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Risky Choice Decisions from a Tri-Reference Point Perspective

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Masters of Science Student
Experimental Psychology

Abstract

Decision theories, such as Prospect Theory, have long made use of reference points. Tri-Reference Point Theory, in contrast to other theories, proposes more than a single point of reference. The three reference points—minimum requirement (MR), status quo (SQ), and goals (G)—were manipulated between gambles in the present study. As part of their participation, 119 undergraduate students from a large Midwestern university were asked to choose between two gambles and then rate the importance of each of three reference points manipulated in the study. A series of logistic regressions were used to determine if rated importance of a reference point predicted the likelihood of choosing a specific gamble that would allow them to reach that reference point. Findings from this study imply that multiple reference points should be considered in future research of human decision making.

Keywords: tri-reference point theory, decision making, binary choice, risk

Introduction

Decisions under risk were once guided by the belief that choices were made by selecting the larger of the products from multiplying probability and payout (Friedman & Savage, 1952). Risk, in this context, is defined as the option with the more variable payout (i.e., the option with the lowest percentage chance of winning). Kahneman and Tversky (1979) argued that this model of decision making does not account for all behaviors that occur in the domain of risky decision making and proposed prospect theory (PT) to better explain these deviations. Risk sensitivity theory (RST), from optimal foraging theory, attempts to explain choice behavior in reference to a minimum survival requirement in which an organism will take on greater risk to avoid starvation (e.g.,
Caraco, Martindale, & Whittam, 1980; MacArthur & Pianka, 1966; Stephens & Krebs, 1986). Other researchers have also proposed a social comparison point of reference to elicit risk preference, wherein people express a risk preference in an effort to outperform competitors (e.g., Festinger, 1954; Hill & Buss, 2010). However, much of this previous work focused on a single point of reference involved in evaluating decision choices.

More recently, a theory has been proposed that incorporates all three of these reference points to predict risk preference (Wang & Johnson, 2012). This tri-reference point (TRP) theory of decisions under risk claims that all three of these reference points—MR, SQ, and G—influence one’s preference for risk. In the context of this theory, MR may be important for predicting risk preference when the decision maker is at risk of falling below this level. However, with the absence of this possibility of starvation (or bankruptcy, etc.), risk preference may still be higher than would be predicted by RST or PT. TRP theory attempts to explain this phenomenon by incorporating these other possible reference points that have been shown in previous research to predict risky behavior (Wang & Johnson, 2012).

In general, people tend to prefer options that are certain or near certain when framed as gains, and prefer options that lack certainty when framed as losses (Kahneman & Tversky, 1979). That is, people prefer the sure thing when it means they can earn money, but prefer the choice that gives a chance not to lose money. This occurs even if this variable option runs the risk of a much greater loss than the more certain option. Wang and Johnson (2012) suggest that the importance of the three reference points may provide more insight into choice behavior. The purpose of this study is to evaluate the predictive ability of rated importance of each of the reference points—MR, SQ, and G—on risk preference. It was hypothesized that reference point importance would be a statistically significant predictor of risk preference when the riskier gamble was the only option that allowed that reference point to be reached. However, if the reference point was rated important and can be attained by both gambles, rated importance should not predict the choice of the risky gamble.

Method

Participants

Data were collected from 119 undergraduate students from a large Midwestern university. Participants consisted of 69 females and 50 males and had an average age of 19.0 years (SD=1.88). Participation in the study was for partial fulfillment of course credit. Participants were also provided alternative assignment options that could be completed in place of research participation. Due to the nature of data collection, further demographic information was not acquired from the participants. The university population was approximately 77% White, 6% Hispanic, 4% Black, 1% Asian, and 12% other or unknown ethnicity; 52% of the undergraduate student population was male.

Materials and Procedure

Eight decision tasks (DTs; singular DT) were created (adapted from Cokely & Kelly, 2009; see Appendix A for exact tasks; see Table 1 for a summary of tasks) each with a 7-point Likert scale to rate the importance of MR, SQ, and G. These DTs varied the MR amount, SQ amount, and G
amount for each set of gambles. The expected value (EV, % chance of winning * win amount – cost to play) of the two options on each task were equivalent, and remained the same between tasks. These DTs were created in an effort to elicit risk taking behavior by varying the ability of each set of gambles to reach the G amount (SQ – cost to play + payout amount), while allowing both gambles to reach MR and SQ in every task.

<table>
<thead>
<tr>
<th>DT</th>
<th>MR</th>
<th>SQ</th>
<th>G</th>
<th>EV</th>
<th>Cost A</th>
<th>MaxA</th>
<th>Cost B</th>
<th>MaxB</th>
<th>Beat G</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$100</td>
<td>$50</td>
<td>$435</td>
<td>$20</td>
<td>$200</td>
<td>$25</td>
<td>$450</td>
<td>Both</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>$200</td>
<td>$200</td>
<td>$150</td>
<td>$200</td>
<td>$200</td>
<td>$25</td>
<td>$400</td>
<td>Both</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>$200</td>
<td>$235</td>
<td>$150</td>
<td>$200</td>
<td>$200</td>
<td>$25</td>
<td>$450</td>
<td>Both</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>$200</td>
<td>$235</td>
<td>$500</td>
<td>$200</td>
<td>$100</td>
<td>$25</td>
<td>$450</td>
<td>Both</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>$300</td>
<td>$320</td>
<td>$415</td>
<td>$200</td>
<td>$200</td>
<td>$25</td>
<td>$450</td>
<td>Both</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>$400</td>
<td>$235</td>
<td>$415</td>
<td>$200</td>
<td>$250</td>
<td>$25</td>
<td>$450</td>
<td>Both</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>$200</td>
<td>$320</td>
<td>$150</td>
<td>$200</td>
<td>$200</td>
<td>$25</td>
<td>$250</td>
<td>$300</td>
<td>$600</td>
</tr>
<tr>
<td>8</td>
<td>$300</td>
<td>$300</td>
<td>$500</td>
<td>$200</td>
<td>$250</td>
<td>$25</td>
<td>$300</td>
<td>$600</td>
<td>B</td>
</tr>
</tbody>
</table>

**Table 1.** Summary of decision tasks, including MR, SQ, G, EV of both options, cost to select Gamble A (Cost A), maximum payout of Gamble A (MaxA), cost to select Gamble B (Cost B), maximum payout of Gamble B (MaxB), and which gamble allows the possibility of exceeding G (Beat G).

Participants were recruited to complete several studies that, in total, required approximately 45 minutes to complete. Due to the numerous studies being conducted simultaneously, verbal instruction was not provided. Instead, participants were given a typed page that provided instructions for completing the study, told them that the highest scores would be placed in a raffle for a prize, and asked for a signature if they consented. Deception was used, in the form of the raffle, to prompt participants to take the study seriously.

The present study presented participants with four of eight possible binary DTs. The four DTs were randomly assigned to one of two possible conditions, each containing four tasks. Because the task was presented in paper-and-pencil format, participants in a given condition completed the tasks in the same order. Ideally, had these tasks been presented in electronic format, the order of the tasks would be randomized to reduce the probability of order effects. These DTs presented two gambles (i.e., Gamble A and Gamble B) each with varied levels of uncertainty and manipulations to status quo (i.e., beginning balance to place bets), minimum requirement (i.e., the winnings required to move on to the next round), and gain level (framed as competitors’ average winnings). Participants were instructed to select their preferred gamble and then rate the importance for each of the three reference points, on a 7-point Likert scale, as it pertained to their preference. At the conclusion of the study, participants read a debriefing form that outlined the purpose of the study and were asked to provide an email address if they wished to be entered into the (fictitious) raffle. This page with identifying information was then shredded to protect the anonymity of the participants.

**Results**

Data were analyzed using a series of logistic regressions in which each Likert scale variable (MR, SQ, and G) was regressed onto risk preference (choice of riskier gamble coded as 1, choice of less risky gamble coded as 0). A separate regression was performed for each of the eight DTs and included all three of the reference point importance ratings as predictors. Table 2 presents the results of the logistic regression and includes the Wald $\chi^2$, log-odds ratios, and p-values for each of the predictors. For DTs 1, 3, 4, and 7, none of the importance ratings
were significant predictors of risk preference (all ps > .10). The rated importance of G was a significant predictor of risk preference for DTs 2, 5, and 8, predicting greater risk preference for an increase in rated importance. The rated importance of SQ was a significant predictor of risk in DT 6.

Table 2. Wald χ2 and log-odds ratios for each predictor and Nagelkerke R2 for each decision task. *denotes statistical significance at the p < .05 level; **denotes statistical significance at the p < .01 level.

<table>
<thead>
<tr>
<th>MR</th>
<th>SQ</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>χ2(3)</td>
<td>p value</td>
<td>χ2(3)</td>
</tr>
<tr>
<td>DT 1</td>
<td>0.98(.12)</td>
<td>0.323</td>
</tr>
<tr>
<td>DT 2</td>
<td>4.13(.16)</td>
<td>0.512</td>
</tr>
<tr>
<td>DT 3</td>
<td>2.00(.29)</td>
<td>0.157</td>
</tr>
<tr>
<td>DT 4</td>
<td>1.23(.19)</td>
<td>0.267</td>
</tr>
<tr>
<td>DT 5</td>
<td>1.23(.22)</td>
<td>0.272</td>
</tr>
<tr>
<td>DT 6</td>
<td>0.32(.15)</td>
<td>0.572</td>
</tr>
<tr>
<td>DT 7</td>
<td>0.31(.18)</td>
<td>0.607</td>
</tr>
<tr>
<td>DT 8</td>
<td>0.31(.15)</td>
<td>0.964</td>
</tr>
</tbody>
</table>

Discussion

An analysis of the proposed hypotheses is presented in Table 3. Half of the DTs supported the original hypotheses, and half contradicted the hypotheses. This seems to point to a lack of predictive ability of TRP in terms of risk preference when outcomes straddle the G reference point.

Table 3. A comparison of hypotheses and results found. Rows highlighted in green indicate DTs that supported the hypotheses; rows highlighted in red indicate DTs that did not support the hypotheses.

Results from DTs 1, 3, 4, and 8 support the proposed hypotheses. DTs 1, 3, and 4 afforded the opportunity to meet or exceed all three of the reference points, and none of the importance ratings for DTs 1, 3, or 4 were statistically significant predictors of risk preference. In DT 8, only option B provided a chance of exceeding the G reference point, and this reference point, alone, was a statistically significant predictor of risk preference and in the predicted direction. As the importance of G increases, the preference for risk also increases in an effort to exceed this value.
However, the logistic regression analysis revealed that DTs 2, 5, 6, and 7 did not support the proposed hypotheses. In DTs 2 and 5, both options would allow the participant to meet or exceed all three reference points, but G was a statistically significant predictor of risk preference. The predictive ability of G importance for this task is peculiar. One possible explanation could be that this small difference in wealth gain possibilities creates a more salient status dichotomy for the decision maker. If this is indeed the case with these two DTs, this could be an example of social comparison effects (e.g., Festinger, 1954; Hill & Buss, 2010).

DT 6 also contradicts the proposed hypotheses. The SQ importance was a statistically significant predictor of risk preference while G was not, but both gambles allowed the SQ to be reached, while only Gamble A allowed G to be reached. The most likely explanation for this finding is that the SQ was low enough that choosing Gamble A would create the possibility of losing all of one’s money. Kahneman and Tversky (1979) explain this effect as resulting from increased psychological weight placed on money lost compared to money earned or won. In this particular gamble, there was a very real chance of the decision maker losing all of their money by choosing the risky option, whereas they would be left with $5 if they chose the less risky option and lost. Therefore, the motivation to prevent a loss was greater than any motivation to increase a possible gain, indicating the presence of loss aversion (effort to prevent taking the larger of two possible losses).

Finally, in DT 7, G importance should predict risk preference since only Gamble B could meet or exceed this reference point. However, none of the reference points were statistically significant predictors of risk preference. In this task again, there was a possibility of losing the entire budget by selecting the riskier gamble if it were not to win. Since this was the same scenario, in terms of the SQ, as was presented in DT 6, it is interesting that the importance of the SQ was not a statistically significant predictor of risk preference. Behavior on this task is best explained by risk aversion (Kahneman & Tversky, 1979; i.e., the preference for the less variable, or more sure, option) as 56 of the 61 participants who received this task chose the less risky of the two gambles. Since the chances of winning were quite different (90% for Gamble A and 50% for Gamble B), risk aversion seems to fit well here to explain risk preference.

Limitations and Implications

Possible limitations of this work include participant recruitment method. Some work has shown that the method used to recruit and compensate research participants actually alters performance on statistical reasoning tasks (e.g., Brase, 2009; Brase, Fiddick, & Harries, 2006). In the present study, participants were recruited to complete multiple studies from several different researchers simultaneously. Participants were compensated with course credit, which Brase (2009) suggests decreases statistical reasoning performance. The researcher introduced the fake raffle in an effort to counteract this potential effect.

Importance ratings for each of the reference points was collected via a self-report measure. Some research has suggested that self-report measures may not always accurately capture attitudes that a participant holds (e.g., Greenwald & Farnham, 2000). So it is possible that the self-reported importance ratings of the reference points in this study are not a true reflection of the weight placed on specific reference points when making a decision.
Threats to ecological validity exist due to the setting in which the research was conducted. As a laboratory or classroom does not mimic settings in which these kinds of decisions are typically made in daily life, generalization beyond laboratory settings are weak at best. However, as the theory being evaluated was created and tested in similar settings, evaluations of TRP conducted in a similar setting should still be valid.

Findings from this study indicate that there may be some merit to TRP in terms of predicting risk preference. However, TRP suggests that risk is preferred when the outcomes straddle a reference point of importance (Wang & Johnson, 2012). This study failed to replicate this finding consistently. Instead, these results suggest that there may be more specific criteria that must be met for TRP to have reliable predictive ability. The next step in this line of work should be to tease apart these details and determine exactly when TRP can predict risk preference.

Risk aversion still seems to offer the greatest predictive strength for each of these DTs, as no fewer than 77% of respondents exhibited a preference for the less risky gamble on any task. The requirements for risk aversion to be present (Kahneman & Tversky, 1979)—task framed as a gain, EV of both gambles equal, no extreme low chances of winning—were present in every task. Although the use of more than a single reference point may well be how humans behave and make decisions, determining which reference points, and when they are used, should be a priority for future work in this area.

The author would like to thank Gary L. Brase for advice setting up this experiment and W. Trey Hill for his assistance running and interpreting the statistics.

References


**Appendix A**

DT 1

![Gambles](image)

Circle your preferred choice: GAMBLE A GAMBLE B

Indicate how true the following statements were regarding your choice by circling a single number for each based on: 1=Not at all true, 4= Somewhat true, 7= Very true

<table>
<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winning enough to move on to the next round was important to me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I was not concerned about winning more than the average amount.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It was important to win at least enough to reach the amount with which I started.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
You currently have: $320
Amount needed for next round: $300
Average winnings of others: $415

<table>
<thead>
<tr>
<th>Gamble A</th>
<th>Gamble B</th>
</tr>
</thead>
<tbody>
<tr>
<td>• This gamble <strong>costs $25</strong> to play</td>
<td>• This gamble <strong>costs $20</strong> to play</td>
</tr>
<tr>
<td>• You have a 50% chance of winning $450</td>
<td>• You have a 55% chance of winning $400</td>
</tr>
<tr>
<td>• You have a 50% chance of winning $0</td>
<td>• You have a 45% chance of winning $0</td>
</tr>
</tbody>
</table>

Circle your preferred choice: GAMBLE A GAMBLE B

Indicate how true the following statements were regarding your choice by circling a single number for each based on: 1=Not at all true, 4= Somewhat true, 7= Very true

| Winning enough to move on to the next round was important to me. | 1 2 3 4 5 6 7 |
| I was not concerned about winning more than the average amount. | 1 2 3 4 5 6 7 |
| It was important to win at least enough to reach the amount with which I started. | 1 2 3 4 5 6 7 |

You currently have: $225
Amount needed for next round: $200
Average winnings by others: $350

<table>
<thead>
<tr>
<th>Gamble A</th>
<th>Gamble B</th>
</tr>
</thead>
<tbody>
<tr>
<td>• This gamble <strong>costs $100</strong> to play</td>
<td>• This gamble <strong>costs $25</strong> to play</td>
</tr>
<tr>
<td>• You have a 50% chance of winning $600</td>
<td>• You have a 90% chance of winning $250</td>
</tr>
<tr>
<td>• You have a 50% chance of winning $0</td>
<td>• You have a 10% chance of winning $0</td>
</tr>
</tbody>
</table>

Circle your preferred choice: GAMBLE A GAMBLE B

Indicate how true the following statements were regarding your choice by circling a single number for each based on: 1=Not at all true, 4= Somewhat true, 7= Very true
Circle your preferred choice: GAMBLE A GAMBLE B

Indicate how true the following statements were regarding your choice by circling a single number for each based on: 1=Not at all true, 4= Somewhat true, 7= Very true
Circle your preferred choice: GAMBLE A GAMBLE B

Indicate how true the following statements were regarding your choice by circling a single number for each based on: 1=Not at all true, 4= Somewhat true, 7= Very true

<table>
<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winning enough to move on to the next round was important to me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I was not concerned about winning more than the average amount.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It was important to win at least enough to reach the amount with which I started.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DT 6

You currently have: $25
Amount needed for next round: $400
Average winnings of others: $435

Gamble A
- This gamble costs $25 to play
- You have a 50% chance of winning $450
- You have a 50% chance of winning $0

Gamble B
- This gamble costs $20 to play
- You have a 55% chance of winning $400
- You have a 45% chance of winning $0

Circle your preferred choice: GAMBLE A GAMBLE B

Indicate how true the following statements were regarding your choice by circling a single number for each based on: 1=Not at all true, 4= Somewhat true, 7= Very true

<table>
<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winning enough to move on to the next round was important to me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I was not concerned about winning more than the average amount.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It was important to win at least enough to reach the amount with which I started.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DT 7
Circle your preferred choice: **GAMBLE A GAMBLE B**

Indicate how true the following statements were regarding your choice by circling a single number for each based on: 1=Not at all true, 4= Somewhat true, 7= Very true

| Winning enough to move on to the next round was important to me. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| I was not concerned about winning more than the average amount. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| It was important to win at least enough to reach the amount with which I started. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

DT 8

Circle your preferred choice: **GAMBLE A GAMBLE B**

Indicate how true the following statements were regarding your choice by circling a single number for each based on: 1=Not at all true, 4= Somewhat true, 7= Very true