

Science Education Collection

# Prospect Theory

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## Overview

Source: Laboratory of Jonathan Flombaum—Johns Hopkins University

What's the value of a dollar? Currencies store value to facilitate trade. Implied in any economic transaction is the value of a unit of currency. But what is the subjective value of a dollar? For a long time, economists assumed the answer to this question to be, specifically, that a dollar has a value determined by the market and that the subjective value of a dollar is always that, more or less.

Beginning in the early 1970s, experimental psychologists Daniel Kahneman and Amos Tversky upended this assumption, showing that the subjective value of currency depends on a number of factors, most notably, whether losses or gains are being discussed, and the overall size of a transaction. To pump intuition, consider the fact that, to most people, it would seem reasonable to drive an extra half-mile in order to save \$2 on a gallon of gas. But very few people would do the same to save \$2 on the cost of a new car. So \$2 is sometimes, but not always worth an extra half-mile drive. Value is context-dependent.

The theory devised by Kahneman and Tversky to describe how people psychologically value currency (and goods and services, generally) is called Prospect Theory. In 2002, Kahneman was awarded the Nobel Prize in Economics for Prospect Theory, along with related research using the methods and theories of experimental psychology to understand economic decision-making (Tversky passed away in 1996.).

Many of the primary implications of Prospect Theory were obtained through survey experiments. The surveys consisted of choices between gambles; for example, subjects might be asked whether they would prefer to receive \$5 or risk receiving nothing with a 50% chance of winning \$10.

This video will demonstrate procedures for designing the type of survey questions used in research on Prospect Theory.

## Procedure

### 1. Stimulus design

1. When options have known outcomes and probabilities, economists describe the value of each choice as the average of its outcomes weighted by their respective probabilities, what they call a choice's expected value.
2. For example, a guaranteed win of \$5 has an expected value of \$5, and a gamble that pays out \$10, 50% of the time (and nothing the other 50% of the time) also has an expected value of \$5:  $0.5 \times 0 + 0.5 \times 10 = 5$ .
3. Devise gambles that tend to lead to different decisions, despite similar or equal expected values (**Figure 1**), in order to design a proper survey to study Prospect Theory.

An expected value of \$5  
as a gain (1) and as a loss (2)

(1)

You have just won a \$5 raffle and you are given two choices:

(A) Keep your \$5.

(B) Or participate in another raffle, in which you can win \$10 with a .5 probability or \$0 with a .5 probability.

(2)

You have just lost a \$5 bet and you are given two choices:

(A) Pay the \$5 you owe.

(B) Or take another bet that has a .5 probability of erasing your \$5 debt and a .5 probability leaving you with a total debt of \$10.

**Figure 1. Two gambles consisting of choices with equal expected value (\$5) as either gains (1) or losses (2).** In gamble 1, the expected value of both choices is a gain of \$5. In gamble 2, the expected value of both choices is a loss of \$5. The choices in each gamble also have equivalent probabilities. Therefore, standard economic theory makes two predictions. First, whatever choice a person prefers in one of the gambles, they should prefer the same choice in the other gamble. A person willing to take a risk in order to win \$5 should be willing to take an equivalent risk in order to avoid paying \$5. And on average, over many participants, choices A and B should be picked equally often. But actual behavior does not conform to these predictions. Many more people will take the risk—choice B—in gamble 2 than would in gamble 1, because losses have greater subjective value than equivalent gains. This is called loss aversion.

- When choosing sample questions for a survey, look for situations with a clear favorite between choices with equal expected values, a preference for a choice with a lower expected value, and a difference when the scenario is applied to gains compared to losses. Also consider situations with very small probabilities and with very high ones (**Table 1**).

A	B
[4000,1]	[5000, .9]
[-4000,1]	[-5000, .9]
[5,1]	[10, .9]
[-5,1]	[-10, .9]
[5000, .9]	[10,000, .45]
[5000, .04]	[10,000, .02]

**Table 1.** The first number in each bracket denotes a currency value, and the second denotes the probability associated with that outcome.

## 2. Procedure

- Once a survey is created, give it to a large group of participants (between 50 and 100 people).
- If one intends the results to be published or shared publicly in other ways, acquire the necessary human ethics approval and informed consent.
- Create a cover page that informs the participant that their responses are anonymous and that they can choose not to complete the survey, and include a place for them to sign to indicate consent.
- After the survey is given to an appropriate number of participants, tally up the number who chose each option—A and B—for each question.
- Compare preferences expressed in related questions to reveal the nature of subjective value with respect to risk, reward, and losses.

## Results

There are several classic effects that arise in these surveys. **Figure 1** illustrates one effect, sometimes known as loss aversion. People seem to place a greater subjective value on losses than on gains of equivalent value. For question 1, between 60-80% of participants will typically choose A, while the same proportion will choose B for question 2. A 50% gamble seems worth the risk to avoid a debt of \$5, but not to earn an extra \$5. \$5 is subjectively more valuable when it is a loss.

**Figure 2** illustrates two more typical effects, associated with certainty and large numbers. In question 1, the participant chooses between a guaranteed win of \$10,000 or a 90% chance of winning \$11,167. 90% is a good bet, and a payout of \$11,167 gives that bet an expected value of \$10,050. Still, almost no one picks the bet, revealing a baseline preference for certain outcomes. Question 2 sets up a very similar situation, but with much smaller numbers: a guaranteed win of \$5 compared to a 0.9 chance of winning \$67. Note that choice B produces an expected value of \$55—\$50 more than the guaranteed win. Here, a majority of participants choose B, forgoing a certain win for a chance to win an extra \$50 (on average). But they don't do the same with question 1. To an economist, \$50 is worth \$50. If a person takes a risk to win it in one place, they should do the same in another. But, psychologically, it turns out that \$50 added to \$10,000 is worth less than \$50 added to \$5.

### Certainty and Large Numbers

(1)

Which of the following options would you prefer?

(80%) (A) \$10,000

(20%) (B) A .9 probability of winning \$11167 and .1 probability of winning nothing.

(2)

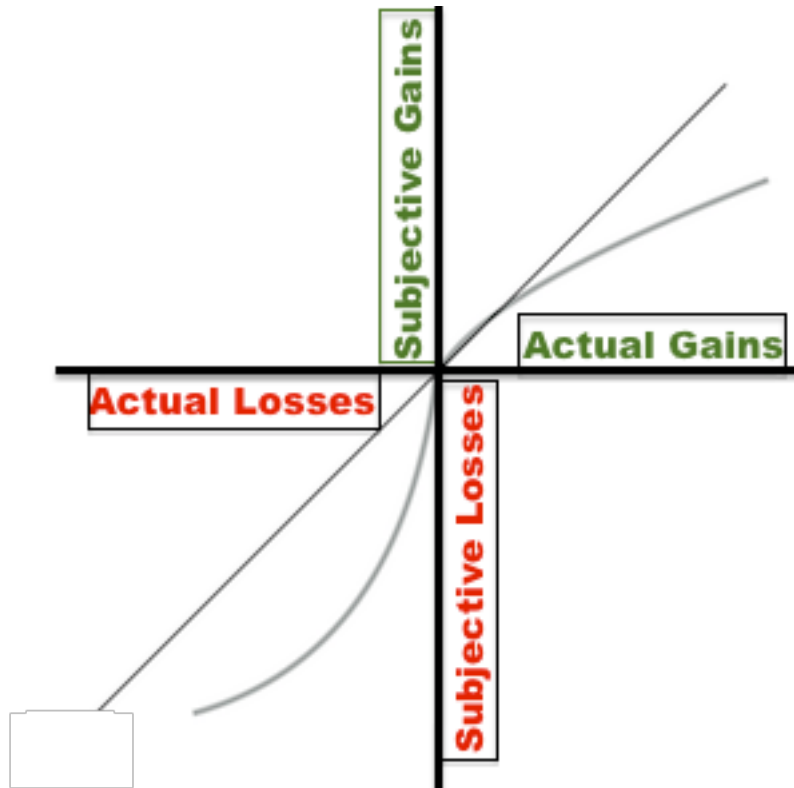
(35%) (A) \$5.

(65%) (B) A .9 probability of winning \$62 and a .1 probability of winning nothing.

**Figure 2. Two gambles that demonstrate the effects of certainty and large numbers on subjective value.** In (1), choice B has an expected value of \$10,050, \$50 more than the guaranteed win in choice A. Yet people overwhelmingly tend to choose A. In (2), the gamble in choice B again has an expected value that is \$50 more than the certain outcome in choice A. But here, people overwhelmingly choose B. \$50 in expected value seems worth the risk when it will be added to \$5, but not when it will be added to \$10,000. The subject value of \$50 is smaller when it is framed in relation to a large number.

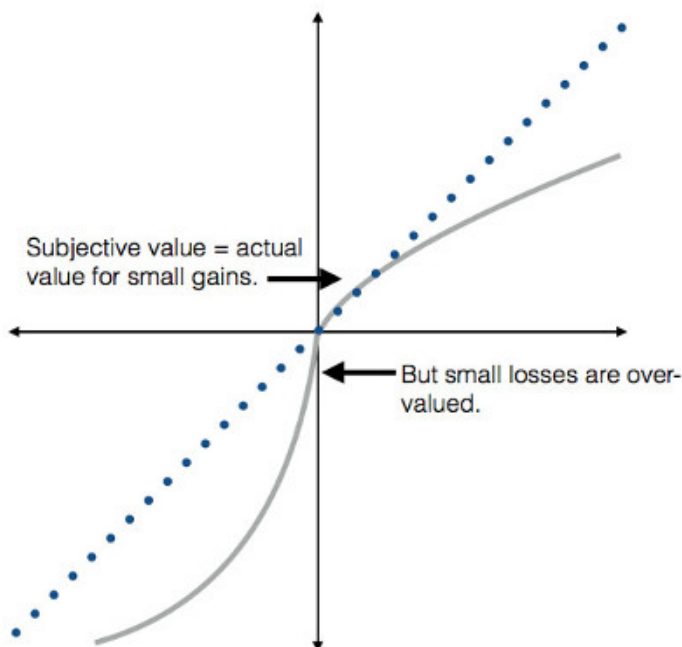
Based on hundreds of comparative gambles of this kind, in experiments spanning gains and losses, large and small numbers, and even using real (as opposed to hypothetical) payouts, Kahneman and Tversky developed the now famous and influential Prospect Theory curve (**Figure 3**). The curve relates subjective value to actual value in terms of gains and losses. **Figure 4** emphasizes two main properties of the curve, rational subjective value placed on small gains—that is, small gains subjectively valued equivalently to their actual value—and an overestimation of small

loses. **Figure 5** emphasizes two more properties of the curve, diminishing subject value as actual value increases for already large gains or losses.



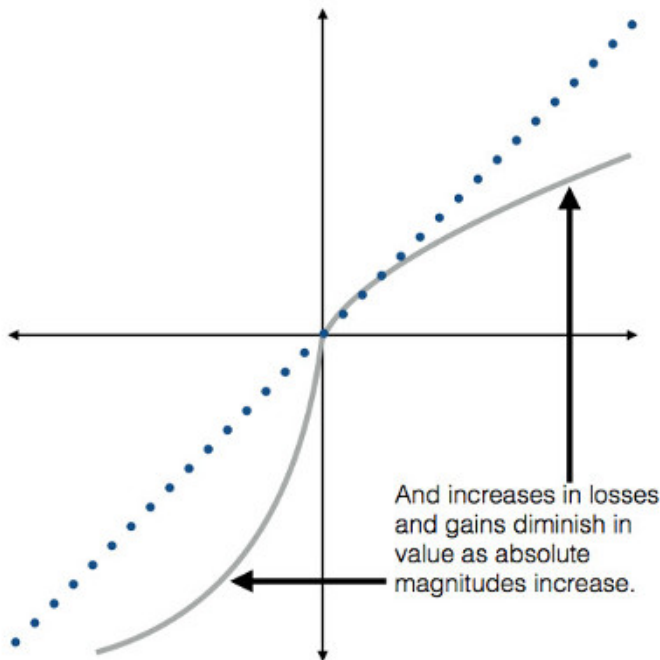
**Figure 3.** Based on their experiments, Kahneman and Tversky devised the descriptive **Prospect Theory** value function. The x-axis denotes the actual value of gains and losses, and the y-axis denotes the psychological value attributed subjectively.

## The Prospect Theory Value Function



**Figure 4.** Drawing a straight line through the origin helps to emphasize the ways that the **Prospect Theory** function deviates from what were previously the assumptions of economists. The straight line reflects a one-to-one correspondence between actual and subjective value. Small gains are valued appropriately. But small losses are overvalued subjectively.

## The Prospect Theory Value Function



**Figure 5. Prospect Theory value function.** Both large gains and losses are relatively undervalued.

### Applications and Summary

Prospect Theory has had wide ranging implications and applications. That is why Kahneman was ultimately awarded the Nobel Prize.

For example, Prospect Theory explains a lot of gambling behavior, such as the tendency of people to continue gambling when they have losses. Even small losses loom large, subjectively, and it makes people willing to take risks they would not normally take when given the prospect of erasing a loss. But this usually has the effect of producing larger and larger debts. As a result, Prospect Theory has implications for preventing pathological gambling.

It also has had an enormous impact on marketing. For example, it explains the effectiveness of “loss leaders.” Stores will often advertise relatively large discounts on cheaper items—\$20 off before Christmas on an item that normally costs \$40. The item may even sell at a loss, a negative profit margin for the store, but the hope is that the discount will be perceived as larger than it actually is, so consumers will subjectively value it as worth more than \$20, owing to it being a *discount*. That will drive them to the store, where they might spend more on high margin and big-ticket items: TVs, stereos, and the like. Imagine if the store offered a \$20 discount on a \$2000 TV instead. Would anyone rush to that particular store?