# PROSPECT THEORY REVISITED: VIEWING THE RESULTS OF FRAMED DECISIONS THROUGH A REVISED VALUE FUNCTION

John Leddo[1] and Mason Elkas[2]

[1]director of research at MyEdMaster, LLC.  USA

[2]researcher at MyEdMaster, LLC.USA

## ABSTRACT

Prospect Theory (Kahneman and Tversky, 1979) 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. Tversky and Kahneman (1981) even found that framing the same decision in terms of gains or losses could influence whether people were risk averse or risk seeking.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 it occurred.  Leddo et al.'s research confirmed this hypothesis, leading to a revision of Prospect Theory's value function. The Leddo et al. revision of the value function has implications for framing decisions as well. Unlike the original formulation of Prospect Theory, which predicts a main effect for whether decisions are framed in terms of gains or losses, but is silent about the effects of goals, the Leddo et al. value function predicts no main effect for gains or losses but a main effect for both gains and losses for whether outcomes presented are above or below a goal state. This hypothesis was tested on 88 high school students by creating a scenario similar to that in the original Tversky and Kahneman (1981)study in which people had to choose between option that would result in lives saved (gain scenario) or lives lost (loss scenario).  In the present study, a goal state was created whereby 100 people out of 1000 survivors of a pandemic needed to live to insure the survival of the human race. Four versions of the basic scenario were created: 100 people would be saved for sure vs. risking saving fewer in order to save more; 50 people would be saved for sure vs. risking saving fewer in order to save more; 900 people would die for sure vs. risking more die to have fewer die; 950 people die for sure vs. risking more die to have only 900 people

die. Participants were given only one scenario and asked to pick which option they wanted. Results showed no main effect for gain vs. loss but that people were risking seeking for both gains and losses when outcomes were below the aspiration and avoidance levels and risk averse for both gains and losses when outcomes were above the aspiration and avoidance levels. These results ran counter to those predicted by the original Prospect Theory and were consistent with the Leddo et al. (2019) revision of the Prospect Theory value function.

## 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 utility between 0 and 100 dollars is not the same as the difference in 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 showsProspect 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 Theories 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).
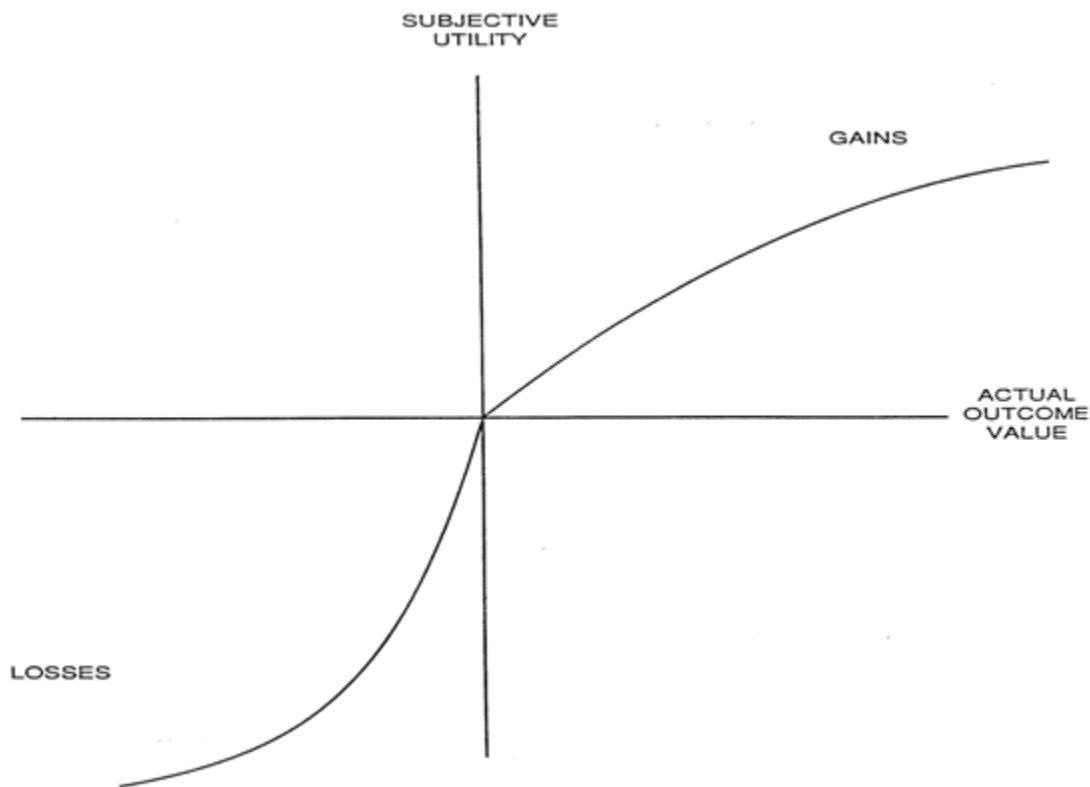
FIGURE 1.  Kahneman and Tversky's (1979) value function showing relationship between actual outcome value and subjective utility.

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.  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.
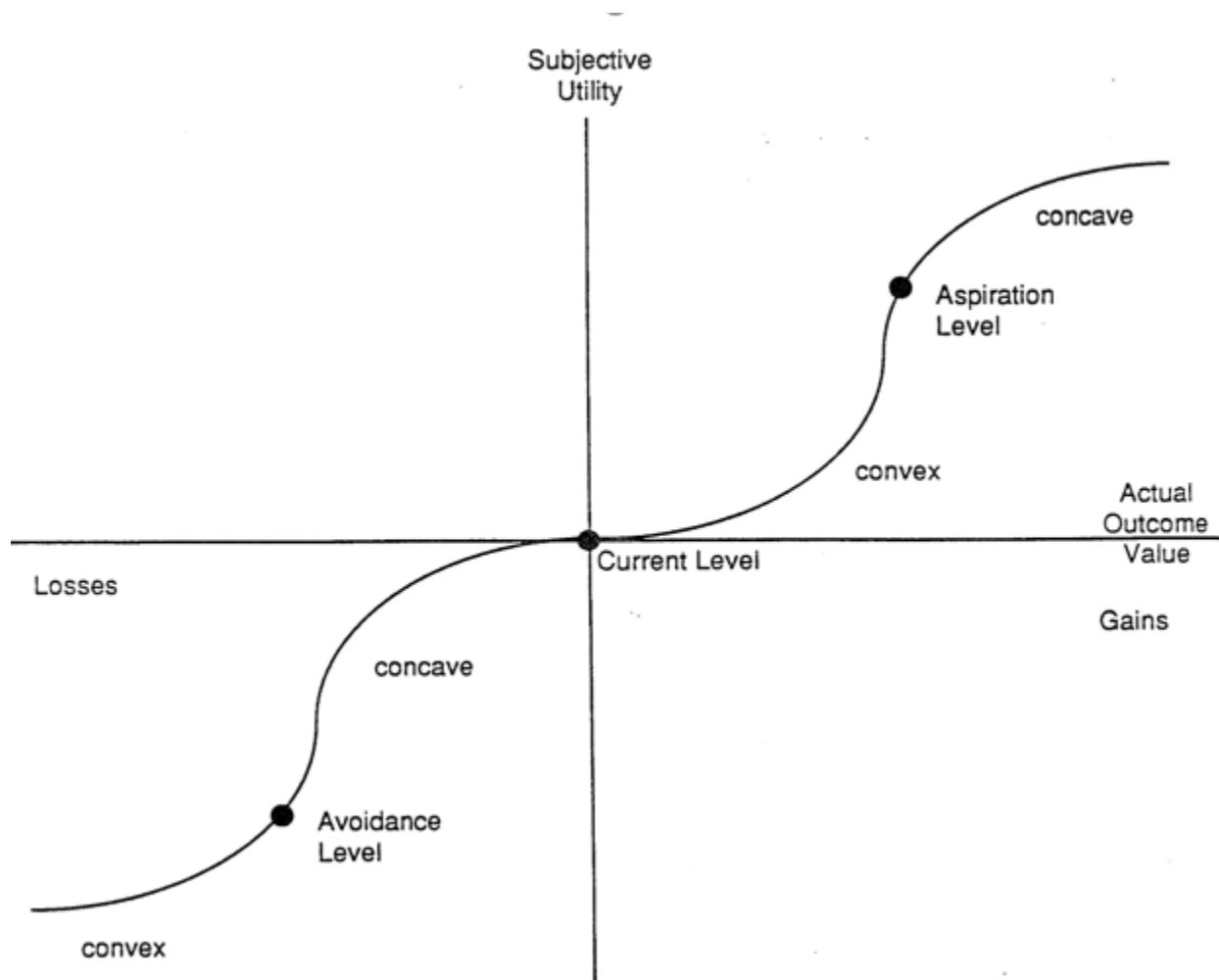
**Figure 2: Revised Prospect Theory value function**

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 achieve the goal of becoming successful (its aspiration level), so we would expect to see it to be more risk averse in decision making.

One of the more interesting findings in the original Prospect Theory (1979) formulation was the notion of framing effects. Tversky and Kahneman (1981) found that people could show opposite attitudes toward risk regarding the same decision, depending upon whether the decision was framed as involving gains or losses. For example, people were confronted with two scenarios in which 600 people were threatened with death. When the scenario was framed in terms of choices involving gains, i.e., how many lives would be saved, people chose to save 200 people for sure rather than gambling to save all at the risk of saving none. On the other hand, when the same scenario was framed in terms of choices involving losses, i.e., how many lives would be lost, people chose to gamble on an all or none scenario rather than allowing 400 people to die for sure (which implied 200 would be saved as in the first scenario).

The above results were seen as further confirmation of the Prospect Theory's value function, which predicted people would be risk averse for gains and risk seeking for losses. The Leddo et al. (2019) reformulation of the Prospect Theory value function would not predict a main effect like that for gain vs. loss when framing a decision. Rather, our value function would predict that the framing effect would depend on whether the decision is presented as being above or below the aspiration level or the avoidance level. For example, if there were a scenario involving the threat of people dying, and there were a target number of people who needed to live (say, to perpetuate the human race), then framing a decision in terms of saving lives would result in risk averse behavior if the number of lives saved were above the aspiration level (the target number of people needed to be saved). This is consistent with the original Prospect Theory formulation. The equivalent scenario, when framed in terms of lives lost, would place the projected lives lost above the avoidance level (i.e., fewer people are expected to die than the target number). Our reformulated value function would predict that this, too, would result in risk averse behavior, contrary to the predictions of the traditional Prospect Theory.

Conversely, in the saving lives version of the scenario, if the projected number of lives that would be saved is below the target number, our version of the value function predicts risk-seeking behavior, which is contrary to the predictions of the original Prospect Theory. The equivalent scenario, when framed in terms of lives lost, would place the projected lives lost below the avoidance level (i.e., more people are expected to die than the target number). Our reformulated value function would predict that this, too, would result in risk-seeking behavior, which is consistent with the original Prospect Theory.

To summarize, the originalProspect Theory value function predicts a main effect in attitude toward risk based on whether a decision is framed in terms of gains or losses. Our revised value function predicts no main effect for gain vs. loss but does predict a main effect for whether outcomes (both gains and losses) are above or below the aspiration and avoidance levels. This

hypothesis is tested in the present paper by replicating the original Tversky and Kahneman (1981) framing experiment, adapting it to include both stated aspiration and avoidance levels.

**Method**

**Participants**

Particpants were 88 high school students recruited from schools in Northern Virginia. They were not paid for their participation in the study.

**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. In the original Tversky and Kahneman (1981)framing study, the authors created alternate versions of scenarios with identical outcomes, framing one version in terms of loss and the other in terms of gains. The present materials mirrored this approach with the exception that the scenarios were constructed to framegain and loss frame choices around the aspiration and avoidance levels, respectively. In this case, the gain scenarios were framed in terms of saving enough people to ensure the survival of the human race or losing enough people so that the human race could not survive. The four scenarios are presented below.

Scenario 1: Gain above the aspiration level of saving 100 people

A deadly pandemic is threatening to wipe out every human on Earth. 1000 people remain. World leaders have gotten together and decided that if 100 people can be saved, the human species will survive. There are enough vaccines to protect 100 people with 100% certainty. A proposal is made to split each vaccine into two doses and try to save 200 people. Scientists claim that the outcome for this is uncertain and if this solution is employed, there is a 50% chance 200 people will be saved and a 50% chance that no people will be saved. Should the vaccines be split in half or kept whole?

Scenario 2: Gain below the aspiration level of saving 100 people

A deadly pandemic is threatening to wipe out every human on Earth. 1000 people remain. World leaders have gotten together and decided that if 100 people can be saved, the human species will survive. There are enough vaccines to protect 50 people with 100% certainty. A

proposal is made to split each vaccine into two doses and try to save 100 people. Scientists claim that the outcome for this is uncertain and if this solution is employed, there is a 50% chance 100 people will be saved and a 50% chance that no people will be saved. Should the vaccines be split in half or kept whole?

Scenario 3: Loss above the avoidance level of losing 900 people

A deadly pandemic is threatening to wipe out every human on Earth. 1000 people remain. World leaders have gotten together and decided that if more than 900 of these people die, the human species would go extinct. There are 100 doses of a vaccine. There are two proposals made. One is to give a full dose of the vaccine to 100 people. If this is done, there is a 100% chance that the other 900 people will die. The second proposal is to split each vaccine into two doses and give half-doses to 200 people. If this is done, there is a 50% chance that 800 people will die and a 50% chance that 1000 people will die. Should the vaccines be split in half or kept whole?

Scenario 4: Loss below the avoidance level of losing 900 people

A deadly pandemic is threatening to wipe out every human on Earth. 1000 people remain. World leaders have gotten together and decided that if more than 900 of these people die, the human species go extinct. There are 50 doses of a vaccine. There are two proposals made. One is to give a full dose of the vaccine to 50 people. If this is done, there is a 100% chance that the other 950 people will die. The second proposal is to split each vaccine into two doses and give half-doses to 100 people. If this is done, there is a 50% chance that 900 people will die and a 50% chance that 1000 people will die. Should the vaccines be split in half or kept whole?

**Procedure**

All four scenarios were administered in paper and pencil format. 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 options presented in the scenario he or she preferred. Which scenario each participant received was randomly determined although each scenario was given to a total of 22 participants.

**Results**

In each scenario, participants had to choose between splitting the doses of the vaccine and potentially saving twice as many people as keeping the dose whole or keeping the dose whole. Accordingly, splitting the vaccine could be viewed as the riskier choice than keeping the vaccine

whole. Table 1 presents the number of participants out of 22 who selected the risky alternative (split the vaccine doses) for each of the four scenarios.

**Table 1:  Number of participants who opted to split vaccine doses based on scenario.**

|  | Below-aspiration level gain | Above-aspiration level gain | Below-avoidance level loss | Above-avoidance level loss |
|---|---|---|---|---|
| Split doses | 16 | 2 | 15 | 5 |

The original Kahneman and Tversky version of the Prospect Theory framing effect stated that people's attitudes toward risk depends on whether the scenario presented a decision framed in terms of a gain (lives saved) or a loss (lives lost).  It was silent as to whether the scenario stated any goals that may impact the desirability of saving or losing a certain number of people. On the other hand, our revision of Prospect Theory's value function predicts that people's attitudes toward risk depend on whether the scenario presented a decision framed in terms of below or above a stated goal (i.e., goal met or not met) and does not depend on gain or loss per se. Therefore, the original version of Prospect Theory predicts a main effect for gain vs. loss with no prediction for location of current state with respect to goals while our version of Prospect Theorypredicts a main effect for location of current state with respect to goals and no effect for gain vs. loss.

A cursory review of Table 1 suggests that the data support our revised version of Prospect Theory, rather than the original version.  Overall, when the decision was presented in terms of gains (how many lives would be saved), participants chose the risky option (split the pills) 18 out of 44 times.  This was statistically equal to the 20 out of 44 times participants chose the risky option when the decision was presented in terms of losses (how many people would die), $z < 1$, ns.  This outcome runs counter to the findings in the original Tversky and Kahneman (1981) framing effects study that was based on their 1979 version of Prospect Theory but is consistent with our revised version and the present hypothesis that there would be no main effect for gains vs. losses.

Our hypothesis also states that there would be a main effect for attitudes toward risk when outcomes are presented as above or below the aspiration and avoidance levels (i.e., the number of people required to live in order to perpetuate the human race).When the scenario was presented as being above the goal,only 7 of 44 participants chose the risky alternative. On the

other hand, when the scenario was presented as being below the goal, 31 of 44 participants chose the risky alternative. This difference was statistically significant, $z = 5.17$, $p < .001$ and confirmed our hypothesis.

Separate analyses of gain and loss data provided further confirmation of our hypothesis. 2 of 22 participants chose the risky alternative when the decision was presented as a gain above the aspiration level, compared to 5 of 22 participants who did the same when the scenario was presented as a loss above the avoidance level, $z = 1.27$, ns. Similarly, when the scenario was presented as being below the goal, 16 of 22 participants chose the risky alternative when the decision was presented as a gain, compared to 15 of 22 participants who did the same when the scenario was presented as a loss, $z < 1$, ns.

On the other hand, whether the scenario was presented as above or below the goal did have an effect on participant's choices. When scenarios were presented with outcomes at or above the aspiration level (saving 100 people), 2 of 22 participants chose the risky alternative when the scenario was presented as being above the aspiration level, while 16 of 22 participants chose the risky alternative when the scenario was presented as being below the aspiration level. This difference was statistically significant, $z = 4.27$, $p < .001$. Similarly, when the decision was framed as a loss, 5 of 22 participants chose the risky alternative when the scenario was presented as being above the avoidance level, while 15 of 22 participants chose the risky alternative when the scenario was presented as below the avoidance level. This difference was also statistically significant, $z = 3.00$, $p < .001$. These results are consistent with predictions made by the Leddo et al. (2019) revision of Prospect Theory but are inconsistent with the original formulation of Prospect Theory.

**Discussion**

The present results provide further confirmation of Leddo et al.'s (2019) reformulation of Prospect Theory and further confirmation that the original formulation of Prospect Theory, as published in 1979, is flawed. A major tenet of the original Prospect Theory is that when it comes to decisions involving uncertainty, there is a main effect of whether decisions involve gains or losses on decision makers' attitudes towards risk. Specifically, Prospect Theory argues that decision makers are risk averse when confronted with decisions involving gains and risk seeking when confronted with decisions involving losses. This finding was highlighted in Tversky and Kahneman's framing effects study (1981) in which the authors showed that the predicted attitudes toward risk could be induced by merely framing the same decision around gains or losses.

Leddo et al. (2019) argued that the original formulation of Prospect Theory lacked consideration of goals that are typically present when people make decision: outcomes they are aspire to achieve or those they are trying to avoid. Our revised version of Prospect Theory posited a value function that took into account these aspiration and avoidance levels and argued that people would be risk seeking when below these levels and risk averse when above. We presented data confirming this revised value function. The present study extends this reformulation of the value function to the framing effects found by Tversky and Kahneman (1981), which also did not take into account goals people might have. Accordingly, we hypothesized that there would be no main effect for gain vs. loss as posited by Kahneman and Tversky, but rather the main effect would be determined by location of the outcome with respect to the aspiration or avoidance level.

The present study confirmed these hypotheses. Contrary to the predictions of the Kahneman and Tversky formulation of Prospect Theory, there was no main effect for gain vs. loss. Consistent, with our formulation of Prospect Theory, there was a main effect for whether outcomes were above or below the aspiration and avoidance levels and this effect held up individually for both gains and losses. Moreover, we were able to show a framing effect just as Tversky and Kahneman (1981).

Collectively, the present study, when combined with the first paper posited the formulation of Kahneman and Tversky's value function (Leddo et al., 2019) and the follow-up paper showing that people act in accordance with the revised value function when dealing with decisions involving friends as well as those involving themselves (Leddo and Shukla, 2020) present a string of compelling findings that Prospect Theory's original formulation is incorrect and, more generally, that any theory of decision making under uncertainty must involve consideration of goals regarding gains and losses and not just look at hypothetical scenarios devoid of decision maker's goals. Further research could examine other variables that could impact decision making in the presence of uncertainty and goals such as time horizon or whether or not the decision creates outcomes one can recover from.

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