Prospect Theory
people evaluate potential changes in relative wealth, not absolute wealth
A reverse sunk cost effect in risky decision making: Sometimes we have too much invested to gamble

Marcel Zeelenberg a,b,*, Eric van Dijk c

a Department of Social Psychology, University of Amsterdam, The Netherlands
b Faculty of Technology Management, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, The Netherlands
c Department of Social and Organizational Psychology, Leiden University, Wassenaarseweg 52, 2333 AK Leiden, The Netherlands

Received 5 January 1996; accepted 27 April 1997

Abstract

The sunk cost effect refers to the empirical finding that people tend to let their decisions be influenced by costs made at an earlier time in such a way that they are more risk seeking than they would be had they not made these costs. This finding seems to be in conflict with economic theory which implies that only incremental costs and benefits should affect decisions. The effect is often explained in terms of prospect theory of (Kahneman, D., Tversky, A., 1979. Prospect theory: An analysis of decision under risk. Econometrica 47, 263–291), suggesting that sunk costs may induce a ‘loss frame,’ consequently causing risk seeking behavior. We argue that sunk costs may also result in risk aversion. In the present study we investigated the effect of time and effort investments (Behavioral Sunk Costs) on risky decision making in gain and loss situations. The results show that, in agreement with prospect theory, participants were more risk averse in gain situations than in loss situations. Moreover, incurring Behavioral Sunk Costs appeared to increase risk averse choices, i.e., a reverse sunk cost effect.
Your bonus: let’s flip a coin

Great Job!

$100,000 salary

$110,000

??

$90,000
Which would you choose?

Great job!

$100,000 salary

or

$110,000

??

$90,000
Compare that with:

Casino promotion

$10,000
Prospect Theory says that people evaluate potential changes in RELATIVE wealth, not in absolute wealth states. This is the most central idea in behavioral economics. It will exert its influence in many key decisions.

When faced with a risky decision we think less about our bank account and more about whether we will be better or worse off afterward.
Everyday example of reference points

- Consumer’s love sales!
- Marketers love sales because it is a reference point to the regular price
- Not saving money when buying something at 20% off.
- However, if one adopts the reference point of the merchandise as the regular price then the sale of 20% can seem psychologically like savings.
Is the left center circle larger?  Is the top yellow line longer?
Are these lines straight or crooked?
How do you represent something with **sufficient range** to accommodate **big numbers** and **sufficient precision** to resolve differences between **small numbers**?
Humans can see over a light intensity range of several million to one.
Surface luminance levels

- Sunlight: $10^5$ candelas/meter$^2$ (cd/m$^2$)
  - Approx. $10^{22}$ photons/m$^2$/sec
  - 3%-90% of photons are reflected as luminance
  - 3% for black surfaces, 90% for white surfaces
  - Only some of the reflected photons enter the pupil of eye
- Indoor lighting, CRTs: $10^2$ cd/m$^2$
- Moonlight: $10^{-1}$ cd/m$^2$
- Starlight: $10^{-3}$ cd/m$^2$
- The eye can adjust to changes in light level by a factor of 100,000,000!
- Yet firing rates only typically range from 0-400Hz.

Mechanisms of light/dark adaptation

1. Pupil size
2. Switchover between rods and cones
3. Bleaching/regeneration of photopigment
4. Feedback from horizontal cells to control the responsiveness of photoreceptors

At night, tiny changes in absolute brightness change the neurons firing rate.

During the day, in bright light, the reference point increases and greater changes in absolute brightness are required to alter the firing rate of a neuron.
the same principles apply to decision-making
Reward prediction errors consist of the differences between received and predicted rewards. ... dopamine ... signal(s) a reward prediction error; they are activated by more reward than predicted (positive prediction error), remain at baseline activity for fully predicted rewards, and show depressed activity with less reward than predicted (negative prediction error).
reward prediction error
DEFINING TERMS:

reward and punish(ment)
DEFINING TERMS:

- **prediction**: involves information about the future.
- **error**: different than what was predicted

**prediction and error**
**How is the error calculated?**

\[
\text{Error} = \text{what is currently happening} - \text{what was predicted}
\]
The reward prediction error is therefore:

\[
\text{Reward Prediction Error} = \text{current reward} - \text{predicted reward}
\]

Reward prediction error is the difference between a reward that is being received and the reward that is predicted to be received.
Dopaminergic Pathways

VTA: Ventral Tegmental Area

- Motor related functions
- Reward related functions

Frontal cortex, Nucleus accumbens, VTA, Striatum, Substantia nigra, Hippocampus
Dopamine Neurons respond by changing their firing rate.

- Decrease rate when rewards are worse than expected.
- If reward is as expected: no change in firing rate.
- Increase rate with better than expected rewards.
Reward Prediction Error

- Brain creates an expectation reference point about the reward received.

Dopamine Neurons respond by changing their firing rate.
Note: DA neurons do not respond to the rewards themselves; they respond to whether a reward was better or worse than the current reference point – the reward prediction error.

If rewards are worse than expected, then dopamine neurons decrease their firing rate.

When rewards are better than expected, then dopamine neurons increase their firing rate.

No change in firing rate when reward is exactly as expected.
Walking along and find a Scratch & Win ticket.

Your DA neurons would be firing because you found the ticket – unexpected reward.
The **expected value** of the ticket is $2.00.
I won money. That should be a ‘reward’. My dopamine neurons are not firing.... because $1 is less than the expected amount.
I won money.
My dopamine neurons are firing!!!
$10 is more than the expected amount.
How Winning Can Mean Losing in Poker and Life

By Jennifer Rigdon Wednesday, Jan. 13, 2010

You can learn a lot about gambling if you’re willing to analyze 27 million hands of online poker. Don’t have time for that? No worries, sociology doctoral student Kyle Siler of Cornell University has done it for you.

Siler’s computerized analysis, the more hands you win, the more money you’re likely to lose — and this has implications that go well beyond a hand of cards.

Siler’s work was published in December in the online edition of the Journal of Gambling Studies and will appear later this year in the print edition. He was not interested in poker alone but in the larger idea of how humans handle risk, reward and variable payoffs. Few things offer a better way of quantifying that than gambling — and few gambling dens offer a richer pool of data than the Internet, where millions of people can play at once and transactions are easy to observe and record.

To gather his data, Siler used a software system called PokerTracker and directed it to collect and collate information on small-medium and large-stakes games. He limited the games to no-limit Texas Hold’Em with six players in order to eliminate at least some extraneous variables. It was in the course of cranking all that information that he found the strangely inverse relationship between the number of hands won and the amount of money lost. He also noticed that it was novice players who lost the most.

The reason for the paradoxical result was straightforward: the majority of the wins the players tallied were for relatively small stakes. But the longer they played — and the more confident they got — the blander they were to get blown out on one of a few very big hands. Win a dozen $50 pots and you’re still going to wind up with less than you lost if you lose a single $1,000 one. “People overweight their frequent small gains vis-à-vis occasional large losses,” Siler says.

Small-stakes players also tend to do better with small-denomination cards. A pair of jacks may easily beat a pair of fours, but people who don’t gamble much tend to win more with the fours — or with any cards from tens to sevens. That’s because the cards’ modest numerical worth is easy to understand: they’re valuable but not that valuable. When you get into the more rarefied area of eights to aces, you start building perspective and putting up more money. “Small pairs have a less ambiguous value,” Siler says. So what does this have to do with you if you don’t gamble? It’s the wrong question because, actually, you do.

Inverted, buying a house and mortgaging the street are all acts that involve discernible risks and uncertain rewards. The more small returns you get from your small investments in stocks, the blander you are to make — and lose — a big investment. The more times you get behind the wheel and speed a little bit, the blander you are to speed a bit — with deadly consequences.

“These kinds of calculations are made every day,” says Siler. “Adultery is another good example. People get away with it countless times but they get caught just once and they lose everything.”

And unlike the risks at the poker table, where your losses are just yours, in the larger world, you can take down a lot of other people’s money. “Organizational malfeasance in general depends on this kind of risk analysis,” says Siler. “Look at a place like Enron. People took a lot of small chances and won, then took big chances and lost big.” Indeed, Siler points out, during the recent financial crisis, an entire nation who bet on the market — went bankrupt in a similar way, trusting high-risk, high-reward investments that quite paying off.

While walking away from the poker table can be easy, walking away from life — and all the risks and rewards it presents to you — is not an option. But in both versions, the rule should be the same: gamble only what you can afford to lose — and know when you’re approaching those stakes.

Social and Psychological Challenges of Poker

By Kyle Siler

Launched online: 25 December 2009
© Springer Science+Business Media, LLC 2010

CORNELL CHRONICLE

Online poker study: The more hands you win, the more money you lose

By Susan S. Lang | January 13, 2010
How is it that the poker players who won most often were also the ones who lost the most money?
Reference dependence and DA neurons

- DA cares about wins and losses – not about the amount!
- So, win $10 – player's brain DA fires! Yay!
- Motivates them to keep playing
- Losing a large amount of money, e.g. -1000 is coded as a bad event – but it does not seem 100x worse than the good events!

- Winning small amounts and losing big amounts is a great way to manipulate the activity of dopamine neurons.
- It is also a fast path to bankruptcy!
Most successful poker players

- 1. they lose often.
- 2. when they lose, they lose small amounts
- 3. when they win, the win big!

- Reference dependency leads to bias in decision making
- The biases should be minimized in order to make better choices.
next week...