration Series)*. San Francisco: Jossey Bass Publishers.

Article:

Rönnlund, M., Karlsson, E., Lagnäs, E., Larsson, L., & Lindström, T. (2005). Risky decision making across three arenas of choice: Are younger and older adults differently susceptible to framing effects? *Journal of General Psychology*, 132(1), 81–92.

Application Demonstration

After obtaining permission from the principal of Roy Cloud School, I will conduct a seminar for eighth grade middle school students in the Redwood City School District, CA, to educate the students about how decisions are made and how they may be able to avoid bad decision in the future. Appropriate examples will be used to illustrate

prospect theory and other research results concerning human decision making. In an essay of approximately 10 pages, I will describe the content of the seminar, the manner in which the seminar was conducted, and any results obtained.

Walden University

Self-Evaluation: Knowledge Area Modules (KAMs)

*Students: Attach this completed form to each KAM prior to forwarding to the
Faculty Assessor
(Please use reverse side as necessary)*

Student Name __Teresa (Terri) Bittner_____ **Date** _____8/31/05_____

KAM number __2__ **Title** _____Theories of Human Development_____

1. What knowledge/experience did you bring to this KAM? How did you capitalize/expand on this base?

Before beginning this KAM I had absolutely no knowledge of the subject area. In fact, I didn't even know that prospect theory or regret theory existed, and had only vague and incorrect ideas about the nature of expected utility theory. However, I did come into this KAM with a good mathematics and statistics background and excellent critical thinking and analytical skills. These skills helped me to understand the theories I studied at a deeper level than would otherwise have been possible. I used these skills to add a great deal to my limited knowledge base about social psychology in general and decision analysis in particular.

2. Describe the quality of the **Breadth** section in the light of the intellectual and communication skills demonstrated in this KAM.

I wrote a 30 page essay about three theories concerning human decision making. These included Bernoulli's expected utility theory, Loomes & Sugden's and Bell's regret theory and Kahneman & Tversky's prospect theory. The three theories were compared and contrasted and integrated with research about human happiness. I believe that my background in mathematics and statistics allowed me to critically analyze the theories about decision under risk in an unusual way in that I was able to look at the quality of the experimental designs in the research experiments conducted in support and criticism of the three theories, as well as to look at various assumptions necessary in order to apply the theories. This resulted not only in comparison of the three theories, but also in some analysis that described why certain aspects of the theories could not be compared to each other.

3. In the **Depth** section, what key ideas/concepts most engaged your thinking and imagination relative to your area of study?

Kahneman & Tversky's prospect theory is a fascinating theory about how humans make decisions. The concept of loss aversion grabbed me, and I read many papers that supported the theory as well as some that tried to find exceptions to it. It was most interesting to me to find that some of the research in refereed journals was not credible, and that a closer look is often necessary to determine credibility, even from authors who do their research at respected institutions and publish in refereed journals. I was also struck by the occasional subtle misunderstanding of key terms, even by researchers in the field they are writing about. A key example of this is given in my Depth essay. Finally, I found some systematic flaws in experimental design in the field I was studying, and this gave me ideas for further research in the future to fill gaps left by poor experimental design.

4. Expound on the most meaningful theoretical construct studied and applied to your professional setting in the **Application** section. What can you do differently/better as a result of this KAM?

Prospect theory's specific tenets were applied in my application section in a variety of ways. The main application was a seminar given to junior high students to help them understand their behavior better. Each student was then required to write a paper of their own on what they learned. My Breadth and Depth essays have also been read and put into practice by other educators and even by an individual engaged in overseas aid work with Africans. Loss aversion is a subconscious phenomenon that most people don't recognize in their own decisions. Yet, while it is subconscious, it is also a strong motivator in decision making. It is my hope that I will continue to teach the material from this KAM to others and that they will apply it in their lives and work.

5. Briefly describe the most important **Social Issue** covered in this KAM.

Since decisions have consequences, it is important to understand what drives human decision making. This KAM helped clarify the psychology of judgment and decision making. It is my hope that if people can understand their innate motivations that they may be able to overcome those that may be harmful to them. Since I work with middle school and high school students, I would eventually like to see this material taught in more schools with the intended result of positive behavioral change due to better understanding of why people make the decisions that they do. However, I believe that this material can also be helpful for adults in their personal and professional lives. This is clear to me because a number of adults in various professions have already requested copies of this paper as a result of hearing a short synopsis of what decision analysis is.

BREADTH DEMONSTRATION

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BREADTH DEMONSTRATION

Introduction

Early in the 18th century, a Swiss professor named Nicholas Bernoulli presented an interesting problem in a letter to his younger cousin Daniel Bernoulli. He proposed the following bet: A fair coin will be flipped until the result is Tails. If Tails appears on the first flip, you will be paid one dollar. If Tails appears on the second flip, you will be paid two dollars. The payout is doubled for each additional flip that is required before a Tails turns up, and the game ends the first time the result is Tails. This pattern continues so that if Tails appears on the n th flip, you will be paid 2^{n-1} . Nicholas Bernoulli wanted to know how much the average person would be willing to pay to play this game (Bernoulli, 1731/1954). This problem became quite famous, was named St. Petersburg Paradox, and became the inspiration for modern decision analysis. Why would this problem be of so much interest?

People make decisions almost constantly, sometimes without even knowing they are doing it. Some of those decisions don't really matter. For example, it usually won't have an affect on your life if you decide to wear a blue shirt today rather than a white one. However, many decisions do affect our lives, and it is these decisions that psychologists, economists and others have generally studied. The way people make decisions is of great interest to those studying psychology, since everything that affects the way humans behave, feel and think is of interest in psychology. However, decision making is also of great interest in many other fields. Economists study the way consumers make decisions because it affects pricing and production decisions. Since managers are also people, the very way that business runs is also affected by the way

people make decisions. The way people make decisions is also of interest to sociologists, philosophers, and even political scientists. After all, the complexities of international politics are based to some extent on the decisions that people make. The kinds of decisions that matter most are decisions that involve risk. These decisions can generally be modeled by looking at “bets” or gambles offered to people with different probabilities of different outcomes. This is the foundation of modern decision analysis, and its cousin, game theory. Nicholas Bernoulli’s St. Petersburg Paradox is a model of decision making in the form of a gamble.

It has long been known that the ability to understand how people make decisions would give people an advantage in understanding and making their own decisions in business, politics, sociology, political science, and many other fields. Unfortunately, decision making is a complex phenomenon, and models that describe it are complex and imperfect. Nevertheless, great strides have been made in this field in recent decades, and it is of interest to look at some of the early and more recent models of human decision making and the implications of these models. Since many decisions are made with the hope that they will enhance human happiness or contentedness in some way, it is useful to combine decision making models with a look at *hedonic psychology*, a term coined in 1999 by Daniel Kahneman, Ed Diener, and Norbert Schwarz. Hedonic psychology is the study of human happiness, sadness, pain, and pleasure, from the perspective of psychology. Though this field has been studied to some extent since the beginning of the study of psychology, recent efforts in this field have been moving towards systematic ways of measuring happiness, and have formed a new interest in the study of this difficult area (Kahneman, Diener & Schwarz, 1999).

Because of the interest in combining human decision making with happiness, it is reasonable to look at the basics of what makes humans happy followed by an introduction to three common models used to describe human decision making. These models, Bernoulli's expected utility theory, Kahneman & Tversky's prospect theory, and Bell's and Loomes & Sugden's regret theory will be compared and contrasted and integrated with hedonic psychology to form conclusions about how human decisions ultimately may affect happiness.

Decision analysis has broad applications in psychology, sociology, business, economics, political science, medicine, and many other disciplines. Insight into human values and decisions has the potential to profoundly affect all of these fields. Since people often make decisions in the hope of increasing their overall happiness and satisfaction in life, the combined study of decision analysis and hedonic psychology has many interesting implications.

There are virtually limitless examples of how accurate models of decision making can be used in real life applications. For example, a business that knows how its customers are likely to decide how much of its product to buy at which price will be able to operate more efficiently than a business that has little knowledge of customer behavior. An accurate decision model will enable a business to produce the right amount of its product and to price the product to optimize profits. Decision models are actually used extensively in business. In fact, decision models become even more important in macro economic analysis. Understanding the behavior of consumers, savers and taxpayers is important for governments and economists. Good decision models help governments and economists decide how to regulate interest rates, the money supply, and even tax policies.

Another interesting application of decision models is international politics. In many cases, international politics is really a form of sophisticated negotiation, and at times strategic positioning. In such situations, an accurate knowledge of how one's adversary is likely to respond to various moves and countermoves can be invaluable, and sometimes can even determine the difference between war and peace (Jervis, 2004).

Hedonic Psychology

The study of what makes humans happy is of interest for the obvious reason that all humans strive for happiness in one way or another. However, the study of hedonic psychology is a difficult one in that it encompasses many areas of psychology as well as studies in sociology, biology, and medicine (Kahneman, Diener & Schwarz, 1999).

Before the study of hedonic psychology can be combined with decision analysis, it is necessary to understand what generally makes people happy or unhappy. This question can be answered at a basic level by looking at what happiness is, how human values and attitudes affect happiness, and how perceptions affect happiness. For this purpose, only normal psychological function is addressed (Kahneman, et al., 1999).

Defining happiness in a comprehensive and consistent way is not possible given the current state of research into Hedonic Psychology. The answer to the question, "Was Mary happy last week?" is far more complex than it may seem at first. Does Mary decide whether she was happy, or does some observer decide? On what basis is the decision made? What if Mary was happy part of the week and unhappy part of the week? Researchers are only now beginning to study a way to answer complex questions like this about happiness in a uniform, quantitative fashion (Kahneman, et al., 1999). In other

words, happiness cannot at this time be measured as one would measure temperature with a thermometer. Until this research is more refined, it is necessary to define happiness in a more intuitive sense. For this purpose it must be assumed that individuals define their own happiness, and that we accept their self-reports. Given this, we can look at studies that have looked at correlations between events or attitudes and happiness.

Studies have shown that happiness is largely based on perception. It can be thought of as the perspective of how good, bad, satisfying or unsatisfying one perceives that things are (Myers, 1992). Suppose event “E” happens to two people, one who is happy and one who is unhappy. The happy person will actually perceive “E” differently than the unhappy person (Freedman, 1978, Myers, 1992). It isn’t just “what” happens that determines happiness, rather a person’s happiness is determined by how what happens is perceived by the person. Furthermore, both pleasure and pain are based largely on memories of similar experiences and anticipation of upcoming ones (Rozin, 1999). However, a further look must be taken at how one’s circumstances affect perceptions and therefore determine happiness. Many people think that wealth and/or good circumstances are highly correlated to happiness. Contrary to popular opinion, affluence stops influencing happiness once basic human needs (food, shelter, clothing) are met (Bernoulli, 1731/1954, Kahneman, 1999, Myers, 1992). Happiness is not dependent on a person’s circumstances in general, and an individual with a physical challenge is as likely to be as happy as a fully healthy person. Moreover, happiness isn’t correlated with style of living, physical location, status, or good or bad circumstances in general. Instead, happiness or unhappiness tend to be based more on immediate events than long term ones. Negative events tend to balance out as people adjust and look for the “good” they

still have (Myers, 1992, Taylor, 1983). Positive events, like getting a windfall financial gain or winning a huge prize one has been seeking, also tend to be temporary. Even after such a huge “high,” people must eat, sleep and do normal things. Normal events can’t measure up to the “highs” from recent memory. More “highs” would be necessary in order to sustain the happiness from a very positive event. When this doesn’t happen, attitudes tend to shift towards “normal.” Therefore, attitudes after both negative and positive events tend to move towards what was normally felt before the event (Myers, 1992, Taylor, 1983).

The question becomes what *does* make people happy? Peoples’ attitudes are highly correlated to happiness. Moreover, behavior itself tends to change our emotions (Myers, 1992). “We are as likely to act ourselves into a new way of thinking as to think ourselves into a new way of acting” (Myers, 1992, p. 123). This works in both positive and negative ways. As it happens, most people consider themselves to be reasonably happy. When people behave as if they are happy, they actually begin to feel happy. Likewise, people who act depressed and allow themselves to join other depressed people in self pity or depressive thoughts actually begin to feel depressed. Based upon this one could argue that happiness breeds happiness and depression breeds depression. In fact, happiness is related to what we value rather than what we have. We value things that we are good at, and we tend to attribute our problems to prejudice or other people rather than to ourselves (Kahneman, 1999, Myers, 1992). People tend to compare themselves to others in their sociological and/or economic group and those above and below the group, and measure happiness according to where they fall within that spectrum. Likewise, people tend to compare themselves to the “status quo,” and feel happier when things are

better than “normal,” and less happy when things are worse than normal. People are happiest when they feel a sense of control over their lives, and a sense of purpose, including the work people do, defines people. We prefer the “familiar” to the “new,” and we fear loss of what we have, including in our social relationships. We feel happiest in familiar environments and when we feel secure in our relationships, especially our intimate relationships (Myers, 1992).

The way we feel about ourselves is also highly correlated to happiness. High self esteem correlates to high levels of satisfaction, and low self esteem correlates with low levels of happiness. Low self esteem also leads to a tendency to judge others harshly. A bias of thinking ourselves better than we are may help protect us against depression (Myers, 1992). Therefore, there may be times when we delude ourselves as a protective mechanism. On the other hand, when people underestimate or overestimate their abilities in a critical situation, a consequence can lead to a loss of actual or perceived control over aspects of their lives (Myers, 1992, Taylor, 1983). This is paradoxical, since a sense of control is associated with happiness and loss of control with depression.

One final note about happiness is that peoples’ feelings of happiness are correlated to their past experiences. Humans look at their experiences relative to a “baseline.” When people experience good things they almost immediately adjust to the new status quo and look for new good things. This is almost like drug “fixes” where the presence of the drug becomes ordinary and the users look for bigger and bigger thrills lest they become depressed (Kahneman, 1999, Myers, 1992). “Emotions trigger opposing emotions” (Myers, 1992, p. 54). Therefore, the contrasts of highs and lows in our personal experiences often bring greater happiness had we never suffered the lows at all.

The exception to this would be the experience of severe trauma, which often leads to sustained depression. It is important to take note of this process as Solomon did in ancient times.

“As Solomon wisely notes, the opponent process principle is bad news for hedonists:

Those who seek artificial pleasures will pay for them later, and repetition will diminish much of the pleasure’s intensity. There is no free lunch. With every kick comes a kickback. An old Spanish saying anticipated the phenomenon: “‘Take what you want,’ said God. ‘Take it, and pay for it’” (Myers, 1992, p. 55).

We now return to decision analysis and continue with the problem that Daniel Bernoulli tackled in 1731, since the purpose of Bernoulli’s utility function was to describe what makes people happy and to explain how decisions are made.

Utility Theory

When Daniel Bernoulli looked at his cousin Nicholas’s St. Petersburg Paradox, he realized that the bet posed with the coin flips had an infinite expected gain. In other words, there is no limit, on the average, to what you would gain if you played Nicholas Bernoulli’s game over and over again. Such a bet would be worth an infinite amount of money. Yet Daniel Bernoulli knew that most people would only pay the equivalent of a few dollars for such a bet. This knowledge caused Bernoulli to think about what makes people happy. But to Bernoulli, “expected desire satisfaction” was not really a psychological experience, but rather the occurrence of outcomes that are desired. Bernoulli’s explanation was that a dollar is worth more or less to an individual depending on how much money that individual possesses to begin with. Therefore, Bernoulli (1738/1954) posited that people do not value gambles based on their expected values, but

rather by a subjective measure of the value of the gamble's outcomes, which he called "utility." Further, the utility function is not linear, but rather a function that is a concave function of money, like the curve shown in Figure 1 (Bernoulli (1738/1954) and Kahneman & Tversky, (2000)).

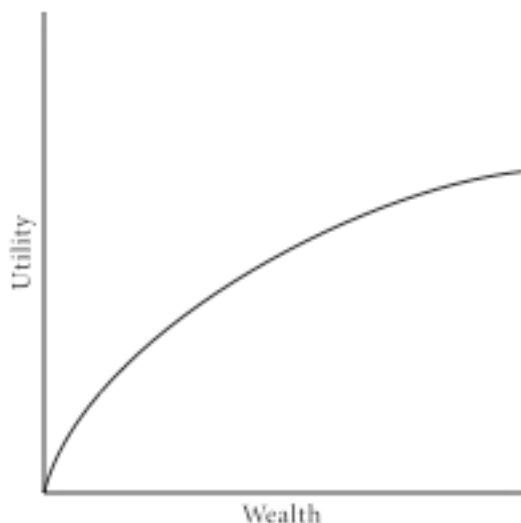


Figure 1. Utility Theory's Concave Utility Function
(Adapted from Bernoulli, 1731/1954)

By thinking of value in this way, the "expected utility" or "value" of St. Petersburg Paradox ends up not be infinite, as the calculation of classic expected value would imply. This is due to the fact that the value of money declines with wealth (Plous, 1993). Bernoulli (1738/1954) suggested that "utility" be thought of by dividing all possible outcomes into finely divided pieces, almost infinitely small. Then these outcomes can be ranked from most preferred to least preferred, with ties allowed. The choice of actual scale is not important. Two outcomes can be chosen, one labeled zero and one 100. Then an arbitrary value between zero and 100 is chosen and labeled x . Finally, a determination is made about what sort of gamble between zero and 100 would

make a person indifferent between outcome x and that gamble. A formula for expected utility is derived directly from this reasoning.

However, it is important to note again that Bernoulli's view of happiness was in informal terms. For him, happiness was what a person thinks would make him happy, regardless of what this "thing" was. In many ways, Bernoulli's view of happiness was remarkably insightful. While people tend to want more and more money, regardless of current wealth possessed, Bernoulli recognized that increases in wealth would produce less of a change in happiness for a rich person than a poor one. This correlates well with current happiness research that says that affluence stops having a significant effect on happiness once basic needs are met (Myers, 1992). On the other hand, expected utility theory imposes a fairly strict formal structure of assumptions about how rational people act. This structure doesn't always conform to psychological realities (K. Norlin, personal communication, July 3, 2005). (Note that Dr. Kurt Norlin is a philosophy professor in southern California.)

As part of a landmark book that was the beginnings of modern game theory, von Neumann and Morganstern defined six assumptions that arise as direct outcomes of Bernoulli's work.

1. *Ordering of Alternatives:* Rational actors should be able to compare any two alternatives. They should prefer one alternative to the other or view them both as equal.
2. *Dominance:* If an outcome is better in all respects than another outcome, it is called *strongly dominant*. If an outcome is better than an alternate outcome in at least one respect then it is called *weakly dominant*. Rational

decision makers should always prefer a dominant alternative to one that is not dominant.

3. *Cancellation*: If two alternatives contain equal and equally likely outcomes as part of the total range of consequences of the alternatives, then those equal outcomes should be ignored when making a decision between the two alternatives. Things that are equal should cancel out.
4. *Transitivity*: If outcome A is preferred to outcome B and outcome B is preferred to outcome C, then outcome A should be preferred to outcome C.
5. *Continuity*: A rational actor should always prefer a gamble between a best and worst outcome to a certain intermediate outcome if the odds of the best outcome are high enough.
6. *Invariance*: Rational actors should not be affected by the way in which alternatives are presented. For example, a simple outcome should not be preferred to a compound gamble that is equivalent.

(von Neumann & Morganstern, 1947)

Paradoxes and Biases in Judgment

It is important to note that Bernoulli looked at what rational decision makers would do under ideal circumstances, not what actual decision makers do in reality under real circumstances. While Bernoulli's rational model has been extremely useful in economics and other fields, its obvious weakness is that it doesn't accurately describe how people truly make decisions. In truth, some of the assumptions posited by von

Neumann and Morganstern are violated by real decision makers. There are two basic ways that the expected utility theory assumptions are violated; these are paradoxes in rationality and biases in judgment.

The Cancellation Principle tells us that only differences between alternatives should be considered by rational decision makers. Equal components inherent in two alternatives should be ignored by rational decision makers. While this seems like a reasonable rule, Maurice Allais seriously challenged this principle in a 1953 paper and created what is now known as Allais' Paradox (Allais, 1953, as cited in Plous). Suppose you are offered a choice between two alternatives. In alternative A, you will receive \$500,000 for sure. If you choose alternative B, you will have a 10% chance of receiving \$1,500,000, an 89% chance of getting \$500,000, and a 1% chance of receiving nothing. Most people choose the sure outcome of alternative A, even though the expected value of alternative B is higher. Now, suppose you are offered two different alternatives again. This time, alternative A gives you an 11% chance of getting \$500,000, and an 89% chance of getting \$0. Alternative B gives you a 10% chance of getting \$1,500,000, and a 90% chance of getting \$0. This time most people will prefer alternative B, reasoning that the difference between \$500,000 and \$1,500,000 is large, but the difference between 89% and 90% is small. The problem is that according to the Cancellation Principle, you should choose alternative A the second time if you chose alternative A the first time. If not, you have violated the Cancellation Principle (Allais, 1953, as cited in Plous).

Just as the Cancellation Principle is violated in Allais' Paradox, there are examples of the violations of intransitivity and even of violations of invariance. In 1969, Amos Tversky published a study showing intransitivity as a consistent behavior.

(Tversky, 1969). In 1971, Sarah Lichtenstein and Paul Slovic hypothesized that people might choose between the same alternatives in inconsistent ways depending on how the alternatives are presented. Specifically, they thought that a choice between gambles would depend mostly on the probabilities associated with gamble, while the bids would depend on the amount to be gained or lost. Their tests of these hypotheses showed consistent preference reversals (Lichtenstein & Slovic, 1971). If we can't count on people to have the same preference when the same alternatives are presented in different ways, it brings the expected utility model into serious question.

Violations of the transitivity assumption of expected utility theory have especially interesting implications. Suppose you have to choose between applicants for a scholarship and you have information on a standardized test that each applicant took, as well as rankings by people who interviewed each applicant. (Suppose that a "1" indicates first choice and a "3" indicates the interviewer's last choice.) You decide that if the difference in test scores is more than 20 points, you will choose the applicant with the highest test score. If the difference is less than 20 points, then you will choose the applicant with the highest interview rating. (See Table 1)

Table 1
Test Scores and Interview Ranks of Applicants

		Test Scores	Interview Rank
Applicants	A	200	3
	B	180	2
	C	160	1

Note: (Adapted from Plous, 1993)

While this seems like a reasonable quantitative way to choose an applicant, it leads to an intransitivity in choices. You would choose applicant B over applicant A because of rank, applicant C over applicant B because of rank, but you would choose applicant A over applicant C because of test scores. This intransitivity occurs because of the two different dimensions being used in the decision rule (Plous, 1993). A person with this kind of bias can actually be used as a “money pump” by repeatedly offering the decision maker the option of changing to a more preferable decision in exchange for some small amount of money (Loomes & Sugden, 1987 and Plous, 1993). If the decisions are changed from applicants to gambles, such a decision maker would be willing to pay 10¢ to change from option B to option C, then another 10¢ to change from option C to option A, and another 10¢ to change from option A to option B, until the person is out of money (Plous, 1993). This is an example of a decision bias that can result in disastrous consequences, and a marked decrease in happiness.

There are countless other biases that decision makers exhibit on a consistent basis. One important example is memory biases, where people remember things differently than the way they actually happened, changing facts and filling in missing details to make things fit to make sense in their minds. Another is hindsight biases which have probably been experienced by most of us. People have a tendency to think that “we knew it all along,” once they have heard the truth about a situation. Humans also exhibit context biases, in which objects look smaller than they are when compared to very large objects or larger than they are when compared to very small objects. Primacy effects, the tendency to weigh what is presented first more heavily, and recency effects, the tendency in certain circumstances to weigh more heavily what is presented most recently, can

become issues in jury trials and other decision making situations (Plous, 1993). Another important bias is that people will attribute positive things to themselves and errors to others more often than deserved in both cases (Myers, 1992 and Plous, 1993). In fact, divorcing and divorced couples tend to blame the breakup of their marriages very heavily on the other partner (Myers, 1992). Since both partners tend to do this in a given situation, the judgment cannot possibly be rational. The amount of total fault would add up to well over 100%. Unfortunately, this list doesn't even cover the majority of major biases.

Despite the importance of the biases elucidated above, perhaps an even more important bias is that most people exhibit to “framing” effects. Framing specifically deals with the idea that different ways of formulating questions can have powerful effects on the choices made. Someone with a knowledge of the psychology of framing effects who designs questions for a survey can have great influence over the ultimate answers obtained from respondents. For example, the following questions were posed by Rugg in 1941:

1. Do you think the U.S. should allow public speeches against democracy?
2. Do you think the U.S. should forbid public speeches against democracy?

(Rugg, 1941, p. 92).

If you are like most of us, when confronted with question number 2, the perception of losing freedom will cause you to answer “no,” while most people will answer “no” to question one (Plous, 1993, Rugg, 1941). However, both questions really ask the same thing. It does not make sense that a rational person should answer “no” to

both questions since the questions are asking for the same opinion from opposing points of reference.

Note that some of these biases connect with the previous discussion about happiness. The human tendency to overestimate their own good deeds and others' bad ones correlates with the need for "contrast" in order to be happy. Humans tend to be happier when they have a mix of good and bad events in their lives. The bias towards extremes is perhaps a way that humans provide that contrast in situations which otherwise might be considered "normal." In addition, the bias towards thinking of ourselves as somewhat better than we actually are protects us from depression and increases self esteem. Generally, self delusion is a negative psychological phenomenon, and is not to be encouraged. Apparently, however, a modest amount of self delusion in the sense of self esteem is normal and even contributes to happiness. On the other hand, this tendency towards the extremes is paradoxical to the "normalizing" effect that humans demonstrate when faced with highs and lows in their experiences. Highs and lows tend to disappear rather quickly and feelings move towards what was normal before the extreme event. In other words, things tend to revert back to the status quo.

Note that Rugg's study on preference reversal, (people answering the same question in opposite ways depending on the way it is presented), demonstrated a tendency for people to avoid loss whenever possible (Rugg, 1941). While people adjust quickly to gains and losses, (Myers, 1992), people adjust more quickly to gains than they do to losses (Jervis, 2004). This may partially explain loss aversion. Loss aversion can also be thought of as a preference for maintaining the status quo. This tendency to avoid loss, also noted by Myers in 1992, and Tversky's 1969 study of intransitivity, is similar to

preference reversal. People change their preferences in seemingly irrational ways depending on how questions or gambles are presented to them. This recognition of loss aversion led to the development of Kahneman & Tversky's prospect theory, which is introduced in the next section.

Rationality of Biases and Paradoxes

An obvious question is whether biases and paradoxes to rationality are really irrational. The answer is not entirely clear, but is certainly complex. Utility theory makes many simplifying assumptions that make the theory simple and analytically elegant. Utility theory assumes that decision makers have complete information, that they use this information rationally in order to maximize "utility" (Bernoulli, 1731/1954 and Plous, 1993). However, while the behavior of decision makers is difficult to model, it is certain that people do not act in the way that Bernoulli posited. Decision makers almost never have complete information, and even the few paradoxes and biases discussed above show that they frequently do not act rationally with the information that they do have. Also important, people do not act only to maximize utility. It must be noted that there is a cost for information. That is, there would be a real cost in time, money, or something other of value in order to obtain complete information before making a decision. This cost must be weighed against any benefit derived from the additional information. Research shows that rather than acting irrationally, decision makers often use heuristics in very reasonable ways (Plous, 1993). In fact, it may well be that at least in some situations, the heuristics used to make decisions may overall be more "optimal" than a decision made with perfect information. Given the cost of obtaining that information, the additional benefit derived

from perfect information may be outweighed by the cost of obtaining it. Furthermore, an investigation must be made into what humans actually look to optimize. If “utility” is not what is being optimized, then what is? Kahneman and Tversky’s answer to this question ended up creating prospect theory, a fascinating new theory about rational decision making under uncertainty.

Introduction to Prospect Theory

Many different models for decision making have been introduced since Bernoulli’s time, but two of the most widely accepted and used are Kahneman & Tversky’s prospect theory and Bell’s and Loomes & Sugden’s regret theory (Plous, 1993). Bernoulli (1738/1954) recognized the human tendency towards loss aversion, which is part of what made his paper so extraordinary. Bernoulli said, “The man who is emotionally less affected by a gain will support a loss with greater patience” (Bernoulli, 1731/1954, p. 26). This quote shows Bernoulli’s remarkable insight that losses and gains are not viewed equally by most people and hints at future decision theories. On the other hand, according to prospect theory, Bernoulli was not entirely correct. Prospect theory posits that although a rich man may take a \$100 gain in stride, he doesn’t necessarily take the \$100 loss with nearly as much “calm” as one might assume.

Prospect theory defines “value” as the variable to be measured while utility theory uses “states of wealth.” Value is defined in terms of gains and losses which can be thought of as changes from a point of reference. A major difference between Bernoulli’s utility function and prospect theory’s value function is that prospect theory specifically accounts for the strong human tendency towards loss aversion. Kahneman & Tversky’s

suggested value curve is shown in Figure 2. The gain part of the curve, (see Figure 2), is concave like Bernoulli's utility curve, but the loss part of the curve is convex and is steeper than the gain curve. This shows that a loss of \$200 hurts the notion of value more than a gain of \$200 helps it. The convexity of the loss part of the curve indicates that the difference in subjective value between a loss of \$200 and a loss of \$100 is greater than the subjective value between a loss of \$900 and a loss of \$1000. This maintains utility theory's notion that equal monetary losses and gains mean less to a rich man than a poor man, but enriches the model to deal with the way humans really view loss (Kahneman & Tversky, (1983).

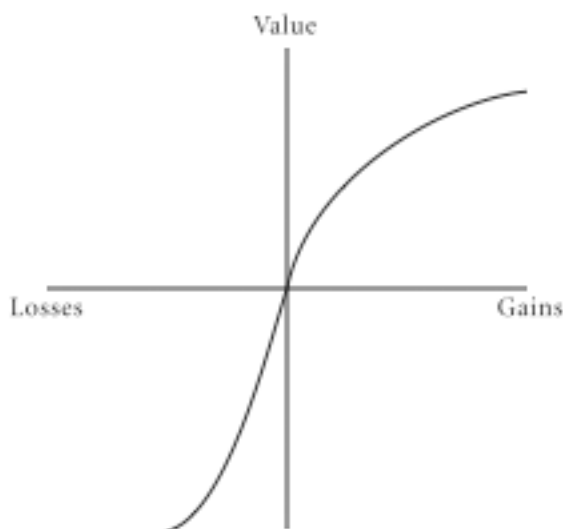


Figure 2. Value Function from Prospect Theory
(Adapted from Kahneman & Tversky, 1983)

In fact, the concept of loss aversion is very robust and has been shown repeatedly in human experiments as well as in applications (Kahneman & Tversky, 1983). In experiments ranging from monetary decisions to hours of pain and loss of human life, people tend to be risk averse when dealing with gains and risk seeking when dealing with

potential losses. (Eraker & Sox, 1981, and Fischhoff, 1983; Tversky, 1977; Tversky & Kahneman, 1981). In other words, people will avoid making even good bets to make modest gains but take sometimes foolish risks in order to avoid losses. The greater the potential loss, the greater the risk seeking behavior. This loss aversion tendency helps explain preference reversal paradoxes that defy intransitivity violations and the Cancellation Principle, (Allais' Paradox), (Kahneman & Tversky, 1983). Loss aversion relates to happiness research as well. Recall that happy people tend to value stability and arrange their lives so that they have stability; they tend to avoid change and prefer the status quo (Myers, 1992). This suggests that some seemingly irrational decisions may actually lead to happiness and therefore may not be so irrational after all.

The tendency for the Invariance Principle of utility theory to be violated is not explained by loss aversion. However, in 1981, Tversky and Kahneman did some experiments in which they realized that posing the same options to people in different ways would yield very different results. For example, consider the following problem:

“The following pair of problems illustrates a violation of [invariance]. The total number of respondents in each problem is denoted by N , and the percentage that chose each option is indicated in parentheses.

Problem 1 ($N = 152$): Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows:

If Program A is adopted, 200 people will be saved. (72%)

If Program B is adopted, there is a one-third probability that 600 people will be saved and a two-thirds probability that no people will be saved. (28%)

Which of the two programs would you favor?

Problem 2 ($N = 155$): If Program C is adopted, 400 people will die. (22%)

If Program D is adopted there is a one-third probability that nobody will die and a two-thirds probability that 600 people will die. (78%)”
(Kahneman & Tversky, 1983, pp. 4–5).

Upon inspection, is it clear that the options in Problem 2 are identical to the options in Problem 1. The only difference is that Problem 1 is “*framed*” in terms of saving people, and Problem 2 is “framed” in terms of mortality level. In other words, the “reference state” is different in the two problems (Kahneman & Tversky, 1983). The reversal in preference based only upon framing is remarkable. Prospect theory’s recognition of framing effects directly contradicts the Invariance Principle of expected utility theory. However, repeated experiments have shown that framing effects are real and repeatable.

For better or worse, framing effects have broad implications. “The moral of these results is disturbing: Invariance is normatively essential, intuitively compelling, and psychologically unfeasible” (Kahneman & Tversky, 1983, p. 6). Kahneman & Tversky’s comment was made because framing effects can happen inadvertently, or they can be used by master manipulators to control events. Framing effects can have profound implications even when they are coincidental. For example, physicians and patients trying to decide between two treatments for a serious disease can be affected depending on whether the treatments are framed in terms of mortality or survival probabilities (Kahneman & Tversky, 1983).

When framing effects are used as an active means rather than as a tool to demonstrate violations of the Invariance Principle, they are sometimes called *formulation*

effects. “A physician, and perhaps a presidential advisor as well, could influence the decision made by the patient or by the President, without distorting or suppressing information, merely by the framing of outcomes and contingencies” (Kahneman & Tversky, 1983, p. 10). Since happiness is highly correlated to perceptions, framing effects can profoundly affect happiness, whether by accident or purposefully. A simple example is in economics; consumers would view a 5% discount as a gain, while they would view a 5% surcharge as a loss. In reality, there is no economic difference if the reference point is set to make them equal (Plous, 1993). Advisors who are familiar with framing effects caution decision makers to try to look at decisions in as many different frames as possible in order to avoid misperceptions (Kahneman & Tversky, 1983).

Utility theory assumed an “expectation rule” where the utility of a prospect was computed by adding the utilities of all possible outcomes, each weighted by its respective probability (Bernoulli, 1731/1954). This formula assumes that the weights are represented by a linear function. In other words, the difference between 30% and 31% must be the same as the difference between 98% and 99%. However, research shows that people do not view value linearly. In particular, changes near 0% and 100% have a larger effect on decisions than changes near the middle between 0% and 100%. For example, a change from 2% to 4% would have a bigger impact on decisions than a change from 30% to 32%. A hypothetical weighting curve for prospect theory is shown in Figure 3.

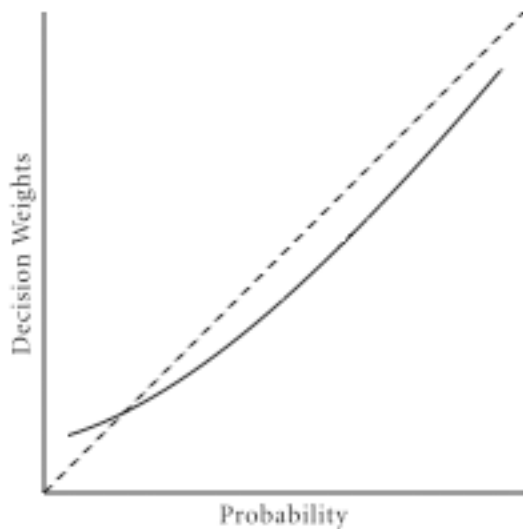


Figure 3. Hypothetical Weighting Function for Prospect Theory
(Adapted from Kahneman & Tversky, 1983)

The weighting function shown in Figure 3 indicates risk aversion for positive gambles and risk seeking for negative ones. Notice that the curve is convex, and most of the curve lies under the line $y = x$. This indicates that people generally underweight the likelihood of events, making people risk averse in comparison to the true likelihood of the events. The one exception is very near the lower endpoint where the curve crosses the dashed line $y = x$. This indicates that people tend to grossly overweight or totally ignore very low probabilities. As a result, people will often take big risks for low probability gains, (like the lottery), and avoid risk with very low probability losses, (which explains why people will pay a lot of money for insurance policies). This tendency is sometimes called the *certainty effect* (Kahneman & Tversky, 1983). The tendency to avoid loss is related to happiness because of the human desire for stability. The propensity to take small risks for improbable gains like the lottery is thrill seeking behavior. Most people believe that a huge thrill like winning the lottery will make them happy for life. As has

been explained earlier, such an event will produce a short period of happiness, followed by a “down” at least as low as the “high” that the extraordinary event produced. Things then quickly revert towards the previous normal state that existed before the big event (Myers, 1992).

Framing effects also have implications in the way people conduct their everyday transactions and trades. When people are making decisions about buying goods or services, they often mentally compute value by weighing advantages and disadvantages of the transaction. Kahneman and Tversky called this “*mental accounting*.” Consider the following problem:

“Problem 3: Imagine that you are about to purchase a jacket for \$125 and a calculator for \$15. The calculator salesman informs you that the calculator you wish to buy is on sale for \$10 at the other branch of the store, located 20 minutes drive away. Would you make a trip to the other store?”
(Kahneman & Tversky, 1983, p. 11)

Kahneman and Tversky found that most people would drive 20 minutes in order to save \$5 on the calculator. However, if the \$5 was offered as a discount on the jacket instead of the calculator, most people chose to forfeit the discount because the driving didn’t seem worth it. Yet, the savings is exactly the same. This behavior illustrates that this form of mental accounting is attached to an object, service or other thing of value. Once done, people use the thing of value as their reference point, even when doing so may not make logical sense in terms of maximizing utility. This is also a violation of the Invariance Principle of utility theory, in which people tend to evaluate gains and losses in relative rather than absolute terms.

Consider a second set of problems:

Problem 4: “Imagine that you have decided to see a play and paid the admission price of \$10 per ticket. As you enter the theater, you discover that you have lost the ticket. The seat was not marked, and the ticket cannot be recovered.

Would you pay \$10 for another ticket? Yes (46%) No (54%)”

Problem 5: “Imagine that you have decided to see a play where admission is \$10 per ticket. As you enter the theater, you discover that you have lost a \$10 bill.

Would you still pay \$10 for a ticket for the play? Yes (88%) No (12%)”
(Kahneman & Tversky, 1983, p. 12).

The observed difference in responses to these two problems illustrates that people would willingly pay another \$10 for a theater ticket if they lost a \$10 bill, but would be much more hesitant about *replacing* a ticket that they lost. Kahneman and Tversky, (1983) hypothesize that the reason for this is that the loss of the ticket is looked at as an increase of the ticket price to \$20 making the theater ticket more expensive than they think reasonable. On the other hand, most people view the \$10 bill as unrelated to the theater ticket.

A similar concept is a comparison between retaining status quo and accepting some alternative to it, sometimes a good alternative, sometimes a bad one. People then evaluate the advantages and disadvantages of the change against retaining the status quo. The advantages will be thought of as gains and the disadvantages as losses. Because losses loom larger than gains in peoples’ minds, most decision makers will be biased in favor of sticking with the status quo (Kahneman & Tversky, 1983). This phenomenon helps explain why incumbent politicians have an advantage over challengers in elections (Plous, 1993).

A further implication of loss aversion was coined *the endowment effect* by Kahneman and Tversky (1983). This effect describes the tendency for people to value an object more once they possess it. Someone may pay \$50 for a rocking chair, but after 10 years in the nursery, the owner may not be willing to part with the chair for \$200. This has nothing to do with the true economic value of the chair, but of the value of the chair to its owner. Companies routinely offer products to people on a “no-obligation” trial basis. Companies do this because they know that it will be difficult for consumers to give up the product once they possess it. What they might never have purchased and paid their good money for may be worth far more to them once they have it in their home (Plous, 1993).

The tendency to avoid change correlates with happiness research in that stability and minimization of changes correlate with happiness (Kahneman, 1999, Myers, 1992). Loss aversion generally favors stability over change. When combined with the tendency for adaptation to new circumstances, loss aversion protects people against unhappiness. Again, what may initially appear to be irrational in theory may in fact be rational in that it increases overall happiness.

Introduction to Regret Theory

In answer to prospect theory was a new theory called regret theory, developed independently by Bell and Loomes & Sugden. Like prospect theory, and unlike utility theory, regret theory aimed to better explain the way that people actually make decisions rather than using a hypothetical model of how perfectly rational people might act under ideal conditions. Expected utility theory was the only accepted decision theory for

centuries, and the analytical work is so elegant that even Kahneman and Tversky didn't want to throw it away. In fact, they tried for a long time to modify utility theory to make it explain the paradoxes to rationality and a lot of the biases they had noticed. However, they found that this was not so easy a task (Kahneman & Tversky, 2000). In the end, they modified traditional utility theory to such an extent that it was not recognizable as utility theory anymore. The end result was prospect theory. Regret theory, on the other hand, took utility theory and added “regret” as a new variable to it. Unlike prospect theory, regret theory retained the major tenets of expected utility theory and modified them in order to account for the paradoxes in rationality and the judgment biases that had been observed by researchers. Both prospect theory and regret theory explain many of the paradoxes to rationality and judgment biases, including Allais' Paradox, preference reversal, intransitivity, and others.

The basic idea of regret theory is that individuals often look at gambles in terms of what *would have happened* had they chosen differently. People will often weigh alternatives by trying to imagine each of the outcomes in advance and try to assess how much *regret* they may feel if they choose a certain alternative and a different outcome ensues. This is sometimes referred to as “counterfactual reasoning,” because it relies on events that are hypothetical rather than real (Dunning & Parpal, 1989).

Regret theory was independently proposed in major papers by David Bell (1982, 1985), and Graham Loomes and Robert Sugden (1982, 1983, 1987). “Regret theory rests on two fundamental assumptions: first, that many people experience the sensations we call regret and rejoicing; and second, that in making decisions under uncertainty, they try to anticipate and take account of those sensations” (Loomes & Sugden, 1982, p. 820).

Regret theory starts with utility theory and uses utility as one basis to measure value. However, regret theory also adds “regret” as a second variable in addition to utility. The combination of the two variables adds enough depth and robustness to utility theory that, much like prospect theory, regret theory gives a more accurate description of how people actually make decisions than does utility theory by itself. Regret theory also maintains much of the analytical elegance and simplicity of expected utility theory. This allows decision analysts to modify existing plentiful research that has been done on expected utility theory rather than develop an entirely new model.

Prospect theory and regret theory are comparable in their abilities to accurately explain human decision making under real conditions. For example, regret theory’s answer to Kahneman & Tversky’s “mental accounting” helped to describe violations of invariance and is called “counterfactual reasoning.” In a 1989 paper, David Dunning and Mary Parpal described mental addition in terms of positive deviation of alternatives from a reference point, and mental subtraction in terms of negative deviation of alternatives from a reference point. Dunning and Parpal posited that people perceive greater impact between choices when alternatives are framed positively than when alternatives are framed negatively. This line of thought resembles prospect theory’s framing effects explanation of violations of invariance. The biggest difference between regret theory and prospect theory is that regret theory uses “regret” as a variable in addition to Bernoulli’s traditional utility function, while prospect theory uses “decision weights” as its additional variable as shown in Figure 3.

All three theories continue to be used in current economic theory, psychology, sociology, political science, medicine, and many other fields where models of decision

making are important. The same research regarding paradoxes in rationality and biases in judgment is used to support both prospect theory and regret theory, while utility theory cannot describe these behaviors. The rationale for the way regret theory and prospect theory explain paradoxes to rationality and biases in decision making are comparable and have been covered in the information in the previous sections.

Conclusions

While prospect theory and regret theory have resulted in great improvements over expected utility theory and have countless applications, it must be noted that most of the results from the research studies are generalities. Even prospect theory and regret theory leave holes in their abilities to accurately describe human risk taking behavior. In most cases, the phenomena, while statistically significant, only describe the behavior of 50-65% of the population. No current model accurately describes what the vast majority of people will likely do. Even with the remarkable discoveries of Kahneman and Tversky and other researchers, much of human decision making behavior still cannot be described by prospect theory or regret theory. New problems are even sometimes presented by the solutions offered by prospect theory and regret theory alone. Specifically, most models that explain Allais' Paradox also introduce violations of dominance (Kahneman & Tversky, 2000). Additionally, despite the many new theories, some people do behave according to the assumptions of expected utility theory, and others behave in ways inconsistent with any known model. Furthermore, decision models do little or nothing to predict how a given individual will choose between alternatives. The models provide

only trends and tendencies for how groups are likely to perform. Even then, large minorities fail to respond according to the models.

Another important note is that virtually all of the decision research in the literature was done on North Americans. This means that much care must be taken when attempting to extend the results to other cultures and societies. It is likely that the research will be at least somewhat different and may be profoundly different if repeated in other cultures. Furthermore, since prospect theory and regret theory have implications in international politics, those applying the theories must be aware that they may not even apply well to the intended application. Kahneman and Tversky warn people to this effect: “The scholars who use the tools to explain more complex decisions do so at their own risk” (Kahneman & Tversky, 2000, p. xi).

New research in decision analysis is emerging all the time, and new research is finding better ways to describe various biases and paradoxical behaviors. Given the similarities between regret theory and prospect theory, it may be that a new model emerges in the future that combines the two models and provides an even better model for decision making. For example, in 1991, Faruk Gul presented a model that explained human preferences in lotteries and was able to take Allais’ Paradox into account. In it, he used a modified expected utility theory that resembles regret theory but also took certain assumptions from prospect theory. On the other hand, there are still many paradoxes and biases that are not fully explained by current models, and limitations and errors in experimental design may have resulted in incorrect or incomplete information about the nature of human behavior. It is likely a reasonable assumption that decision analysis is

just emerging from its infancy, and research still to come will have broad implications in many fields of study.

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Citation 1: When do Losses Loom Larger than Gains?

Ariely, D., Huber, J., & Wertenbroch, K. (2005). When do losses loom larger than gains? *Journal of Marketing Research*, 42(2), 134–138.

Critical Summary

This paper is a comment about and extension to Novemsky and Kahneman's (NK) 2005 paper on the boundaries of loss aversion. The authors agree with NK that money intended for the purpose of purchasing goods or services is not subject to loss aversion. They further postulate that emotional attachment and change of perspective may change the nature and strength of loss aversion and the endowment effect. The authors suggest further study and experiments in this area, particularly with objects that tend to have strong hedonic value.

Critical Analysis

This paper makes a good point that previous studies on loss aversion have dealt with small, low cost objects for which subjects tend to have low emotional attachment. The suggestion that studies be done with objects that have high hedonic value is important, as results may lead to new information about the causes and relationships between loss aversion and the endowment effect, as well as other behavior related to decisions under risk. This paper will provide the means to comment about the peanuts effect and its nonconformance to prospect theory.

Citation 2: Three Cheers for Loss Aversion

Camerer, C. (2005). Three cheers—psychological, theoretical, empirical—for loss aversion. *Journal of Marketing Research*, 42(2), 129–133.

Critical Summary

Camerer suggested that Bernoulli's concave explanation for the utility function is a sufficient but not necessary explanation for loss aversion. Since prospect theory explains gains and losses as "value," or "status quo" relative to a reference point, the "utility" function can be described as a nonlinear piecewise function.

The author's view of loss aversion is as a psychological phenomenon, a theory useful in modeling, and an empirically observable phenomenon. He also pointed out that loss aversion contradicts Bernoulli's Utility Theory in that it doesn't require a concave utility function.

Finally, the author suggested that loss aversion can be explained as an emotional adaptation, an "exaggerated emotional reaction of fear" of the kind that used to be a response to life and death situations. He questioned whether loss aversion is a preference or a bias, (error) in judgment, that represents distaste for transition states. He finally suggested that better understanding of loss aversion could lead to more optimal marketing and business strategies.

Critical Analysis

This paper contains an excellent analysis of the St. Petersburg Paradox, as well as a new way of looking at its solution. The solution involves looking at ways to compute "reasonable" amounts to invest in playing the St. Petersburg game. While the paper made some interesting points, it is disjointed and at times difficult to follow. Pieces of this paper will be useful in the Depth essay in discussing different ways of viewing loss

aversion, including a perspective from biology, as well as possible applications in economics.

Citation 3: Stochastic Model for Reflection of Preference

González-Vallejo, C., Reid, A. A., & Schiltz, J. (2003). Context effects: The proportional difference model and the reflection of preference. *Journal of Experimental Psychology/Learning*. 29(5), 942–953.

Critical Summary

This study questioned prospect theory's value function that separates positive and negative outcomes. Instead, a stochastic model is presented that claims to be a cognitive theory of choice, and accounts for differences in the value function between gains and losses. Further, the paper claims that the stochastic model describes individual behavior as well as group behavior. The model claims that it can distinguish between risk attitudes and the gain-loss effect posited by prospect theory.

Method

The experiments used to show validity of the stochastic model used college students. The students were broken up into risk seeking and risk averse groups through some initial experiments. Then the groups were asked to imagine various scenarios in which they were "endowed" with more or less wealth and income. Finally, the subjects made hundreds of decisions each, and the results were tabulated and examined using sophisticated statistical techniques.

Critical Analysis

While interesting, this study raised many flags, particularly in experimental design. Too many variables are being tested at once, including risk propensity, wealth, many possible outcome choices, ranges of preference strength, etc., making the probability of serious design problems high. Further, subjects were all college students,

hardly a representative sample of the population when dealing with risk taking preferences. The subjects were asked to imagine scenarios unlike any they were likely to have actually experienced during their lives. This makes suspect the validity of their choices relative to the general population who presumably would have experienced the real-life situations being simulated. Finally, the authors used only subjects at the far extremes of risk taking preferences. All of the subjects were extremely risk averse or risk seeking. Yet, the authors interpreted trends over the entire function of risk preferences using only the tails. Also, the authors used citations to challenge prospect theory that Kahneman and Tversky used multiple times to support the theory in their famous book.

This paper can be used in the overall Depth report as the most extreme challenge to prospect theory. However, the many problems inherent in the study also need to be brought out.

Citation 4: Rare Events

Hertwig, R., Barron G., Weber, G., Elke, U. & Erev. I. (2004). Decisions from experience and the effect of rare events in risky choice. *Psychological Science*, 15(8), 534–539.

Critical Summary

Kahneman & Tversky, (1983) suggested that people tend to overweight rare events and underweight common events, and research has supported this pattern on a consistent basis. However, this paper's authors noticed that people make decisions either based upon descriptive information or by their personal experiences. They further noted that virtually all of the experiments supporting prospect theory's claims about the overweighting of rare events dealt with descriptive decision making and only one choice per problem. They hypothesized that people actually underweight rare events when making decisions based upon experience. The hypothesis was tested for validity and to determine whether the underweighting of rare events in experiential decisions is based on direct experience or on the basis of repeated decisions.

Method

An experiment was performed that tested decisions of both types, descriptive and experiential. The test group of 100 students was divided into two groups of 50 subjects each. One group was given descriptive information about six decision problems and the other was allowed to determine the nature of the underlying distributions of the problems using buttons that sampled an outcome each time it was pressed. The data was tabulated using simple percentages and simple tests were used to determine statistical significance.

Results

The experiment supported the hypothesis that people underweight rare events when making decisions based upon experience rather than description. Results showed that this bias was based upon direct experience instead of repeated decisions. The results were robust across the entire experiment, with only one problem failing to show statistical significance. The authors posited that the reason for the underweighting bias may be due to memory limitations and the fact that the skew of binomial distributions when p and n are small results in people seeing fewer than the expected number of rare events in most cases.

Critical Analysis

The reasoning seems sound until one notices that the experiment involves decisions under uncertainty and not decisions under risk. This paper will be used in the Depth demonstration to discuss the confusion about the definitions of decisions under risk versus uncertainty.

Citation 5: Human Nature and Values

Jervis, R. (2004). The implications of prospect theory for human nature and values. *Political Psychology*, 25(2), 163–176.

Critical Summary

The author explored prospect theory from the perspective of human nature as it relates to politics, business, psychology and other disciplines. Loss aversion and the endowment effect are explored in relation to how both individuals and societies view risk when considering loss, gain, or the possibility of either.

Prospect theory states that humans will take greater risks to avoid a loss than to obtain a similarly valued gain. The author contends that this may explain why humans will often resist change even when it is possible to better their situations. However, when faced with a loss that is sure unless some action is taken, foolish risks may be taken to avoid that loss. According to the author, prospect theory does not explain this phenomenon. The endowment effect also appears to lead to a resistance to change. People or governments holding an advantage in a certain situation sometimes take large risks to keep that advantage.

Finally, people view their positions relative to what has happened recently rather than what their absolute position is. People quickly start to expect that what they have gained will be retained, and will take risks accordingly. Additionally, individuals make choices about risk differently depending on whether a choice is framed negatively or positively.

Critical Summary

The author presented a convincing argument about how humans view risk. He also gave an excellent overview of how prospect theory relates to many aspects of life,

and gave applications in numerous fields of study. However, the author's assertion that prospect theory cannot explain the propensity for foolish risk when trying to avoid certain loss is questionable to this student. If humans tend to avoid loss, prospect theory explains well why greater and greater losses are risked in order to avoid certain or almost certain loss. Despite a few problems, this citation provides a good overview of how prospect theory applies to many aspects of our modern world.

This paper will add to the Depth essay as it provides some applications to prospect theory and explains how the theory may be used in many varied examples, including some in international politics.

Citation 6: A Perspective on Judgment and Choice

Kahneman, D. (2003). A perspective on judgment and choice. *American Psychologist*, 58(9), 697–720.

Critical Summary

Kahneman reviews the recent history of judgment and decision making with a review of major findings over the last several decades in this paper based on his Nobel Prize lecture from 2002. He specifically makes a distinction between two kinds of thinking: (1) intuition, which he calls System I, and (2) purposeful, rational thinking, which he calls System 2. The paper is split into sections that discuss accessibility, framing, the basic tenet of prospect theory that is based on changes from a reference point rather than states of wealth, and various types of heuristics. Some famous experiments in perception and judgment are reexamined in an effort to explain some judgment biases based on simple, widely known psychological principles.

Critical Analysis

This paper covers a wide range of material on judgment and choice. The paper will be of use in the Depth essay in identifying some famous examples of judgment biases and heuristics, applications of prospect theory, and Kahneman's unique perspectives on the causes of some common heuristics and biases. Most of the material in this article has been covered in greater depth in earlier works.

Citation 7: A Certain and Uncertain Outcomes

Mazur, J. E. (2004). Risky choice: Selecting between certain and uncertain outcomes. *Behavior Analyst Today*, 5(2), 190–203.

Critical Summary

This paper examined three kinds of risky choice: (1) choices between fixed delays and variable delays, (2) choices between sure reinforcers and probabilistic reinforcers, and (3) choices between fixed and varied amounts of reinforcement. Most experiments were performed with pigeons or rats, and these experiments showed that for choice types (1) and (2), the animals were generally risk seeking. There experiments showed a mixture of results for the third choice type. It was also noted that experiments with humans have shown risk aversion, results that are diametrically opposed to the animal experiments. Several possible reasons were suggested for this, mostly having to do with the way human experiments are conducted. Two major differences between the animal and human experiments exist. Animal experiments generally include many choices per animal per experiment while questions are often asked only once in human experiments. Perhaps a bigger difference is that animals are tested with primary reinforcers such as food, while humans are generally tested with secondary reinforcers such as money, or even hypothetical questions with no reinforcement. The author suggests that more study should be conducted to compare risky behavior between humans and non-humans, perhaps by making the human experiments more like the animal experiments.

Critical Analysis

This paper suggests some possible problems with human risk experiments. It is possible that these problems may be giving false information about the true nature of

human propensity towards risky behavior. While the author's experiments only included two species of animals, he points out other research with other animal species that support his findings. Further, his suggestions of reasons why human experiments have such different results are compelling. This paper will be useful in supporting the weaknesses in risky choice experiments that will be discussed in the Depth essay. It also provides a useful contrast from a fresh perspective to other articles' results about risky choice.

Citation 8: Prospect Theory and Political Science

Mercer, J. (2005). Prospect theory and political science. *Annual Review of Political Science*, 8(1), 1–21.

Critical Summary

This paper examined prospect theory from the perspective of political science. The author noted that prospect theory is not widely accepted or used in the discipline of political science and examined possible reasons for this, especially given that prospect theory is so widely accepted in other fields such as economics and psychology. The fact that prospect theory cannot predict the “domain” of actors was examined from several viewpoints. In order to predict the domain of an actor, it is necessary to know his reference point. This may be determined by the status quo, his aspirations, or heuristics. Further, frames may be based on analogies or emotions. It is sometimes difficult to tell whether actors choose because of their preferences or whether the preferences are a result of the choices they make. The difficulty in assessing the frame of mind of actors was given as the reason for resistance to prospect theory generally, although the author mentioned that the real resistance is probably due to resistance of psychology generally than to the limitations in prospect theory, since all theories of rational choice have inherent weaknesses.

Even given the frame of mind of an actor, predicting actions in the political arena is not a given. The author examined whether risk aversion is more likely to cause action or lack of action. Mercer finally posited that it is more helpful to know how actors will behave than how they should behave. He also drew on Davis (2000) to conclude that threats will be most effective against those who seek gains and least effective against

those who are trying to avoid loss, and promises will be most effective against those trying to avoid loss and least effective against those who seek gains.

Critical Analysis

Mercer's paper suggested political science as an application for prospect theory. He correctly pointed out the problems of predicting behavior in the laboratory vs. the world's political arena, and the inherent problem that prospect theory only predicts behavior after the point of reference of an actor is known. When it is not known whether an actor is in the domain of losses or gains, prospect theory may be of limited value. Mercer also pointed out some interesting limitations to the theory even when the frame of the actor is known, and yet suggested a few ways to apply the theory in the real world. Even so, the paper is probably of more use as a comparison of strengths and weaknesses of prospect theory in political science than as a suggestion for applications to real problems. Mercer also brought up several recent examples of real political choices made by major world players and examined these in light of the tenets of prospect theory. This paper will add the application of political science to the Depth demonstration and can be used to show and back up strengths and weaknesses of prospect theory, especially in the arena of political science applications.

Davis, JW. (2000). *Threats and promises: The pursuit of international influence*. Baltimore, MD: Johns Hopkins Univ. Press.

Citation 9: Boundaries of Loss Aversion

Novemsky, N. & Kahneman, D. (2005). The boundaries of loss aversion. *Journal of Marketing Research*, 42(2), 119–128.

Critical Summary

The authors proposed a model for bounding loss aversion, and posited that money used for purchases is not subject to loss aversion. Perhaps the key point of the paper is three propositions about the psychology of loss aversion. They are:

1. The value placed on an item that is exchanged reflects loss aversion.
2. When items are intended to be exchanged, then the items are not viewed as losses.
3. Risk aversion is limited to loss aversion in “balanced” risks.

The authors also tested prospect theory’s tenets of the endowment effect, Finally, the authors tried to disprove the 1997 findings of Bateman and colleagues that argued against some tenets of prospect theory involving loss aversion.

Critical Analysis

The experiments were carried out in a well-designed and sound manner, and the statistical analysis was logical and easy to follow. It should be noted that the authors started their study standing clearly in the “prospect theory camp.” Their aim was to disprove certain results that they did not agree with. Because of this, the paper was viewed with a particularly critical eye. Even so, no obvious flaws jumped out. The authors gave some extremely interesting marketing applications to prospect theory and to their findings in general. They made suggestions to marketing managers about how to change the perception of loss in marketing campaigns. This paper will be used briefly in the

Depth portion of the KAM in the discussion about loss aversion and the concept of boundaries on loss aversion.

Citation 10: The Effect of Intentions on Loss Aversion

Novemsky, N. & Kahneman, D. (2005). How do intentions affect loss aversion?
Journal of Marketing Research, 42(2), 139–140.

Critical Summary

The authors suggested that the intentions of a person who is endowed could affect loss aversion and the endowment effect. Specifically, the author suggested three possible ways that intentions can affect loss aversion. First, it was noted that those who had experience trading goods display less of an endowment effect when trading, and tend to look at the money to be gained as the point of reference rather than the loss of the good to be exchanged or sold. This affect suggests that there is an exaggerated anticipation of negative effects for the inexperienced.

A second possible effect related to intentions is the degree of emotional attachment to the good. When someone forms an intention to trade or exchange a good, it may attenuate the emotional attachment to the good, lessening the endowment effect.

A third possibility for changing intentions related to the endowment effect and loss aversion is changing the reference point against which results are compared. If the reference point is the amount of money expected to be gained from a sale or exchange rather than the good to be exchanged, this can attenuate the endowment effect.

Critical Analysis

The suggestion of a correlation between loss aversion/the endowment effect and intentions has not been studied thoroughly as of yet. The authors' observations are interesting and are backed up with current research. This paper will be used in the Depth essay to fill out the analysis of loss aversion and the endowment effect.

Citation 11: The Effect of Affect

Rottenstreich, Y., Hsee, C. K. (2001). Money, kisses, and electric shocks: On the affective psychology of risk. *Psychological Science*, 12(3), 185–190.

Critical Summary

Kahneman & Tversky's S-shaped weighting function suggests that people underweight large probabilities and overweight small ones. This is based on a psychophysical approach to outcomes. The authors suggested that when an affective approach to outcomes is used, (i.e., the outcomes have emotional impact), the underweighting and overweighting is exaggerated, producing a more pronounced S-shape. The authors performed experiments to validate this assumption.

Method

The authors used two experiments with only positive outcomes and one with a negative outcome. Each experiment compared affect-rich outcomes with affect-poor ones. The affect-poor outcomes were monetary, while the affect-rich outcomes were a kisses, vacations and electric shocks. Experiments were intended to validate both the right and left ends of the weight function.

Results

The results validated the authors' hypothesis on both ends of the weight curve. Affect would appear to make the S-shape more pronounced, and affect-poor outcomes make the S-shape less pronounced.

Critical Analysis

While the authors showed results at both ends of the spectrum, they also posited that the middle of the curve would not be affected. Yet, they failed to do any experiments to show results in the middle of the curve, or even anywhere between 1% and 99%.

However, the results from this paper make an interesting comparison to Hertwig, and will add richness to the discussion of prospect theory's weight function.

Citation 12: The Effect of 9/11 on Decision Making

Sacco, K. Galletto, V., & Blanzeiri, E. (2003). How has the 9/11 terrorist attack influenced decision making? *Applied Cognitive Psychology, 17*(9), 1113–1127.

Critical Summary

The events of 9/11 allowed for an unusual ability for researchers to look at decision making behavior under adverse global circumstances. Sacco, et al. performed experiments on Italian college students in order to compare how 9/11 affected decisions under risk compared to previous results observed by Kahneman and Tversky's experiments on prospect theory.

Method

Kahneman and Tversky's problems were repurposed to account for the currency difference and for inflation since the previous experiments, and the questions were asked one month and six months after 9/11 to similar groups of adult students. Each decision consisted of two choices with identical expected value. Some decisions were in the gain domain, others in the loss domain.

Results

The results showed that people lost the tendency to overestimate small probabilities in the domain of gains, preferring sure gains instead. The tendency to take risks in the loss domain was also lost, suggesting that people preferred sure outcomes to risk for both gains and losses. In general, people tended to make conservative decisions one month after 9/11. The experiment conducted six months after 9/11 showed that the preference for sure gains was intact, while the preference to take risks in the loss domain was being slowly recovered. People did continue to show decision making biases dependent on the reference point, and to treat gains and losses differently. However, the gain and loss

weighting curve looked different after 9/11 compared to prospect theory's model. Besides the loss of the overestimation of small probabilities in the gain domain, the reflection effect was lost. The loss function didn't mirror the gain function, but looked similar to it. In contrast to prospect theory, people not only lost their trust in chance in the domain of gains after 9/11, but also preferred to take sure losses in order to avoid possible greater ones.

Critical Analysis

While the results are interesting, and there is no reason to doubt the experimental design itself, it should be noted that at best the experiments show how 9/11 affected decision making for adult college students in Italy, and not necessarily for the general population of Italy. Further, no causal relationship is established for certain. The results seen could be a secondary effect of 9/11, not a primary effect. This paper will be useful in the Depth essay as an application to prospect theory and to examine violations of prospect theory and possible causes of them. It will also provide an additional opportunity to discuss cautions about experimental designs.

Citation 13: Prospect Theory and Multi-Stage Trials

Sasaki, H. (2005). The effects of trial repetition and individual characteristics on decision making under uncertainty, *Journal of Psychology*. 139(3), 233–246.

Critical Summary

These authors set out to repeat Kahneman and Tversky's results of the certainty effect and the reflection effect in a single stage trial of choice under risk, and then to test whether these effects of prospect theory remained in multi-stage experiments. Japanese college students were used in both of these trials. The authors also tested personalities for risk prone tendencies and compared choices to the personality profile results to see if choices were correlated to risk taking tendencies.

Method

The authors set up a single choice trial that was equivalent to Kahneman and Tversky's 1979 landmark experiment. The second experiment used computers to allow participants to make multiple choices with pretrial information about the decisions and feedback about the results of the decisions. Finally, participants were given a personality test to determine the impulsivity of each participant.

Conclusions

Prospect theory's certainty and reflection effects were supported in the single stage experiment. However, the certainty effect vanished in the multi-stage experiment, and the experiment's results resembled expected utility theory's predictions more closely than prospect theory's. Risk seeking choices were also generally correlated with impulsivity and with males.

Critical Analysis

While prospect theory's predictions are repeatable with simple single stage gambles, some of its tenets seem to disappear when subjects are allowed multiple stages and feedback, suggesting that expected utility theory may be the more correct theory in this more complex scenario. However, the fact that personality profiles and gender were also correlated to risky decisions over certain ones suggests both theories need to be tested further based on personality and gender rather than based only on the decision scenario. This was one of the few papers with non-American students, and the only paper that used Asian subjects. This paper will add to the Depth demonstration in the discussion of prospect theory in simple vs. complex experimental design and the confusion about decisions under risk versus uncertainty. It will also add to the discussion about the subjects chosen for experiments and the hint that gender and personality may play a role in decision making behavior.

Citation 14: Deterrence and Compellence in Prospect Theory

Schaub, G. Jr. (2004). Deterrence, compellence and prospect theory. *Political Psychology*, 25(3), 389–410.

Critical Summary

In political science, the conventional wisdom has always said that deterring an adversary is easier than compelling him. Expected utility theory would predict that deterrence and compellence are equally expensive, and that an adversary would be equally likely to choose to comply or defy when stakes and costs are equal. Prospect theory, on the other hand, posits a theory that agrees with the conventional wisdom about the cost of deterrence versus compellence. The author suggested that prospect theory can be used as a practical way to predict actual political situations involving deterrence and compellence.

According to prospect theory, deterrence would be viewed in the realm of gains. Therefore, an adversary would be most likely to comply unless the deterrent threat is high. In this case, the certainty effect comes into play and the adversary will actually be more likely to view the deterrent as a possible loss and may risk defiance. On the other hand, compellence will generally be viewed in the realm of losses. As such, an adversary will be likely to gamble in order to avoid any loss at all. If the compellent threat is too high, however, the certainty effect again comes into play, and the adversary may actually decide to comply and think of the loss as a sort of insurance premium.

The author also cites experiments designed to measure the actual cost of deterrence versus compellence. The author's results state that deterrence may cost as much as slightly less than half as much as compellence or as little as one tenth as much.

Critical Analysis

Prospect theory requires the apriori knowledge of a reference point. In real life it is not simple or obvious what this reference point is. The author does point out this weakness, but he may underestimate its severity. While the trends of behavior for deterrence and compellence are more than likely correct, the actual measurements of costs are probably a stretch given the complexities of real political scenarios. This paper adds the possibility of real applications to prospect theory in political science and points out important strengths and weaknesses to the theory in this application. For this reason it will make an excellent addition to the Depth demonstration discussion of applications to prospect theory.

Citation 15: Long Run—Biological vs. Economic Rationality

Thorngate, W., & Tavakoli, M. (2005). In the long run: Biological versus economic rationality. *Simulation & Gaming*, 36(1), 9–26.

Critical Summary

This is a major paper dealing with risk taking behaviors. Specifically, the authors noted prospect theory's tenet that people tend to be risk averse with gains and risk seeking with losses. The authors posited that economic rationality, the method of making decisions based on expected values, differs from biological rationality, the method of making decisions based on insuring survival. In this case survival indicates having enough money to make another bet, or avoiding financial ruin.

Method

Thousands of computer simulations were conducted, making bets with different starting wealth, antes, outcome probabilities, and expected gains. Sets of simulations were run with positive expected gains, zero expected gains, and negative expected gains. In each case, a wide range of outcome probabilities were run, and a range of different antes were run for each case as well. The results were tabulated and graphed. The goal was to determine which scenarios would result in the longest survival. In other words, the goal was to avoid running out of money for the greatest possible number of bets.

Results

The object was to survive for the greatest number of bets. Under the scenario of long term expected gains, gamblers should choose a low ante and a high probability of winning a small amount for each bet. When dealing with no expected gain or loss, gamblers still benefited from choosing a small ante and a high probability of winning a

small amount for each bet, though the benefit was lower than in the case of expected gains. However, under the scenario of long term expected loss, gamblers should choose a low ante and a low probability of winning a larger amount for each bet. In other words, gamblers survived more bets by taking the approaches explained above than if they took a different approach. This result supports prospect theory's risk aversion for gains and risk seeking when dealing with losses.

Critical Analysis

This study was conducted in an extremely logical manner. Results were easy to understand, and tied in with hedonic psychology and prospect theory. This paper and its results can be used in the Depth essay to explain behavior under risk and to support prospect theory's hypotheses. The results also tie in excellently with biological fact and behavior as well as economics.

Citation 16: Risk Preference and Belief

Wakker, P. P. (2004). On the composition of risk preference and belief. *Psychological Review*, 111(1), 236–241.

Critical Summary

One of the tenets of prospect theory is that judgments under uncertainty are described by a weighting function instead of expected utility theory's utility function. The authors propose that prospect theory's weighting function should be broken down into two components consisting of a linear function reflecting beliefs and a nonlinear function reflecting attitude about risk.

By considering only gain outcomes, the authors introduce and prove a theorem explaining mathematically that for uncertain events, a person who is less sensitive to uncertainty than to risk, will, for uncertain outcomes, be less sensitive to changes in the middle of the region (between 0 and 1), than they will for known probabilities.

Though in general people are assumed to show aversion to ambiguity, there are exceptions to this rule. When events are likely, less sensitivity to uncertainty than to risk makes aversion to ambiguity stronger. However, when events are unlikely, less sensitivity to uncertainty causes people to overweight uncertain events, and therefore people become ambiguity seeking rather than ambiguity averse.

Critical Analysis

While the results seem sound, it should be noted that this is an extremely "special" case for decision under risk. In order to use these results, all assumptions must be met. Nevertheless, this paper will be used in the Depth essay as a challenge to prospect theory. It will also add to the discussion about differentiating decision under risk and decision under uncertainty.

Citation 17: The Peanuts Effect

Weber, B., & Chapman, G. (2005). Playing for peanuts: Why is risk seeking more common for low-stakes gambles? *Organizational Behavior & Human Decision Processes*, 97(1), 31–46.

Critical Summary

The *Peanuts Effect* is defined as the tendency to be willing to take risks when the payoffs are very low, but to become increasingly risk averse as the stakes increase. In other words, a preference reversal for risk taking is observed based on the *magnitude* of the payouts. This effect is important because most studies on risk involve choices that are not terribly important, whereas real choices often involve extreme consequences, (e.g., war or peace). This paper studies the possible causes of the peanuts effect.

Method

The authors conducted two experiments to determine whether this effect could be explained by any utility function, including that of prospect theory or expected utility theory, or whether the effect might be connected to disappointment and/or regret. The first experiment studied only decisions in the domain of gains, and was conducted in order to study three factors that can affect “choice” questions. These factors are (1) the magnitude difference between small-stakes gambles and large-stakes gambles, (2) the magnitude of the probabilities used in the gambles, and (3) the ratio between the probabilities in the gambles. The second experiment included decisions in both the gain and loss domains, and studied decisions with a high tendency towards the peanuts effect in order to determine whether the effect could be explained by a utility function, disappointment or regret.

Results

The results strongly showed that the peanuts effect exists. In addition, the first experiment showed that the peanuts effect was larger for larger probability magnitudes and for larger probability ratios. The second experiment showed that the peanuts effect could not be explained by any utility function that is consistent with either prospect theory or expected utility theory since either theory prohibits utility functions that are dependent on the probability of outcomes. The experiment also showed that the peanuts effect is incompatible with regret, but likely to be explained by disappointment.

Critical Analysis

This is a major paper in that it deals with the fact that most decision studies may be flawed in the sense of dealing only with decisions that have rather unimportant consequences in comparison to many real life decisions. The paper also shows a weakness in prospect theory in that many important real life decisions cannot be explained by any utility function. This paper is one of the few that has admitted that the use of college students may pose an additional problem with decision studies. Even so, there are some unexplained results in the study for which the authors offer no explanation or hypothesis. Further, some results are diametrically opposed to other major studies.

This paper will be an important part of the Depth essay in offering a weakness to prospect theory, some real examples of decisions that are not covered by most decision studies, and an effect that is partially explained by prospect theory but in some ways contradicts it. The paper offers some interesting comments and results that will make for a rich discussion of decisions under risk and shows the only really compelling weakness

in prospect theory of all the paper reviewed. It will also be useful to include Daniel Kahneman's answer to this weakness in the essay.

DEPTH DEMONSTRATION

Introduction

In the previous section, three major theories about human decision making were compared and contrasted and integrated with research about human happiness. These included Bernoulli's expected utility theory, Kahneman and Tversky's prospect theory, and Bell's and Loomes and Sugden's regret theory. In this section, precise definitions and mechanisms of decisions will be explored and research in prospect theory from the last 10 to 15 years will be examined in depth. Challenges to the theory will be analyzed for strengths and weaknesses and the precise intention of prospect theory will be discussed. Finally, several applications of prospect theory will be examined.

Kahneman & Tversky's prospect theory was proposed only about 25 years ago and has therefore been the subject of many verification tests, suggested alterations, and suggested applications in recent years. Though prospect theory is now considered the leading theory of decision under risk (Jervis, 2004; Mercer, 2005; Rottenstreich & Hsee, 2001; Schaub, 2004; Trepel, Fox, & Poldrack, 2005; Weber & Chapman, 2005), there are also some recent suggestions of alternative theories that prospect theory is totally mistaken in some or all of its tenets, at least under some circumstances or for some kinds of risk decisions (González-Vallejo, Reid, & Schiltz, 2003; Sasaki & Kanachi, 2005; Wakker, 2004; Weber & Chapman, 2005). The challenges to prospect theory generally take on three forms. Sometimes the essentials of the theory are accepted, but an adjustment is proposed to one or more details such as the shape of the value or weighting function (Rottenstreich & Hsee, 2001). Other times, the general thrust of the theory is accepted as promising, but one of the key tenets is challenged on the basis of unexpected

results to an experiment (Weber & Chapman, 2005). Finally, sometimes the entire approach characteristic of prospect theory is rejected as misguided and an alternate theory is suggested (Bell, 1982, 1985; González-Vallejo et al., 2003; Loomes & Sudgen, 1982, 1983, 1987). On the other hand, a number of researchers find prospect theory fruitful and have concentrated not on criticizing it but on using it and applying it to specific real-world decision problems. Some of the most interesting applications deal with politics, international relations, terrorism, and the effect of prospect theory on human values (Jervis, 2004; Mercer, 2005; Sacco, Galletto, & Blanzeiri, 2003; Schaub, 2004). This paper contains sections which examine some of the recent challenges and proposed additions to prospect theory as well as applications of the theory. Strengths and weaknesses of prospect theory and experimental methods will be analyzed along with strengths and weaknesses of prospect theory's major challengers.

Defining Decisions

One obstacle to progress in understanding the strengths and weaknesses of prospect theory has been widespread confusion about what, exactly, prospect theory is really trying to explain. In other words, some critics misunderstand the aims of prospect theory. To understand those intentions properly, a clarification must be made about the differences between two types of decisions (Trepel et al., 2005). In order to analyze decision making theories in any kind of systematic way, it is vital to have an understanding of the types of decisions being studied as well as psychological and biological factors that may affect the decision making process. From Daniel Bernoulli's expected utility theory developed in the eighteenth century, to prospect theory and its

extensions, theorists have studied two major kinds of risky decisions. *Decisions under risk* denote decisions that are made with the decision maker's full knowledge of the outcomes and the probabilities of those outcomes. Most experiments about decision making have examined these types of decisions. Though decisions under risk tend to be somewhat artificial compared to most real life decisions, they are the simplest to study because the outcomes are discrete and simple calculations can be made with the data. Simple gambling decisions with known probabilities are an example of decision under risk. Suppose you can choose between a guaranteed \$1000 or \$5000 with a probability of 20%. This is a decision under risk and is the kind of decision used in most decision making experiments, including the landmark experiments performed by Kahneman and Tversky in 1979 which supported their landmark paper. Note that the expected gain is easily calculated, as is expected utility if the utility function, value function, and/or weighting function is given or assumed. The function needed is dependent upon the specific decision theory being used (Trepel et al., 2005).

Decisions under uncertainty are decisions with uncertain outcomes where the decision maker does not know all the outcome probabilities and may not even know all of the outcomes. These are the more common types of decisions that people make in real life. Let us consider an example of decision under uncertainty. Suppose two adolescents are considering engaging in unprotected sex. There are multiple risks in this kind of behavior including a large number of diseases, of which at least one, AIDS, is incurable and deadly. There is also the risk of pregnancy and all that it entails. There is the further much more nebulous risk of emotional pain if the relationship goes bad. None of the probabilities for the various outcomes are known, and decision makers in a situation like

this almost certainly could not think about the entire range of possible outcomes even if they tried. This example of decision under uncertainty has many interesting properties and will be returned to later in this paper. While many decisions under uncertainty are unimportant, such as what a person chooses to wear when there is a chance of rain, some decisions, like the risky sexual behavior of adolescents, can have huge negative consequences (Johnson, McCaul, & Klein, 2002). Additionally, most decisions about international politics or domestic economic policy are decisions under uncertainty rather than decisions under risk, and either can have huge consequences if made poorly (Jervis, 2004; Mercer, 2005). Unfortunately, decisions under uncertainty are difficult to study and model exhaustively because of the complexity or impossibility of defining the outcomes and/or outcome probabilities (Trepel et al., 2005).

While expected utility theory has long been considered an appropriate model to handle both decisions under risk and decisions under uncertainty, prospect theory is only intended to describe decisions under risk. However, it is still sometimes useful to look at decisions under uncertainty against some of the basic tenets of prospect theory (Kahneman & Tversky, 1979). Tversky and Kahneman developed a different model in 1992 called *cumulative prospect theory*. This second theory is intended to handle decisions under uncertainty (Tversky & Kahneman, 1992). As an aside, regret theory is a modification of expected utility theory and like expected utility theory, it is intended to explain both decisions under risk and decisions under uncertainty (Bell, 1982, 1985; Loomes & Sugden, 1982, 1983, 1987). This will be a very significant distinction as articles about advances and challenges to prospect theory are discussed in this paper.

The Psychology and Biology of Decisions

Much research concerning decision making has been done with animals. This research has generally shown that animals are risk seeking whether they are dealing with gains or losses (Mazur, 2004). On the other hand, prospect theory has shown that people are loss averse, showing risk adverse behavior in the domain of gains and risk seeking behavior in the domain of losses (Kahneman & Tversky, 1979). Therefore, risk seeking behavior drives animals while loss aversion drives humans. Whatever risk seeking or risk averse behavior humans display is generally caused by loss aversion rather than propensity to take risk in general. Such a marked difference in basic biological and psychological tendency is in need of examination. It has been suggested that the reason for this discrepancy has more to do with the way in which experiments are conducted than basic differences between the way animals and humans make decisions (Mazur, 2004). While animals have generally been tested with primary reinforcers such as food, humans are generally tested with secondary reinforcers such as money, and sometimes even with purely hypothetical questions with no reinforcement at all (Mazur, 2004). This important difference in the method of testing decision making merits a further look, as it is pivotal in recent discussions about prospect theory.

Daniel Kahneman, in a 2003 paper based on his 2002 Nobel Prize lecture, made a distinction between two kinds of thinking. The first type is intuition and the second type is purposeful, rational thinking. While both kinds of thinking are involved in many decisions, it is probably reasonable to assume that the primary reinforcers, like the food rewards which are used in most animal experiments, deal with intuitive decisions rather than rational ones. The dopamine system of the brain appears to be responsible for the

reward mechanisms associated with decisions. In fact, animals that have had their dopamine systems blocked stop acting to receive rewards (Trepel et al., 2005). While the reward mechanism of the brain seems to be a very primary element associated with decisions and with happiness as well, there are multiple, complex parts of the brain that are associated with rational thinking at higher levels. It is these more complex kinds of decisions that prospect theory aims to explain (Trepel et al., 2005). This may account for the differences between results in animal and human decision experiments. Human decisions involve parts of the brain that include memory, emotions, rewards, punishments, anticipation and many other things. Human happiness is also integral to these interactions. The interactions of these various parts of the brain are complex enough that neurologists are only at the beginning of their understanding of them (Trepel et al., 2005). This background gives adequate preparation to examine recent experiments concerning decisions under risk and decisions under uncertainty.

Review of the Basic Tenets of Prospect Theory

Recall that prospect theory operates on several basic tenets:

1. Humans look at decisions as gains or losses from a fixed point of reference, sometimes thought of as the status quo.
2. Humans are risk averse in the domain of gains and risk seeking in the domain of losses (loss aversion).
3. Low probabilities are underweighted while high probabilities are overweighted (the certainty effect).

4. People tend to value something more once they possess it than before (the endowment effect).
5. The way that a problem is posed will affect the way a person responds to it (framing).
6. There is a “value function” that replaces expected utility theory’s “utility function.” This value function is concave for gains and convex for losses. It is also steeper in the domain of losses than gains because of tenet (2). An example of a value function is shown in Figure 2 in the previous section.
7. The value of each prospect is multiplied by a decision weight. These weights can be described by an S-shaped decision function that illustrates the certainty effect and the fact that probabilities are not weighted in a linear fashion. An example of a typical weighting function is shown in Figure 3 in the previous section.

(Kahneman & Tversky, 1979)

The Effect of Affect

Necessary preparations have now been made in order to have the basic understanding to look at current research concerning prospect theory. Analysis will first be undertaken regarding articles that tend to support or slightly modify prospect theory. Afterwards, papers will be explored that challenge prospect theory.

Some recent work concerns the shape of the value function or the weighting function in prospect theory. Prospect theory suggests that the weighting function has an

“S” shape because of the certainty effect. That is, decision makers tend to underweight low probabilities and overweight high ones. Rottenstreich and Hsee (2001) suggested that Kahneman and Tversky’s “S” shaped weighting function has an even more pronounced “S” shape when decisions are made with high *affect value*, or emotional impact. The authors illustrated this with three experiments, two with only positive outcomes and one with a negative outcome. Each experiment compared affect-rich outcomes with affect-poor ones. Money was used as a reward for the affect-poor outcomes, while kisses with movie stars, vacations, and electric shock were used for affect-rich positive and negative outcomes. The experiments were designed to look at both the high probability and low probability ends of the weighting function. The results supported the authors’ hypothesis at both ends of the weighting function. Therefore, emotional impact tends to exacerbate the underweighting of low probabilities and the overweighting of high ones. It is not surprising that emotion had an affect on the weighting function in Rottenstreich and Hsee’s experiment. Current research on the brain shows that loss aversion is not based on the parts of the brain dealing with rational thought, cognition, or intellect. Rather, it is based on the part of the brain that controls emotion. In fact, patients with their rational thought processes intact, who have lesions on the amygdala, the part of the brain dealing with emotions, cannot seem to learn to avoid dangerous or risky behavior (Trepel et al., 2005).

While there is no reason to doubt the validity of the experiments conducted, the authors also posited that the middle of the weighting function would not be affected by affect-rich outcomes at all. Yet, no experiments at all were performed in this range of the probability spectrum. In fact, no experiments were undertaken between 1% and 99%

probability. Only the two extreme ends of the weighting function were explored.

Therefore, it seems premature to make comments about the middle of the weighting function based on the experiments conducted.

Loss Aversion

One of prospect theory's basic tenets is loss aversion (Kahneman & Tversky, 1979). In recent years, loss aversion has been extended and has been explained as the reason for the endowment effect, which can be described as the difference between the price a person is willing to buy and sell a product (Thaler, 1980). Experiments have been done with things as diverse as mugs (Kahneman, Knetsch, & Thaler, 1990), pizza toppings, (Levin, Schreiber, & Gaeth, 2002) and gift certificates (Sen & Johnson, 1997) to demonstrate this effect. All of these experiments showed that there is a significant difference between what people will pay for an item versus what they will accept for that same item once they possess it. However, in two separate 2005 papers, Novemsky and Kahneman demonstrated that there are boundaries to loss aversion and the endowment effect. For example, if one item is exchanged for an item identical in every way, loss aversion does not occur. Further, when a primary resource such as money is used in exchange for a good, there is no loss aversion for the money. By using some clever experiments, these authors made and demonstrated in practice three propositions about loss aversion and its boundaries.

- “1. The value attached to a consumption good that is given up in an exchange reflects loss aversion.
2. Goods that are exchanged as intended are not evaluated as losses.

3. "There is no risk aversion beyond loss aversion in balanced risks."

(Novemsky & Kahneman, 2005(a), p. 125)

In other words, loss aversion has limits and does not occur in every decision situation.

In a follow-up paper by the same authors, the emotional and cognitive impact on loss aversion is discussed. It has been suggested that loss aversion and the endowment effect is tied in with emotional attachment to an item (Ariely, Huber, & Wertenbroch, 2005). However, experience in trading can reduce or eliminate this effect by reducing the emotion involved in giving items up (List, 2004). If a person is intending on trading for an item, he is unlikely to show loss aversion for the item (Novemsky & Kahneman, 2005(b)). Therefore, it is again seen how emotions take part in decision making. Also, emotional attachment affects loss aversion by attenuating the degree to which giving an item up feels like a loss, whereas changes in cognitive perspective offer an explanation why outcomes in the domain of losses are weighted more lightly or heavily (Ariely, Huber, & Wertenbroch, 2005).

In other recent research on loss aversion, Camerer (2005) suggested that Bernoulli's concave explanation for the utility function is a sufficient but not necessary explanation for loss aversion. St. Petersburg Paradox can be looked at in terms of the actual probability of winning a certain amount of money x . When looked at in this way, the approximately \$20 that Bernoulli determined that most people are willing to pay to take the gamble is a rational choice. This experiment has been repeated many times, and the amount people are willing to pay to play the St. Petersburg game is quite consistent (Camerer, 2005). Even given the infinite expected value of the bet, most people will lose money each time they pay \$20 to play. Camerer posits based on this that the utility

function could alternatively be a piecewise nonlinear function consistent with prospect theory's value function instead of the concave function suggested by Bernoulli. Camerer also suggests that loss aversion is a psychological phenomenon, a theory that is useful in modeling, and is an empirically observable phenomenon. An important question posed is whether loss aversion is an emotional response, a judgment error, or simply a preference. The answer is that it depends on the circumstances involved. If the potential loss is temporary and is followed by gains that will bring the decision maker to the right side of the starting reference point, loss aversion can be a mistake (Camerer, 2005). Camerer says, "...loss aversion is often an exaggerated emotional reaction of fear, an adapted response to the prospect of genuine, damaging, survival-threatening loss" (Camerer, 2005, p. 132). Loss aversion factors in to the application section later in this paper, especially the applications to political science, international relations, and the 9/11 terrorist attacks.

Some recent research on decision under risk concerns the difference between economic rationality and biological rationality (Thorngate & Tavakoli, 2005). Recall prospect theory's tenet that people tend to be risk averse with gains and risk seeking with losses. The authors posited that economic rationality, the method of making decisions based on expected values, differs from biological rationality, the method of making decisions based on insuring survival itself. Thorngate and Tavakoli (2005) attempted to mimic biological rationality by simulating "survival." In Thorngate and Tavakoli's experiment, the goal for the subjects was to avoid running out of money for the greatest possible number of bets. In other words, bankruptcy mimicked death and signaled the end of the experiment for any subject that ran out of money.

Thousands of computer simulations were conducted making bets with different starting wealth, antes, outcomes probabilities, and expected gains. Sets of simulations were run with positive expected gains, zero expected gains, and negative expected gains. In each case, a wide range of outcome probabilities were run, and a range of different antes were run for each case as well. The results were tabulated and graphed. The goal was to determine which scenarios would result in the longest survival (Thorngate & Tavakoli, 2005).

Under the scenario of long term expected gains, gamblers should choose a low ante and a high probability of winning a small amount for each bet. When dealing with no expected gain or loss, gamblers still benefited from choosing small antes and a high probability of winning a small amount of money for each bet, though the benefit in this case was lower than in the case of expected gains. However, under the scenario of long term expected loss, gamblers should rationally choose a low ante and a low probability of winning a larger amount for each bet. In other words, gamblers survived more bets by taking the approaches explained above than if they took a different approach (Thorngate & Tavkoli, 2005).

Results of the experiments tied in with the above expectations and supported the tenets of both prospect theory and hedonic psychology (Thorngate & Tavakoli, 2005). While similar animal experiments don't yet exist and may be difficult to design (Mazur, 2004), further research in this area could begin to bridge the gap between animal and human experiments about decision making. One further note of caution is required; the simulation of biological rationality using economics must be considered with care since the entire experiment was designed to distinguish between economic and biological

behavior. As a later section will show, experimental design may be the single largest problem in postulating and verifying theories regarding decisions under risk and decisions under uncertainty.

Challenges to Prospect Theory

Wakker (2004) suggested that prospect theory's "S" shaped weighting function should be broken down into two components consisting of a linear function reflecting beliefs and a nonlinear function reflecting attitudes about risk. By considering only gain outcomes, the authors prove a theorem explaining mathematically that for uncertain events, a person who is less sensitive to uncertainty than to risk, will, for uncertain outcomes, be less sensitive to changes in the middle of the region (between 0 and 1) of the weighting function than they will for known probabilities. Because of the lack of sensitivity in the middle of the curve, that part of the curve should be linear, which mimics the beliefs of expected utility theory (Wakker, 2004).

Further, though people are assumed to show aversion to ambiguity, there are exceptions to this rule. When events are likely, less sensitivity to uncertainty than to risk makes aversion to ambiguity stronger. However, when events are unlikely, less sensitivity to uncertainty causes people to overweight uncertain events, and therefore people become ambiguity seeking rather than ambiguity averse (Wakker, 2004). Recall from the Breadth section that most people are happiest when there is security and little ambiguity in their lives (Myers, 1992). This makes ambiguity seeking behavior an interesting paradox.

While these results are interesting, it must be noted that Wakker's work deals with decisions under uncertainty rather than decisions under risk, and Kahneman and Tversky never suggested that prospect theory was a model for decision under uncertainty. Rather, it is a model for decision under risk (Kahneman & Tversky, 1979). Recall that cumulative prospect theory is Tversky and Kahneman's 1992 model designed to handle the more ambiguous problem of decisions under uncertainty. Tversky and Kahneman also note that cumulative prospect theory handles decisions with many possible outcomes better than their original theory. Cumulative prospect theory has some important differences to prospect theory and they cannot be used interchangeably. One of the most important differences is that cumulative prospect theory replaces the weighting function with a group of cumulative weighting functions. (Tversky & Kahneman, 1992). Therefore, Wakker's discussion would better be left as a discussion about cumulative prospect theory than the original prospect theory being challenged in the 2004 paper.

Kahneman and Tversky suggested in 1979 that people tend to overweight rare events and underweight common events, and the research has supported this pattern on a consistent basis (Rottenstreich & Hsee, 2005; Sacco et al., 2003). However, Hertwig, Barron, Weber, Elke, and Erev (2004) hypothesized that people make decisions based either on descriptive information or based on their personal experiences. They further noted that virtually all of the experiments supporting prospect theory's claims about the overweighting of rare events dealt with descriptive decision making and only one choice per problem. These authors further hypothesized that people actually underweight rare events when making decisions based upon experience. The hypothesis was tested for validity and to determine whether the underweighting of rare events in experiential

decisions is based on direct experience or on the basis of repeated decisions. Hertwig et al.'s (2004) experiments supported the hypothesis that people underweight rare events when making decisions based on experience and that this bias was based upon direct experience instead of repeated decisions. The results were robust across the entire experiment, with only one problem failing to show statistical significance. This result would tend to undermine the shape of prospect theory's weighting function. The authors further posited that the reason for the underweighting bias may be due to memory limitations and the fact that the skew of binomial distributions when the probability and sample size are small results in people seeing fewer than the expected number of rare events.

Hertwig et al.'s (2004) experiment seems to be a legitimate challenge to prospect theory until it is considered that the authors' experiments about experiential decisions were decisions under uncertainty and not decisions under risk. The authors' criticism that previous work in prospect theory only considered descriptive experiments rather than experiential ones is surprising, for the description of an experiment is the very definition of decision under risk, which is exactly what Kahneman and Tversky set out to describe. Therefore, this study is not a compelling challenge to prospect theory. However, Hertwig et al.'s comment about the way most decision making behavior has been studied is both perceptive and relevant. In fact, the authors are correct that most of the decision making experiments have been descriptive ones (Kahneman & Tversky, 1979; Novemsky & Kahneman, 2005; Thorngate & Tavakoli, 2005; Weber & Chapman, 2005). In itself, this is not a major problem if models are being examined that concern only decisions under risk rather than decisions under uncertainty as well.

However, another issue that almost certainly is a problem with most of the experiments conducted about decision making under risk is that virtually all of the experimental designs used only college students as subjects (Trepel et al., 2005). The use of college students poses some unique potential problems. College students are often in their late teens or early twenties, which means that only one age group is generally being studied. In addition, most college students lack the kind of experience with earning and spending money that more mature adults have (Weber & Chapman, 2005). Because many of the decisions under risk are attempting to study money decisions and the behavior of consumers and businesses, the lack of experience of the subjects used in the vast majority of experiments could bias results in profound ways. College students are normally less affluent than established working adults (Weber & Chapman, 2005). Further, college students may lack the maturity of working adults. Their tendency to engage in risky behaviors such as unprotected sex, drug use, and fast driving is known to be markedly different from those of average adults (Johnson et al., 2002). Given that decision making under risk and uncertainty are the very things being studied, this information and tendency to use primarily college students as subjects for assessment of risky and uncertain decisions should give researchers pause.

There are two further potential problems with the human subjects used by most researchers studying decision making. Most of the subjects used in decision experiments have come from the United States or Canada, though there are occasional studies from other cultures such as Japan (Sasaki & Kanachi, 2005) and Italy (Sacco et al., 2003). The use of subjects that mostly reside in the United States or Canada raises questions about the potential for bias arising from cultural issues. Without further research, there is no

way to know whether this is a problem or not. Finally, the overwhelming majority of subjects in decision making research are college students in the field of psychology. The study of such a narrow sector of the population creates suspicion about whether the behaviors observed are really representative of the population at large. Therefore, there are a number of potential problems in experimental design having to do with the human subjects. These are the narrow scope of age, education, area of college study, economic status, and culture. More research clearly needs to be done on subjects with a wider variety of ages, professions, education levels and cultures in order to determine whether past research is sound.

Other recent research concerning the validity of prospect theory has revolved around the effects of very low stakes on risk taking behavior. The *peanuts effect* is defined as the tendency to take risks when the stakes are very low, but risk aversion becomes markedly higher as the stakes increase (Weber & Chapman, 2005). To some degree, most people have probably experienced this effect to. You might find yourself having no problem throwing a couple of quarters into a slot machine at a casino. However, you may find yourself very hesitant to play a \$10 or \$20 hand at a blackjack table even though the odds of winning at blackjack are significantly greater than slots. This behavior can be thought of as a reversal of preference for risk taking based on the magnitude of the payouts. This effect is important because most studies on risk involve choices that do not have extreme consequences, while many real life choices involve substantial risks such as war, peace, or economic stability (Weber & Chapman, 2005).

Weber and Chapman (2005) explored the causes of the peanuts effect. Two experiments were conducted to determine whether the peanuts effect could be explained

by prospect theory, expected utility theory, regret theory, or a combination of those factors. The experiments conducted studied three factors that can affect decisions under risk. Decisions under risk can theoretically be explained by prospect theory. The factors studied in Weber and Chapman's experiments were (1) the magnitude difference between small-stakes gambles and large-stakes gambles, (2) the magnitude of the probabilities used in the gambles, and (3) the ratio between the probabilities in the gambles. Experiments contained gambles in the domains of both gains and losses and studied decisions with a high tendency towards the peanuts effect.

Results of the experiments showed a definite peanuts effect in decision making. While much of the peanuts effect can be explained by the tenets of prospect theory, some results were diametrically opposed to the theory. For example, one of the experiments showed that the peanuts effect was larger for larger probability magnitudes and for larger probability ratios. The second experiment further demonstrated that the peanuts effect could not be explained by any utility function that is consistent with either prospect theory or expected utility theory, since either theory prohibits utility functions that are dependent on the probability outcomes. In addition, the results showed that the subjects were slightly risk seeking in the domain of gains, which is incompatible with prospect theory's notion that decision makers are risk seeking for losses and risk averse in the domain of gains. This is illustrated by the concavity of the value function in the domain of gains and its convexity in the loss domain (Weber & Chapman, 2005).

The peanuts effect is fairly easy to understand psychologically because decision makers probably feel that they can afford to lose small stakes. It explains the propensity for certain kinds of gambles in casinos and a willingness to take other small risks that

may not seem rational from a probabilistic point of view. However, if the peanuts effect is incompatible with some tenets of prospect theory, what can explain it? Small stakes gambles are unlikely to carry high emotional affect, because a loss would not be very important to the decision maker. Therefore, there would not be an expectation of much regret or disappointment if the gamble is lost. Contrast this with larger stakes where regret and disappointment are likely to be pronounced. It is for these reasons that Weber and Chapman (2005) suggested that the peanuts effect is likely to be explained by regret, disappointment, or a combination of both. Also note that small purchases with low affect value are not subject to loss aversion (Ariely et al., 2005; Novemsky & Kahneman, 2005). Much of the peanuts effect can be explained by prospect theory, but the solution to this puzzle appears to be a combination of theories and not one single theory currently in existence. This important result may tend to suggest that the future of decision theory may involve combinations of existing theories.

Another mystery arises indirectly from this experiment. If people are risk seeking when the potential losses are small, but increasingly risk averse as the stakes increase (Weber & Chapman, 2005), how does one explain adolescents' risky behavior given the large magnitude of the potential negative consequences? This apparent paradox suggests that willingness to take risk may be dependent not just on the magnitude of the stakes and the emotional impact of the stimulus, but also on heuristics and biases that cause adolescents to seriously underestimate the true risks they are taking. This will be reexamined in the section on applications of prospect theory later in the paper.

One further note about the peanuts effect experiments is warranted. The result they obtained was the reverse of the results of the other experiments, and the authors

were unable to explain it. Weber and Chapman found that students were unwilling to take risks to avoid loss in the experiments that they conducted, which is the opposite of what they expected given all other research in this area. Weber and felt that this anomaly might be due to the fact that college students are not accustomed to spending the amounts of money used in one of the experiments. Their suggestion was that it would be interesting to repeat the experiment using adults who are accustomed to spending the amounts of money in question.

Finally, we examine a rare experiment regarding decision making that used Japanese students from the Sendai College of Medical Welfare as opposed to psychology students from the United States or Canada. Sasaki and Kanachi (2005) set out to repeat Kahneman and Tversky's results of the certainty and reflection effects in a single stage trial of choice. Then they tested whether these effects of prospect theory remained in multi-stage experiments. The authors also tested the students using standard psychological tests designed to determine whether people are risk prone or risk averse. The standard personality tests used to measure risk prone tendencies were adapted to the Japanese culture.

Sasaki and Kanachi (2005) set up a single choice trial that was equivalent to Kahneman and Tversky's 1979 landmark experiment which asked whether subjects preferred a small sure gain or a much lower probability of a significantly larger gain. Several versions of this question were used with varying magnitudes and probabilities of gains. Similar loss experiments were also performed. In a second experimental design, computers were used to allow participants to make choices multiple times with pretrial

information about the decisions and feedback about the results of the decisions. Finally, participants were given a personality test to determine the impulsivity of each participant.

The results of the experiment confirmed prospect theory's certainty and reflection effects in the single stage experimental design model. However, the certainty effect vanished in the multi-stage experiment, and the experiment's results resembled expected utility theory's predictions more closely than prospect theory's. Risk seeking choices were also generally correlated with males and with impulsivity, as determined by the personality tests (Sasaki & Kanachi, 2005).

It is interesting to note that Sasaki and Kanachi (2005) defined both of their experiments as decisions under uncertainty. However, based on the authors' descriptions of their experiments, both experimental designs were actually decisions under risk. This further demonstrates the confusion, even among researchers in the field, about the definitions of decision experiments and the intent of prospect theory and its rivals in describing behavior. Despite the confusion, the second experiment involved decisions under risk rather than under uncertainty, and it would therefore seem like a reasonable expectation that prospect theory would hold up in this experiment if the theory is a correct description of decision making under risk. Its failure to do so may lie in Sasaki and Kanachi's experimental design rather than a true failure of prospect theory. In the second experiment, subjects were given a description of the various options and were given a sheet of paper to help them recall the options during the experiment. There were eight different decisions, and each decision had a very complex range of responses. In practice it may have seemed tedious to subjects to constantly refer to the sheet of paper to remind them of the various probabilities and outcomes, and many students may therefore

have simply used the feedback to determine their future decisions. If so, the experiment would closely resemble Hertwig et al.'s (2004) experiment, which was a test of judgment under uncertainty. Recall that Hertwig, et al. posited that memory limitations could have contributed to the results of their experiment. This could also be true of Sasaki and Kanachi's work. For the reasons cited, there is no way to know for sure whether Sasaki and Kanachi's experiment was truly a test of decision under risk or uncertainty, even though it was *designed* as an experiment of decision under risk. Lacking this crucial information, the results cannot be interpreted with certainty either. Finally, prospect theory has been shown not to perform well in some cases where a choice contains many possible outcomes (Tversky & Kahneman, 1992). Tversky and Kahneman suggest cumulative prospect theory as an alternative model in this situation.

Despite the uncertainty about the nature of Sasaki and Kanachi's (2005) second experimental design, their experiment was still important in other aspects. For example, the authors' work is one of the only experiments concerning decision making that was performed in an Asian culture. Sasaki and Kanachi's first experiment constituted a first step in verifying the basic tenets of prospect theory across cultural boundaries. Furthermore, their personality tests and gender differentiation provide hints that further research may reveal significant differences in risky behavior based on gender and/or personality type.

An Alternative Model?

Perhaps one of the most radical recent challenges to prospect theory was proposed by González-Vallejo et al. (2003). Their study questioned prospect theory's value

function that separates positive outcomes from negative ones. Specifically, the authors claim that prospect theory does not explain individual differences of preference about risks, personality differences, or group behavior, and that Kahneman and Tversky's reflection effect cannot be demonstrated across different stimuli with any consistency. González-Vallejo et al. base these claims on several older works (Hershey and Schoemaker, 1980; Schneider and Lopes, 1986; Fagley & Miller, 1987, 1990) that the authors claim have demonstrated that the reflection and framing effects posited by prospect theory are either inconsistent or weaker than prospect theory predicts.

To replace prospect theory, González-Vallejo et al. (2003) suggested a mathematically complex stochastic model that they claimed can explain individual personality differences in decision making, individual preference differences, and group decision making. The authors claimed that their theory is a cognitive theory of choice, and that it accounts for differences in the value function between gains and losses without requiring two differently shaped pieces. Recall that prospect theory's value function is concave in the domain of gains and convex in the domain of losses.

While interesting, González-Vallejo et al.'s (2003) work raises many caution flags. The authors are claiming to explain multiple complex variables including wealth, risk propensity, many possible outcome choices, ranges of preference strength, and group decisions. Yet they attempted to test all the variables at once with a single experiment. The authors used only subjects who were tested and known to be at the far extremes of risk taking preferences. All of the subjects were extremely risk seeking or risk averse. Yet, the authors interpreted trends over the entire population of risk preferences using only the tails. Finally, the authors' use of Hershey and Schoemaker (1980) and Schneider

and Lopes (1986) to question the validity of prospect theory is suspect. Astonishingly, Daniel Kahneman and Amos Tversky (2000) cited these same papers multiple times in support of prospect theory in their landmark book. Fagley and Miller's (1987, 1990) papers are also suspect in their assertion that framing effects and the reflection effect do not always exist. While Fagley and Miller used an experimental design very similar to Kahneman and Tversky's (1981) study, the subjects used by Fagley and Miller were all sophisticated statistics students in an MBA program. Such subjects may well be able to calculate that the expected values for each choice were identical, and indeed, many students stated an explicit indifference to the choices. This is especially true given that the experiment was conducted in the statistics class itself, which may have made students more likely to make the expected value calculations before choosing.

There is also a problem with the way that González-Vallejo et al. (2003) attempted to demonstrate the validity of their model. In order to validate a model such as the one proposed by González-Vallejo et al., variables should have been tested individually in one experiment at a time and then carefully combined in other experiments to show that the model truly explains all of the variables and behaviors claimed.

Applications of Prospect Theory

Before 1980, most risk assessment work in economics was based on expected utility theory. However, in recent times, prospect theory has been increasingly replacing expected utility theory in this field (Mercer, 2005). The more interesting examples of recent uses of prospect theory may be found in the fields of psychology, sociology and

political science. The theory does not immediately come to mind in these fields, and at least in the case of political science, and the field's experts are resistant to using it (Mercer, 2005). It is applications of prospect theory in these fields that will therefore be explored in this paper.

Consider the earlier example about two adolescents considering engaging in unprotected sex. This is certainly a decision with extremely high emotional value. The reward is almost certain immediate pleasure, yet some of the potential consequences are devastating. Nevertheless, many adolescents do engage in this risky behavior (Johnson et al., 2002). Johnson et al. further state that adolescents take these risks because they are overly optimistic about the possibility of negative outcomes, and that their attitudes mimic those of adults who engage in similar risky behavior. If humans are loss averse, can this risky behavior be explained by prospect theory? The probable answer is intriguing. When dealing with uncertainty, humans tend to judge the probability of an event by a few known cases of what happened under similar circumstances rather than on correct statistical data, even when that data is well known. In other words, personal experience plays a bigger part in uncertain decisions than rational knowledge (Nisbett, Borgida, Crandall, & Reed, 1976). Therefore, if many of their friends are thought or known to be engaging in similar behavior without apparent consequences, it is possible that individuals contemplating risky sexual behavior severely underestimate the true probabilities of adverse consequences because they are underestimating what they perceive to be small probabilities of an adverse consequence as is consistent with prospect theory's weighting function. Interestingly, risky decisions are also based on the way people frame the outcomes in their minds (Johnson et al., 2002), an idea that also

conforms to prospect theory. Note that the example above describes decision under uncertainty rather than decision under risk. Therefore it may not align with all the tenets of prospect theory even if the theory is an accurate description of decision under risk. The problem posed is complex for many reasons, and no attempt is being made to fully explain the human behavior associated with it. Still, it makes an interesting example of a high affect decision and illustrates the tendency to severely underweight low probability events and to make decisions based on framing as suggested by prospect theory.

Loss aversion is perhaps the most important tenet of prospect theory and has some interesting implications about human nature and values (Jervis, 2004). Jervis also notes that it is clear from careful analysis of decisions under risk and uncertainty that loss aversion often does not optimize gain and often results in devastating consequences for those making loss averse decisions. Logic tells us not to “throw good money after bad,” (Jervis, 2004, p. 166), to avoid taking foolish risks in order to avoid a loss already realized, and to sell losing stocks and keep the winners. In fact, one would think that safeguards would have been put in place, at least by organizations such as businesses and nations to adjust for this irrational bias. Yet, prospect theory, indeed, human nature, tell us that people often do not behave in a rational manner (Jervis, 2004).

Yet, in international politics, loss aversion may in some cases actually lead to increased stability rather than decreased stability. Examples in political science include the relative stability and restraint shown by the United States and Russia during the Cold War, and the United States’s failure to support the rebels in East Germany in 1953. In these cases, the chance for gaining against an enemy regime was approached cautiously rather than recklessly, behavior consistent with prospect theory. On the other hand,

countries protecting what they feel to be an established “status quo,” or trying to recoup losses, sometimes behave in a less careful manner. Examples include the Cuban missile crisis and President Bush’s current policy of “preventive” war (Jervis, 2004).

Others claim that countries have indeed put safeguards in place to protect against loss aversion, and that loss aversion plays a smaller role in reality than prospect theory would suggest (Jervis, 2004). Still, an accurate application of prospect theory requires a priori knowledge of the status quo. This frame of reference may be determined by the existing state of affairs, the actor’s aspirations, or heuristics (Mercer, 2005). Since we often do not know the status quo of an actor, it is sometimes difficult or impossible to assess whether a decision maker views himself in the domain of gains or losses. Without this frame of reference, it is not sure whether behavior is loss averse or not. This is potentially the biggest reason for resistance to prospect theory in the arena of political science, though Mercer also comments that a resistance to psychology in general may be a factor.

Another fascinating application to prospect theory involves deterring and compelling behavior. Deterrence and compellence have obvious applications in international politics and war, as countries often use threats to get other countries to act or not to act. It also has applications in family relationships between parents and children. There are also societal applications in criminal behavior and the way in which countries attempt to control their citizens or subjects. Schaub (2004) examined deterrence and compellence in relation to prospect theory from the perspective of political science. However, the implications of the paper may rationally extend to the other applications stated above.

The conventional wisdom in political science has always said that deterring an adversary is easier than compelling him. Against this conventional wisdom, expected utility theory predicts that deterrence and compellence are equally expensive, and that an adversary would be equally likely to choose to comply or defy when stakes and costs are equal. On the other hand, prospect theory suggests a model that conforms to the conventional wisdom about the cost of deterrence and compellence. It may also be used in a practical way to predict actual political situations involving deterrence and compellence (Schaub, 2004). This is important, since expected utility theory predicts how people *should* behave, while prospect theory posits to explain how people *actually* behave. In most applications, it is far more important to know how an actor will behave than how he should behave (Mercer, 2005).

According to prospect theory, deterrence, the demand that an actor *not* do something that would be viewed as a gain to that actor, would be viewed in the realm of gains. Therefore, prospect theory posits that an adversary will be risk averse in this domain. Risk aversion would indicate that an adversary should comply with demands rather than risk the consequences. However, there is a paradox. If the deterrent threat is high, the certainty effect comes into play and causes the adversary to overestimate the probability of the deterrent threat being carried out. In the face of certain consequence if an action is taken, the adversary is likely to experience a preference reversal and view the deterrent threat as a loss instead of a the gain of the possible action that is being considered. Therefore, when the deterrent threat is too high, an adversary may actually risk defying the threat in order to protect himself from a sure loss (Schaub, 2004).

Likewise, compellence, the demand that an adversary carry out an action, would be viewed by prospect theory as a loss. Therefore, since prospect theory predicts risk seeking behavior in the domain of losses, the theory would predict that an adversary will resist a compellent threat and take the gamble of the compellence threat in order to avoid the loss. There is a paradox in this case as well. If the probability of the compellent threat is high, the certainty effect again comes into play, and the domain changes from loss to gain. In this case, the adversary is likely to comply and to view the cost of compliance as a sort of insurance premium against loss (Schaub, 2004).

Schaub (2004) goes on to use experiments to measure the actual cost of potential deterrence and compellence situations. Schaub's results show that deterrence is indeed cheaper than compellence, and that its cost may be as much as slightly less than half as much as compellence or as little as one tenth as much. Therefore, according to these experiments and analysis, prospect theory can give specific information about how to construct deterrence and compellence threats as well as help compute the cost of each. However, there is a reason for caution in applying prospect theory in this way. Recall that prospect theory requires a priori knowledge of the adversary's reference point, also called the status quo, in order to be certain whether the adversary will view a particular act as a potential gain or as a loss (Mercer, 2005). While Schaub directly acknowledges this weakness in applying prospect theory to deterrence and compellence situations, he may be underestimating its severity since the theory cannot be used in practice without such a priori knowledge. This crucial information may be difficult or impossible to ascertain for many real problems. In addition, the complexity of real political scenarios would probably prohibit the actual computation of costs advocated by Schaub.

Finally, the unprecedented events of 9/11 offer an opportunity to see how adverse global circumstances may affect decision making. Sacco et al. (2003) performed experiments on Italian college students in order to compare Kahneman and Tversky's (1979) previous results on decision under risk to decisions made shortly after the 2001 terrorist attacks. Kahneman and Tversky (1979) performed experiments to determine whether people prefer a certain small gain or a lower probability of a larger gain. This experiment was repeated after repurposing to account for inflation and for the currency used in Italy. Kahneman and Tversky's experiment in the loss domain was also repeated under similar circumstances. Adult Italian college students were asked these questions 1 month and 6 months after the terror attacks. The results showed that people lost the tendency to overestimate small probabilities in the domain of gains, preferring sure gains instead. In other words, the certainty effect was diminished. The tendency to take risks in the loss domain, loss aversion, was also lost, suggesting that people preferred sure outcomes to any kind of risk for both gains and losses. In general, the subjects tended to make conservative decisions 1 month after 9/11. Interestingly, the experiment conducted 6 months after 9/11 showed that the loss of the certainty effect in the domain of gains was unchanged compared to the experiment 1 month after 9/11, but the preference to take risks in the loss domain was being slowly recovered. Subjects did continue to show decision making biases dependent on the reference point, and to treat gains and losses differently. Both of these results are consistent with the tenets of prospect theory. However, the gain and loss weighting curve had a different shape after 9/11 when compared to prospect theory's model posited in 1979. Besides the loss of the certainty effect in the gain domain, the reflection effect was lost. The loss function didn't mirror

the gain function but looked similar to it. In contrast to prospect theory, people not only lost their trust in chance in the domain of gains after 9/11, but they also preferred to take sure losses in order to avoid possible greater ones (Sacco et al., 2003).

The results of this experiment are reminders of the effect that emotion has on decisions under risk (Rottenstreich & Hsee, 2001). However, Rottenstreich and Hsee's work showed that the certainty effect is actually more pronounced when emotion is involved in decision, in stark contrast to Sacco et al.'s (2003) results. There is a critical difference between the two experiments, however. While the 9/11 terror attacks are likely to have evoked emotional response in general, Rottenstreich & Hsee's experiments dealt with decisions that in themselves were designed to produce emotion. The results of Sacco et al.'s 9/11 experiments suggest that general trauma or adversity may have profound effects on risk taking tendencies, a finding consistent happiness research (Myers, 1992). A few cautions are warranted when interpreting the results of this experiment. The terror attacks occurred not in Italy but in the United States. While there was undoubtedly concern about the attacks on a global basis, the actual emotional effects on those so far from the events are difficult to ascertain. Further, no causal relationships between the terror attacks of 9/11 and the results were determined definitively. The results seen could possibly be a secondary effect of 9/11 rather than a primary one. It is not possible even to speculate on the nature of such an effect. Finally, the experiments were performed only on college students, and the group of subjects tested in the experiments one month after 9/11 did not overlap with the subjects used in the experiments six months after the attacks. Therefore, the difference seen between the two experiments could possibly be a result of differences between the preferences of the two groups of people rather than a

primary effect of the time since the attacks. Furthermore, the college students may not accurately represent the general population's response to the attacks. Even so, the results of the experiment fit in well with research from hedonic psychology which was discussed in the Breadth section of this paper. Except in the case of personal trauma, humans tend to have strong initial reactions to adverse events and then gradually return to a normal state (Myers, 1992). Note that 9/11 did not inflict personal trauma on the Italian subjects due to lack of personal involvement in the horrific events, though they may well have been experiences adverse conditions. It is therefore difficult to assess what actually was affecting any changes in decision making patterns. While the subjects had begun displaying risk taking patterns more consistent with past research results 6 months after the attacks, the results were still not completely consistent. Even so, Sacco et al. asserted that it is not surprising that subjects had not totally reverted back to a normal state of response to risk after 6 months due to global instability and fear of future attacks in the months following 9/11. Future work may shed additional light on the results.

Conclusions

Recent examinations of prospect theory and experiments concerning decisions under risk have shown that prospect theory holds up fairly well to scrutiny. However, no current theory perfectly describes something as complex as human decision making. Research has shown that many things affect decisions. These include but are not limited to emotion (Rottenstreich & Hsee, 2001), trauma (Sacco et al., 2003), the magnitude of the outcomes (Weber & Chapman, 2005), the number of trials (Sasaki & Kanachi, 2005), and personality (Sasaki & Kanachi, 2005; Wakker, 2004). Future research in decision

making and neurology will no doubt continue to result in improvements in the understanding of decision making behaviors, further improvements in the theories that attempt to describe them, and applications that use the theories in real problems.

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APPLICATION DEMONSTRATION

APPLICATION TABLE OF CONTENTS

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APPLICATION DEMONSTRATION

Introduction

In the last section of this paper, Kahneman & Tversky's prospect theory was examined and analyzed in depth. Strengths and weaknesses of the theory were discussed in light of recent research papers found in refereed journals. This work complemented the breadth section where expected utility theory, regret theory, and prospect theory were compared and contrasted. As an application to the previous research on human decision making, a seminar was conducted for eighth grade students at Roy Cloud Elementary School in Redwood City, California. The seminar was highly interactive, and students were then asked to demonstrate their learning by writing a short essay about risky behavior among American teenagers. This paper describes the usefulness of the seminar, seminar participants, content, how the seminar was conducted, and the results of student participation. A comparison will also be made of research results from prospect theory and aggregate responses that students gave to classic research questions during the seminar.

Seminar Participants

The material contained in the previous sections of this paper is useful in that an accurate understanding of the underlying motivations of human decision making has the possibility of helping people to recognize and change harmful decision patterns. Several individuals working in various professions have requested copies of the breadth and depth sections of this paper and have found the paper useful in their work with people and in understanding their own decisions. However, while most professional adults have

the capability of reading a paper such as this, the material and reading level are too difficult for the vast majority of middle school students. Further, teens are known to engage in risky behavior (Johnson, McCaul, & Klein, 2002), and are therefore in greater need of understanding what motivates their decisions. A discussion with a senior teacher in the Redwood City School District revealed that no material about decision making similar to the topics discussed in this paper is taught in the district at any grade level (S. Boulliane, personal communication, July 14, 2005). For this reason, eighth grade students were chosen for the seminar with the hope that a better understanding of human decision making will enable these teens to make better decisions in the future.

The seminar lasted 2 hours and was conducted at Roy Cloud Elementary School, Redwood City School District, in Redwood City, California on August 26, 2005. The school principal was aware of the seminar in advance and approved the material to be presented. Roy Cloud teaches grades Kindergarten through eighth grade, where grades six, seven and eight are considered to be middle school.

The seminar was attended by 30 advanced English literature students who had qualified for the course by scoring either proficient or advanced in English on recent standardized tests given in California. Therefore, the students attending the seminar were more advanced than average eighth grade students. This particular class was chosen because the reading, comprehension, writing, and critical thinking skills of these students were the highest in the Roy Cloud eighth grade, and the course instructor felt that the material might be too difficult for some of the other eighth grade students. This assumption was verified by attempting to give the same seminar to the average English class on the same day as the advanced. Many of the students in the average class had

trouble even comprehending basic questions and information about decision preferences and trends. The seminar had to be simplified and less material was covered in the 2 hour allotment. Therefore, this paper covers only the seminar given to the advanced class. Stephanie Boulliane, who is the regular teacher for the English class, also attended and participated in the seminar discussion.

Method of Presentation

The seminar was divided into two parts. In the first part, a handout with adaptations of classic research questions on decision making and judgment was given to each student. Students answered the questions and then kept the handout. A copy of the handout is contained in Appendix A. All questions were quoted or adapted from Plous, 1993. Each question was discussed with the group, a show of hands was taken for some questions in order to facilitate discussion about human behavior, and various viewpoints were discussed. For each question, an underlying tenet of prospect theory or a specific type of error in judgment was then explained to students. The summary data from student responses was then compared to known research and discussed with the class. This part of the seminar was highly interactive, and student participation and interest was excellent. The second part of the seminar was a general description of the main tenets of prospect theory, with an emphasis on loss aversion. Specific examples were discussed that were relatable to teenage culture and knowledge. These will be described in the next section.

Seminar Content

In addition to a detailed discussion of each of the questions in Appendix A, the basic tenets of prospect theory were discussed. These are detailed below.

Basic Tenets of Prospect Theory

Recall that prospect theory operates on several basic tenets. Due to the complexity of some concepts, not all of the main tenets were discussed during the seminar, and those that were discussed were simplified for the teenage audience. The following tenets of prospect theory were discussed during the seminar, some directly and others only through examples appropriate for the audience:

1. People look at gains and losses relative to the starting place of the decision maker. In other words, \$25 will be worth less to an adult with a full time job than it will be to a teen who is not working.
2. When people are given a choice between a sure gain or a bigger gain that is less likely, people tend to avoid risk and choose the sure thing. In this case, people look at the risky choice as a possible loss rather than a possible gain because if they lose the gamble they focus on what they could have had if they had chosen the sure thing rather than what they would have won if the gamble had gone their way. However, people will take risks to avoid losses. In fact, they will often take large and foolish risks to avoid a loss. Both of these traits are examples of loss aversion.

3. People tend to think that very likely things are even more likely than they are, and that unlikely things are even more unlikely than they are (the certainty effect).
4. People tend to value something more once they possess it than before. In other words, people are willing to pay less for an item that they want to buy than they are willing to accept to sell the same item once they own it (the endowment effect).
5. The wording of questions effect the way people respond to them. People tend to give inconsistent responses to the same question when the wording is changed slightly to give it a positive or negative slant (framing and preference reversal).

To illustrate these tenets, examples from historical and hypothetical events were used. One of these was President Clinton's affair with Monica Lewinsky. Miss Boulliane pointed out to students how President Clinton lied multiple times in various situations in order to avoid having his affair exposed. Students were asked what the probable consequences would have been if President Clinton had admitted the affair the first time he was asked. The majority of students felt that the consequences would have been limited to a short period of time where the American public would have been "mad" at him. Most students also agreed that the lies compounded the problem and that the consequences for President Clinton were far greater as result. When the discussion concluded, students were told how this example related to prospect theory's tenet of loss aversion. In order to avoid a small loss, President Clinton took bigger and bigger risks as

he lied to the public and eventually lied under oath to Congress and to a Grand Jury. These risks almost certainly resulted in much greater losses than the President would otherwise have incurred, including impeachment and loss of reputation.

A second example that was discussed to illustrate loss aversion was the hypothetical event of a student who cheats on a test. Students participated in a discussion about the probable consequences of cheating if the student told the truth about it the first time the teacher asked about it versus insisting that the cheating did not happen until the teacher revealed that there was absolute proof of what happened. The example was given in progressive steps and temptation and consequences were discussed at each step. The students agreed that there would be a large temptation to lie, yet they also admitted that the punishment would be worse the more the student lied about the cheating. As in the example of President Clinton's affair with Monica Lewinsky, this example illustrates loss aversion and the propensity for people to take bigger and bigger risks when faced with a loss.

The concept of framing effects was explained to students and was illustrated by two sets of questions designed to show them how a positive or negative "spin" on a question can effect a person's gut level reaction. Immediately afterward, students were asked two questions. First, students were asked to raise their hands if they thought that the United States should pull out of Iraq. Virtually all the students agreed that this should happen. Students were then asked whether the United States military should abandon the Iraqis. This time only about 10 students raised their hands. When it was pointed out that the two questions were identical except for framing, students were surprised that they had been so inconsistent. While the answers students gave were consistent with prospect

theory, it seemed surprising that framing would have such a dramatic effect immediately after the concept was explained. As prospect theory predicts, very few students initially recognized that the questions were both asking the same thing.

At the end of the seminar, students were given an assignment to write about their perceptions of why teens engage in fast driving, drug and alcohol abuse, and unprotected sex. Since one of the major causes of these behaviors is peer pressure of one sort or another (Johnson, McCaul, & Klein, 2002), an interesting experiment was conducted to lead into the discussion about decisions that are harmful to the decision maker.

Four students were sent out of the room on an errand for the teacher at the beginning of the seminar while the handouts were being distributed. While they were gone, four lines were drawn on the board. Lines one and four had unique lengths, and lines two and three, which were next to each other, had equal lengths. It was quite obvious which two lines had equal lengths. The students remaining in the room were told that they should all raise their hands when asked if lines one and four were equal. The seminar began when the missing students returned to the class and everyone had finished answering the questions on the handouts. Towards the end of the seminar students were asked to look at the lines on the board. When asked which lines were equal, two of the four students who had been sent out of class gave the same incorrect answer as the rest of the class. Two of the students answered the question correctly. This experiment was similar to several classic experiments done in experimental settings, and the results obtained during the seminar were also similar (Asch, 1956; Plous, 1993).

Finally, several harmful, risky behaviors that teens are prone to were discussed from the standpoint of prospect theory. Students were asked to discuss why teens tend to

engage in fast driving, drug and alcohol abuse, and unprotected sex. Students cited the desire to fit in with friends, the fear of looking “uncool,” and the belief that “nothing bad will happen to me” as reasons for this behavior among teens. Interestingly, these reasons fit in well with prospect theory. The first two are really fears of loss. The desire to fit in is fear that the person will not fit in if they do not go along with the group, and the fear of looking “uncool” is a fear of losing social reputation. Both of these reasons are consistent with prospect theory’s loss aversion. The idea that “it won’t happen to me” is consistent with prospect theory’s certainty effect because the consequence of the behavior is perceived as small, and then small probabilities tend to be further underweighted in people’s minds.

Results and Interaction

Among the most interesting aspects of the seminar were the aggregate responses to some of the questions on the handout. The classic questions and research of all questions described in this section are based upon work done by Daniel Kahneman and Amos Tversky that was published in 1979. The original intent of the handout was to provide students with something tangible to help them think about the material and to facilitate discussion. Students were given time before the seminar formally began to answer all the questions on the handout, but informal tallies were only taken of some of the questions during the seminar discussion. The students were not asked to turn in the handouts. These results are discussed below. All questions can be found in Appendix A, and will be referred to according to their numbering on the handout. The correct answers to the questions are shown in Appendix A in italics. Questions that deal with preference

only have no answers next to them. While 30 students were present at the seminar, all tallies consisted of a total of 29 students who voted. One student helped count votes because she came in late and was unable to complete the questionnaire. The results for the questions for which responses were recorded are given in Table 1.

Table 1
Student Preferences

Question Number	Number of Students preferring choice a.	Percentage preferring choice a.	Number of Students preferring choice b.	Percentage preferring choice b.
2	7	24%	22	76%
8	22	76%	7	24%
9	5	17%	24	83%
10	13	45%	16	55%
11	19	66%	10	34%

Question 2 from the questionnaire was:

If you had to choose one of the following options, which one would you choose?

- a. A 100% chance of losing \$25.
- b. A 25% chance of losing \$100, and a 75% chance of losing nothing.

Question 11 from the questionnaire was:

You have another choice that you have to make. Please choose one of these:

- a. A sure loss of \$25
- b. A 75% chance of losing \$40, and a 25% of losing nothing.

Question 2 was a choice between (a) a sure loss, and (b) a small chance of losing a much larger amount and a large chance of losing nothing. Consistent with prospect theory, only 7 students chose the sure loss, while 22 students opted to gamble with the hope of losing nothing. Question 11 was similar to Question 2 except that the chance of losing the larger amount was 75% and instead of the 25% and the amount that would be lost in the gamble was \$40 instead of \$100. It would be logical in this case to expect more students to choose the sure loss in this case because of the high probability of losing more money and because the expected loss for the gamble in Question 11 was \$30 instead of the \$25 expected loss for Question 2. It is not surprising that the number of students opting for the sure loss rose from 7 students to 19 students. Perhaps what is surprising is that 10 students (34%) still opted for the gamble in Question 11 even with the high probability of losing more money and the higher expected loss. This result underlines loss aversion. These phenomena were explained to students, and many seemed surprised by their own choices.

Question 9 from the questionnaire was:

If you had to choose between one of the following choices, which alternative would you choose?

- a. A sure loss of \$500
- b. A 25% chance of losing \$2000 and a 75% chance of winning nothing.

Question 10 from the questionnaire was:

Again, suppose you had to choose between one of these alternatives. Which one would you select?

- a. A sure loss of \$500
- b. A 75% chance of losing \$700 and a 25% chance of losing nothing.

Questions 9 and 10 were identical to questions 2 and 11 except that the amounts at risk were much larger in Questions 9 and 10. In this case only 5 students chose the sure loss when the probability of greater loss was 25%, while 13 students chose the sure loss when the probability of greater loss was 75%. Notice that even with a 75% probability of losing more money, 16 students chose to gamble when the stakes were higher, versus 11 students who chose to take the risk when the question was identical but with lower stakes. This also is consistent with prospect theory, and has to do with the point of reference. Five hundred dollars is a huge amount of money to these students, so most preferred to gamble losing \$700 rather than lose \$500 for sure, even when the probability of losing \$700 was as high as 75%.

Question 8 from the questionnaire was:

If you had to choose between one of the following choices, which alternative would you choose?

- a. A sure gain of \$45
- b. A 25% chance of winning \$200 and a 75% chance of winning nothing.

Question 8 had to do with preference in the domain of gains rather than losses. As prospect theory predicts, 22 students (76%) preferred the sure gain of \$45 over a 25% chance of winning \$200. Only 7 students would choose to gamble in the domain of gains, even with low stakes. Notice that the student responses for Question 2 and Question 8 are exact opposites, with 7 students preferring to avoid risk in Question 2 and 22 students preferring to avoid risk in Question 8. This is interesting since the stakes are similar in each question, and the major difference is that Question 2 is in the domain of losses while Question 8 is in the domain of gains.

While the other questions were discussed in detail during the seminar, student responses were not polled because the other questions tested various types of judgment errors rather than any theory of decision under risk. Even so, the discussion indicated that in almost all cases the students displayed the various types of judgment errors and biases typically found in the literature. These included classic errors concerning simple probabilities (Questions 1 and 12), and failure to identify a random pattern versus a non-random pattern (Question 15), and a tendency to think something is more probable because it evokes a greater emotional response (Questions 4 and 5). Question 6 showed a strong *anchoring bias*, which is the tendency to be unduly influenced by the base rate given, in this case the thickness of a single sheet of paper (Plous, 1993). However, the biggest error that students showed was a tendency to infer information that wasn't given, and to add detail that could not logically be added given available information. Students did this repeatedly and severely. The judgment error questions were asked in order to add breadth to the topic and to keep students interested. A 2 hour lecture on the finer points of expected utility theory and prospect theory may have been put students to sleep rather than taught them how to make better decisions.

Conclusions

The seminar was extremely well received (personal communication, S. Boulliane, 8/26/2005). Students seemed engaged throughout the 2 hours, and actively participated in all parts of the class. The results of the risk preference questions were striking in that each result strongly supported prospect theory's main tenet of loss aversion. Most students also indicated that they found the seminar useful. Since the vast majority of

decision analysis research has been done using subjects who were college students (Trepel, Fox, & Poldrack, 2005), it would be a fascinating and useful study to do additional research with teenagers, especially given their propensity to engage in risky behavior. In the meantime, it would also be interesting to determine whether seminars such as this one would help teenagers to change their thinking about risky behavior through a better understanding of the human motivations that drive decision making when risk is involved. It is interesting to note that responses tallied in the average English class seminar, though not discussed in this essay, were as consistent with prospect theory as those obtained in the advanced class. Though the sample size was small and the experimental design was far from perfect, the responses to classic research questions obtained during these two seminars indicate that middle school students may indeed behave according to the tenets of prospect theory.

APPENDIX A

1. Ashley is 13 years old. She has always been interested in how her school operates and has thought about running for student government. She also talks about getting a job in the summer working for her father. Which of the following is more likely?
 - a. Ashley got a job working for her father for the summer.
 - b. Ashley got a job working for father for the summer and ran for student government in the fall.

Answer: a

2. If you had to choose one of the following options, which one would you choose?
 - a. A 100% chance of losing \$25.
 - b. A 25% chance of losing \$100, and a 75% chance of losing nothing
3. Compared to other students of your gender and age, what are the chances that the following events will happen to you? (Check the answer that comes closest to your opinion for each event.)

- a. Will develop a drinking problem:

- | | |
|------------------------|--------------------------|
| 60%+ more likely | <input type="checkbox"/> |
| 40% more likely | <input type="checkbox"/> |
| 20% more likely | <input type="checkbox"/> |
| No more or less likely | <input type="checkbox"/> |
| 20% less likely | <input type="checkbox"/> |
| 40% less likely | <input type="checkbox"/> |
| 60%+ less likely | <input type="checkbox"/> |

- b. Will someday own your own home:

- | | |
|------------------------|--------------------------|
| 60%+ more likely | <input type="checkbox"/> |
| 40% more likely | <input type="checkbox"/> |
| 20% more likely | <input type="checkbox"/> |
| No more or less likely | <input type="checkbox"/> |
| 20% less likely | <input type="checkbox"/> |
| 40% less likely | <input type="checkbox"/> |
| 60%+ less likely | <input type="checkbox"/> |

c. Will have a heart attack before age 40:

- 60%+ more likely
- 40% more likely
- 20% more likely
- No more or less likely
- 20% less likely
- 40% less likely
- 60%+ less likely

4. Which causes more deaths in the United States each year?

- a. Shark attacks
- b. Falling airplane parts

Answer: b

5. For each pair, circle the cause of death that is most common in the United States each year:

Diabetes or Homicide *Answer: Diabetes*

Tornados or Lightning strikes *Answer: Lightning strikes*

Car Accidents or Stomach cancer *Answer: Stomach cancer*

6. Suppose that a regular piece of paper is folded in half. It is then folded in half again, and again, and again. After 100 folds, how thick will it be?

I think it will be _____ in. thick after 100 folds

I am 90% sure that the correct answer lies between _____ in. and _____ in.

Answer: 1.27×10^{23} kilometers

7. Memory is like a storage chest in the brain into which we put material and from which we can take material later when we need it. Once in a while something gets lost from the “chest,” and then we say we have forgotten.

Do you think this is a reasonable description of how memory works? _____

Answer: No

8. If you had to choose between one of the following choices, which alternative would you choose?
- a. A sure gain of \$45
 - b. A 25% chance of winning \$200 and a 75% chance of winning nothing.
9. Again, suppose you had to choose between one of these alternatives. Which one would you select?
- a. A sure loss of \$500
 - b. A 25% chance of losing \$2000 and a 75% chance of losing nothing
10. You have another choice that you have to make. Please choose one of these:
- a. A sure loss of \$500
 - b. A 75% chance of losing \$700, and a 25% of losing nothing
11. One more choice. Please select one of the following alternatives.
- a. A sure loss of \$25.
 - b. A 75% chance of losing \$40 and a 25% chance of losing nothing.
12. Suppose a “fair” coin (a coin that has an equal chance of landing on heads or tails when it is flipped) is tossed 4 times. Each time it lands on heads. You must bet \$20 on what you think the next flip will land on. What would you choose?
- a. Heads
 - b. Tails
 - c. No preference

Answer: There should be no preference since tosses are independent

13. Does acting like you are happy make you feel happier?
- a. Yes
 - b. No

Answer: Yes

14. Does voting for a certain person for student body president change your opinion about whether that person will win the election?

Answer: It does for most people

15. Which of the following sequences of ones and zeros do you think is more likely to have been generated randomly?
- 101110000101100011101
 - 101010001101010011101

Answer: b.

16. Suppose there are four cards and each one has a number on one side and a letter on the other. One of your friends tells you: “If a card has a vowel on one side, then it has an even number on the other side.” Which of the cards would you need to turn over in order to know for sure whether the person is telling the truth or lying?

CARD 1 HAS A CAPITAL E ON THE SIDE YOU CAN SEE

CARD 2 HAS A CAPITAL K ON THE SIDE YOU CAN SEE

CARD 3 HAS A “4” ON THE SIDE YOU CAN SEE

CARD 4 HAS A “7” ON THE SIDE YOU CAN SEE

All of the questions are quoted or adapted from

Plous, S. (1993). *The Psychology of Judgment and Decision Making*, New York: McGraw Hill Publishers, pp. 1–12, (Questions 1, 3–7, 12–16) and

Kahneman, D., & Tversky, A. (1979). Prospect Theory: An analysis of decision under risk. *Econometrica*, 47, 263–291. In Kahneman, D., & Tversky, A. (2000). (Eds.), *Choices, Values and Frames*, Cambridge University Press, Cambridge, UK, 2000, Chapter 1. (Questions 2, 8, 9, 10, 11)

Questions 3–7 are directly quoted. The remaining questions were adapted.

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