INVESTIGATING THE LEDDO, JAYANTI AND DUAN (2019) REVISED PROSPECT THEORY VALUE FUNCTION WITH CHINESE STUDENTS

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ABSTRACT

Prospect Theory (Kahneman and Tversky, 1979) is a highly influential theory that predicts decision making when people are confronted with choices involving gains or losses with different degrees of uncertainty. Prospect Theory argues that people are generally risk averse when it comes to seeking gains and risk seeking when it comes to seeking losses. Leddo et al. (2019) noted that the original formalization of Prospect Theory did not take into account people's goals. They argued that people would be willing to take risks to achieve goals but become more risk averse once those goals are achieved, and they would become risk averse when confronted with losses in order to avoid a highly negative outcome but become more risk seeking to negate the negative outcome once the highly negative outcome occurred. Leddo et al.'s research confirmed this hypothesis, leading to a revision of Prospect Theory's value function. The present research investigates whether the same revised value function can predict decisions made by people in other cultures. Accordingly, the present paper replicated the Leddo and Shukla (2020) study that examined choice of standardized tests in high school students. In the present study 44 high school students in China, a large economy with a different economic system than the US where previous research suggests students are more risk averse, were given the Leddo and Shukla (2020) scenarios involving gains and losses. Results showed that students chose the less risky alternative in all scenarios except in cases involving losses where an avoidance level had already been met, in which case, almost all students chose the risky alternative. These results were not consistent with those predicted by the Leddo et al. (2019) revised Prospect Theory value function for gains but were consistent with those predicted for losses.

INTRODUCTION

One of the most prominent and influential theories of decision making and choice behavior is Kahneman and Tversky's Prospect Theory (1979), which evolved from attempts to understand the place of expectation-based theories in describing individual decision making. Prospect Theory proposes a value function that relates actual outcome value to subjective utility and a decision weighting function which translates the stated probability of an outcome to a subjective weight that the stated probability carries in assessing the attractiveness of that outcome.

The Kahneman and Tversky value function has two distinct properties: a) it is concave for gains and convex for losses so that, for example, the difference in subjective utility between 0 and 100 dollars is not the same as the difference in subjective utility between 100 and 200 dollars, and; b) the function for losses is steeper than the function for gains so that a given amount of loss is more aversive than the same amount of gain is attractive. Figure 1 shows Prospect Theory's value function.

Since its inception, there have been many tests of Prospect Theory in a variety of contexts such as business and political decision making (Kahneman & Tversky, 2000; Jones 2001; Gilovich, Triffen& Kahneman, 2002; Weyland 2006). Many studies have cited support for some of Prospect Theory's main claims. However, results have not always been consistent. For example, Weyland (1996) found that in Latin American countries, politicians facing economic hardships would sometimes enact bold, risky policies and others would enact conservative ones. Similarly, Alghalith et al. (2012) found that investors tended to be risk seeking regardless of whether they were gaining or losing money. Riabacke (2006) examined several lumber companies. These were first grouped into established companies and new and upcoming companies. The companies were asked to choose between a new risky technology not used yet but promised to be more efficient vs the current/old technology. The established company chose the old one while the new company chose the newer technology. Thus, when confronted with the same decision, established companies were risk averse (which generally seems to be the case), whereas the newer companies were risk seeking (which generally seems to be the case).
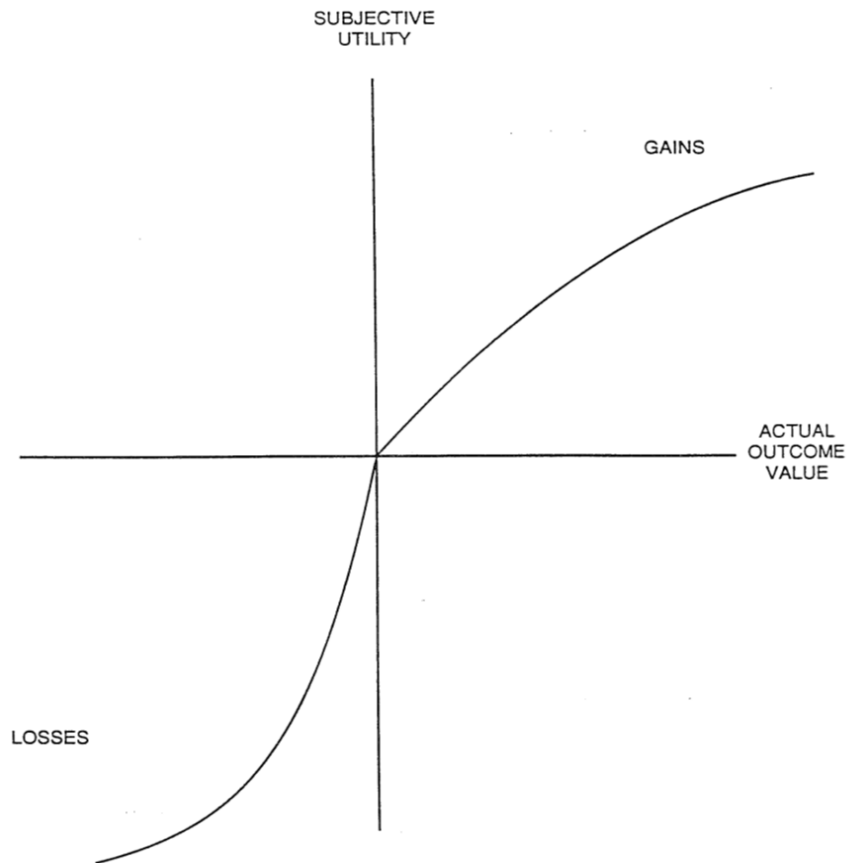
FIGURE 1. Kahneman and Tversky's (1979) value function showing relationship between actual outcome value and subjective utility.

Leddo et al (2019) Extension of Prospect Theory

Kahneman and Tversky have done an excellent job in explaining cases where people would be risk averse versus risk seeking and have shown how framing choices can lead to one tendency or the other. However, Prospect Theory fails to account for the real-world decisions described above. The reason for this may be reflected in the critique of Prospect Theory offered by Nwogugu (2005) that Prospect Theory was created based on hypothetical decisions that do not reflect the types of real-world decisions involving risk and reward that people typically face. In the real world, gains and losses may not be uniform in how they appear to the decision maker.

As a result, Leddo et al. (2019) noted that real-world decisions often occur in the context of goals, represented in terms of outcomes a decision maker is trying to achieve or ones s/he is trying to avoid. Accordingly, Leddo et al. (2019) created a revised value function that included an aspiration level that represented an outcome the decision maker is trying to achieve and an avoidance level that represented an outcome that the decision maker is trying to avoid. The inclusion of aspiration and avoidance levels in the value function leads to predictions of decision making that run counter to those of classical Prospect Theory.

For example, Prospect Theory's value function argues that each successive dollar a person receives is worth less than the previous dollar. However, suppose a person has a goal of becoming a millionaire. Prospect Theory states that the 10th dollar the person gets along the way towards achieving that goal will be subjectively worth more than the 1 millionth dollar the person gets. Common sense suggests the reverse is true. On the other hand, once the million-dollar goal is achieved, it is reasonable to argue that each successive dollar earned has decreasing subjective value.

Conversely, suppose a person owns a business that will fail if it loses 1 million dollars. Prospect Theory states that each successive dollar lost has decreasing subjective value such that the first dollar lost is subjectively more aversive that losing the one millionth dollar that causes the business to fail. Again, this goes against common sense. As with the argument in the previous paragraph, it is reasonable to also argue that once the one-million-dollar loss occurs and the business is sure to fail, any losses greater than that have decreasing aversiveness.

Accordingly, unlike the traditional Prospect Theory value function, which is concave for gains and convex for losses, the Leddo et al. (2019) revised Prospect Theory value function is convex for gains up to the aspiration level and concave thereafter and concave for losses up to the avoidance level and convex thereafter. The Leddo et al. (2019) revised value function is shown in Figure 2.
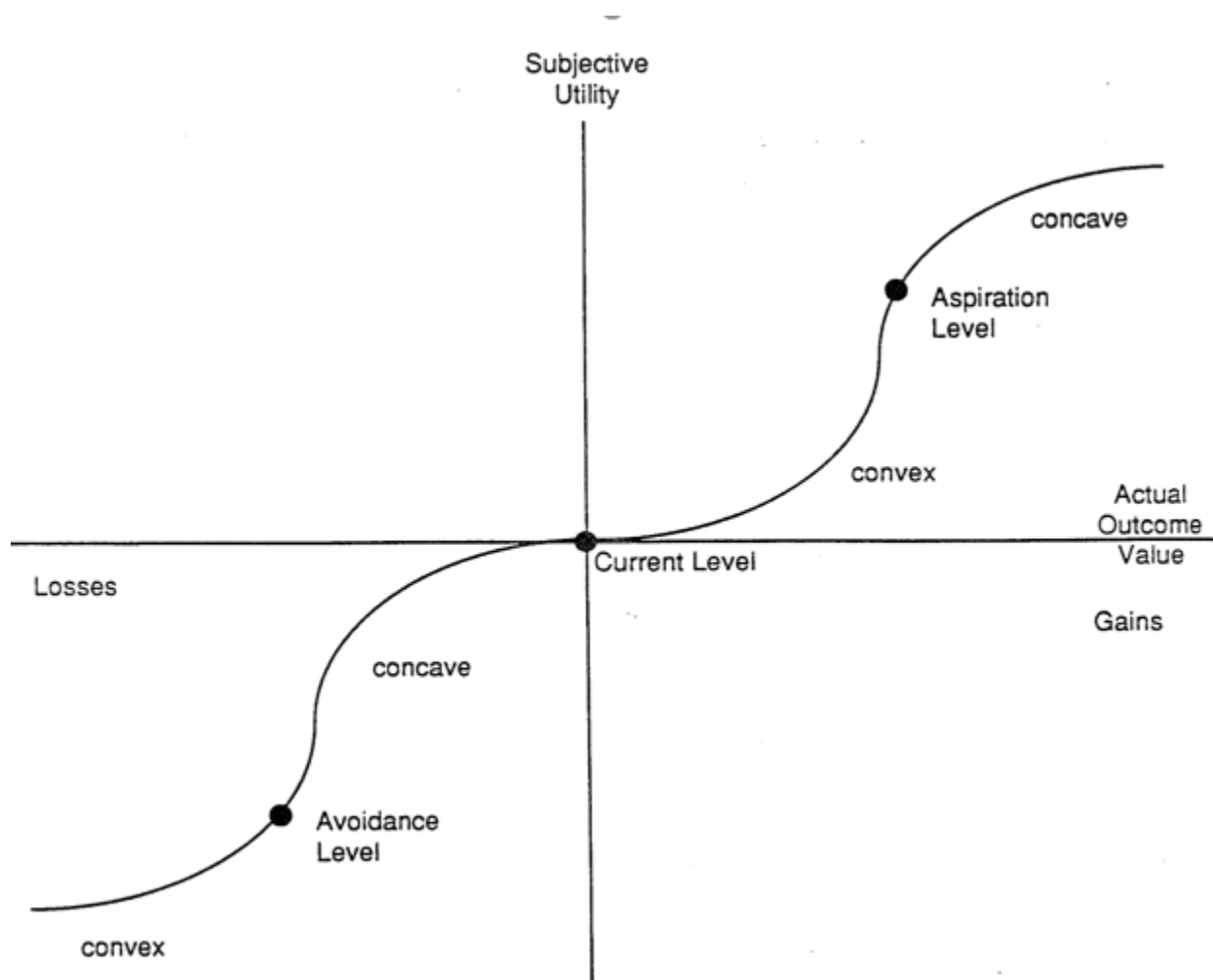
Figure 2: Revised Prospect Theory value function

The reformulated value function is useful in explaining the empirical results described earlier that appear at odds with the original version of Prospect Theory. For example, investors presumably have a very high aspiration level, so it makes sense for them to be risky when they are gaining money at levels below whatever aspiration level they set. For the lumber companies, new companies have not yet established themselves. Therefore, we would expect new companies to be below their aspiration levels and be willing to engage in risky behaviors. On the other hand, an "established" company has already achieved the goal of becoming successful (its aspiration level), so we would expect to see it to be more risk averse in decision making.

The revised value function is useful in explaining apparent discrepancies in economic policies. For example, when countries show modest economic declines, they often enact austerity programs (e.g., Greece in recent years or the sequester in the United States) that are marked by reduced government spending and attempts to reduce debt. On the other hand, severe economic downturns (e.g., the Great Depression in the 1930's or the recessions in 2008 and 2020 in the United States) are often marked by bold economic initiatives like high government spending, new programs (e.g., the New Deal during the Great Depression), and incurring large amounts of debt. This apparent contradiction can be explained using the avoidance level. As long as the economy has not reached disastrous conditions (the avoidance level), governments are risk averse, but once those levels are reached, they become risk seeking.

In addition to the Leddo et al. (2019) study, further evidence for the reformulated value function has been shown in Leddo and Shukla (2020) that found that not only do people's decisions that they make for themselves conform to the predictions of the revised value function, but so, too, do recommendations for decisions they make on behalf of their friends. In the Leddo and Shukla (2020) study, high school students were presented with scenarios in which they or their friends were applying to college and had to make decisions on whether to take the SAT or ACT test or recommend that their friends take the SAT or ACT. Scenarios varied to reflect conditions below an aspiration level (their of their friends' test scores were below the required level for the college they wanted and they were choosing between a sure gain that would still place the score below the aspiration level and an uncertain gain that would either place the score at the aspiration level or the current level), were above an aspiration level (their or their friends' test scores were at the aspiration level and they were choosing scenarios of a certain gain of 50 points or an uncertain gain of either 0 or a 100 points), were below the avoidance level (the student is choosing for him/herself or a friend between a test that has a certain chance of producing a lower test score but one still higher than the level that would cause the student or friend to be rejected by colleges being applied to and a test that will either produce the same score that the student or friend has now or one that is at the level that would cause the student or friend to be rejected by colleges being applied to), were above the avoidance level (the student or a friend has a test score that will result in rejection by the college being applied to and the student is choosing between a test that has a certain chance of producing a test score that is 50 points lower and a test that will either produce the same score as the student or friend has now or one that is 100 points lower). In this study, students chose the risky option for themselves and their friends when their scores were below the aspiration levels, chose the non-risky option for themselves and their friends when their scores are already at the aspiration levels, chose the non-risky option for themselves

and their friends when their scores were below the avoidance levels and the risky option for themselves or their friends when their scores were above the avoidance levels.

The revised Prospect Theory value function was even shown to hold up when investigated under the framing of decisions. In the classical version of Prospect Theory, Tversky and Kahneman (1981) found that the same decision could produce either risk seeking or risk aversion behavior in people depending on whether that decision was framed in terms of losses or gains. Leddo and Elkas (2021) mirrored the original Tversky and Kahneman (1981) framing study, but with inserting aspiration and avoidance levels in the gain and loss versions of the decision scenarios. When these aspiration and avoidance levels were included, people's decisions conformed to the predictions of the revised Leddo et al. (2019) value function rather than the original Kahneman and Tversky (1979) value function.

While Leddo and his colleagues have amassed considerable evidence for a revised value function when studying American decision makers, the question remains whether this revised value function would hold up when tested in other countries. In fact, it is often the case that documented social science-related findings fail to hold up in tests in other cultures (Henrich, Heine, and Norenzayan, 2010). A landmark study investigated how well the traditional probability weighting function of Prospect Theory (something we did not investigate in our revision of Prospect Theory's value function) held up in 30 different countries (Haridon and Vieider, 2019). These researchers found that, generally speaking, people in countries investigated had probability weighting functions that were similar to that in Prospect Theory in which smaller probabilities were overweighted and higher probabilities were underweighted. Nicaraguan people showed a similar pattern except that lower probabilities were overweighted even more and higher probabilities were underweighted about the same as those stated in the original Prospect Theory probability weighting function. While Nicaraguan people had the most pronounced effect in this departure from the standard probability weighting function, this general pattern was true for other low-income countries included in the study. This pattern suggested that people in low-income countries had a greater sense of optimism and higher risk tolerance than those in higher income countries. Further, Boucher and Leddo (2022) found that when it came to the value function, Nicaraguan students showed a fairly consistent pattern of risk tolerance regardless of whether the prospects they were faced with involved gains or losses or were above or below an aspiration or avoidance level.

The purpose of the present study is to extend the original Leddo, Jayanti and Duan (2019) and Boucher and Leddo (2022) findings regarding the revised Prospect Theory Value function to yet another country: China. China presents an interesting case as it represents the world's second

largest economy but has a different economic system, communist, than does either the United States or Nicaragua. China was also one of the countries investigated in the Haridon and Vieider (2019) study. In that study, Chinese people showed a very similar decision weighting function to that of US people. It would be interesting to compare their value functions as well. Given previous research by Sasaki et al. (2006), which found that Chinese students tended to be risk averse, it may be expected that the value functions for Chinese students would be concave for both gains and losses.

METHOD

Participants

Participants were 44 native Chinese high school students living in China. They were studying to attend a US college and were, therefore, familiar with the SAT and ACT college entrance exams.

Materials Used

A total of four scenarios were used. According to Leddo et al. (2019), there are four distinct portions of the revised Prospect Theory value function. These are: decisions involving gains once a goal or aspiration level has been met; decisions involving gains prior to a goal or aspiration level having been met; decisions involving losses prior to an avoidance level having been met; decision involving losses once an avoidance level has been met. One scenario for each portion of the value function was used. These scenarios were taken from the Leddo and Shukla (2020) study to enable direct comparisons between US and Chinese populations.

Because the participants were all high school students, the scenarios presented goals that were meaningful to such students. The scenarios involved decisions on whether to take an SAT or ACT test that is required for college admission. In each scenario, the student has an existing SAT score. In gain scenarios, the existing SAT score is at or below the level needed to get into a dream college. The student chooses between taking a test that provides a sure gain in test score or one that has a 50-50 chance of no gain or double the sure gain. In loss scenarios, the student has a test score above or at a score that would negate his/her ability to get into college. The student chooses between taking a test where there is a sure loss in test score or one that has a 50-50 chance of no loss or double the loss. The actual scenarios presented to students are shown below.

1. Gain-below aspiration level

You currently have a 1400 SAT score. You need 1500 on the SAT or an equivalent ACT score to get accepted to your dream college. Your high school is offering its students an in-school SAT or ACT test and is requiring you to take one of them. This is the last available SAT or ACT test before college applications are due. If you retake the SAT, you will get exactly 50 points more. If you take the ACT, you have a 50% chance of getting an ACT score equivalent to the 1500 SAT score you need to get accepted and a 50% chance of getting an ACT score equivalent to your current 1400 SAT score. Will you take the SAT or ACT?

2. Gain-above aspiration level

You currently have a 1400 SAT score. You need 1400 to get accepted to your dream college, so you have made your goal. Your high school is offering its students an in-school SAT or ACT test and is requiring you to take one of them. This is the last available SAT or ACT test before college applications are due. If you retake the SAT, you will get exactly 50 points more. If you take the ACT, you have a 50% chance of getting an ACT score equivalent to a 1500 SAT score and a 50% chance of getting an ACT score equivalent to your current 1400 SAT score. Will you take the SAT or ACT?

3. Loss-above avoidance level

You have an 1100 SAT score. Your high school is offering its students an in-school SAT or ACT and is requiring you to take one of them. This is the last available SAT or ACT test before college applications are due. If you get 1000 on this SAT test or an equivalent score on the ACT test, the colleges you are applying to won't accept you. You are out of practice. If you take the SAT, you are guaranteed to get exactly 50 points lower. If you take the ACT, you have a 50% chance the equivalent SAT score remains exactly the same and a 50% chance of getting exactly 100 points lower in terms of equivalent SAT scoring and thus be at the level that the colleges you are applying to won't accept you. Will you take the SAT or ACT?

4. Loss-below avoidance level level-decision made for self

You have a 1000 on the SAT. At this level, the colleges you are applying to won't accept you. Your high school is offering its students an in-school SAT or ACT and is requiring you to take one of them. This is the last available SAT or ACT test before college applications are due. You are out of practice. If you take the SAT, you are guaranteed to get exactly 50 points lower. If you take the ACT, you have a 50% chance of getting exactly 100 points lower in terms of equivalent SAT scoring or 50% chance the equivalent SAT score remains exactly the same. Will you take the SAT or ACT?

Procedure

All four scenarios were administered electronically. Each participant was given only one scenario so that the participant's decision on the scenario would not be affected by answers given to other scenarios. Therefore, the participant was simply directed to state which of the two tests s/he would take. Which scenario each participant received was randomly determined. A total of 11 students received each version of the scenario.

RESULTS

In each scenario, participants had to choose between taking an SAT or an ACT exam. In all scenarios, taking the SAT had the guaranteed outcome and ACT had the 50-50 outcome. Therefore, choosing the ACT could be seen as the risky option.

Table 1 presents the percentage of participants who selected the risky alternative for each of the four scenarios. The first row shows the results of the present study (for the Chinese students).

The second and third rows show the results of the Boucher and Leddo (2020) and Leddo and Shukla (2020) study, for comparison purposes.

Table 1: Percent of participants who selected the risky outcome, broken down by type of scenario.

Nationality	Below-aspiration level gain	Above-aspiration level gain	Below-avoidance level loss	Above-avoidance level loss
Chinese	21.70	15	0	94.40
Nicaraguan	72.73	54.55	63.64	63.64
American	90	50	30	90

A visual inspection of the table indicates that Chinese students chose the risky alternative far less often than did either the American or Nicaraguan students in all of the conditions except when making a decision involving losses above the avoidance level (meaning the avoidance level was already reached).

The first prediction from the Leddo et al. (2019) revised value function is that people are more risk seeking when faced with prospective gains below the aspiration level than they are when faced with prospective gains above the aspiration level. Operationally, this would predict that the percentage of students picking the risky option would be higher in the gains below the aspiration level scenario than the percentage picking the risky option in the gains above the aspiration level scenario. While the data were in the direction of the hypothesis, the difference was not statistically significant, $z < 1$.

The second prediction from the Leddo et al. (2019) reformulation predicts that people are more risk seeking when faced with prospective losses above the avoidance level than they are when faced with prospective losses below the avoidance level. Operationally, this would predict that the percentage of students picking the risky option would be higher in the losses above the avoidance level scenario than the percentage picking the risky option in the losses below the avoidance level scenario. In this case, the data were dramatically in the direction of the hypothesis and highly statistically significant, $z = 5.67$, $p < .001$. Accordingly, decision making behavior among the Chinese students conformed to the predictions made by the Leddo et al. (2019) framework for losses but not for gains.

The second type of analysis we conducted was to compare the decision-making behaviors of Chinese students to their American and Nicaraguan counterparts. When confronted with prospects involving gains below the aspiration level, Chinese students were less risk seeking than either their American ($z = 5.67$, $p < .001$) or Nicaraguan counterparts ($z = 2.86$, $p < .01$). When confronted with prospects involving gains above the aspiration level, Chinese students again were less risk seeking than either their American ($z = 2.04 < .05$) or Nicaraguan ($z = 2.32$, $p < .05$) counterparts. When confronted with prospects involving losses below the avoidance level, Chinese students were marginally less risk seeking than their American counterparts ($z = 1.87$, $p = .06$) and significantly less risk seeking than their Nicaraguan counterparts ($z = 3.89$, $p < .001$). Finally, when confronted with prospects involving losses above the avoidance level, Chinese students showed no difference from their American counterparts ($z < 1$), but were actually more risk seeking than their Nicaraguan counterparts ($z = 2.13$, $p < .05$).

DISCUSSION

The data from the present study showed that the choices made by Chinese students were uniformly risk averse for gains, regardless of whether the scenarios presented situations that were above or below the aspiration level. This is consistent with theoriginal Prospect Theory (1979) value function and inconsistent with the Leddo et al. (2019) revised value function. However, the data also show that for losses, Chinese students were risk averse when making choices in the scenario in which the situation presented was below the avoidance level and risk seeking when making choices in the scenario in which the situation presented was above the avoidance level. This is inconsistent with the original Prospect Theory (1979) value function and consistent with the Leddo et al. (1979) revised value function.

Moreover, Chinese students, overall, were more cautious than either US or Nicaraguan students when it came to making choices regarding potential gains. However, when it came to losses, Chinese students appear to show an even greater interaction effect between tolerance for risk and scenario (i.e., whether the event described above or below the avoidance level) than either US or Nicaraguan students in that no Chinese student opted for the risky alternative when the situation presented was below the avoidance level while almost all Chinese students opted for the risky alternative when the situation presented was above the avoidance level.

The present results, along with those of Boucher and Leddo (2022), underscore the Henrich, Heine and Norenzayan (2010) findings that social science findings established in one country often do not hold up in other countries. Therefore, there may not be a universal framework such as Prospect Theory (even in its revised form) that can account for decision making across cultures. Rather, we need to think about creating culture-dependent predictive models and link these to cultural values that may drive that behavior. In this case, the results with Chinese students were consistent with previous results that suggested that Chinese students are risk averse, except for the condition in which an avoidance level has been met. At this point, there is no benefit to being cautious in that cautious alternatives lead the decision maker to remain in a situation where the avoidance level is still met.

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