

To What Extent Does Cognitive Bias Play a Role in the Prediction of Black Swan Events Using the Challenger's Case Study

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Abstract: In this essay, different types of cognitive biases and its role in the prediction of black swan events is explored through the use of the 1986 Challenger disaster. The challenger's case was mainly caused by its o-rings failure due to cold weather, which was unpredictable and unexpected by all engineers at NASA. The different types of cognitive biases that were involved in this event were confirmation biases, sunk cost fallacy and groupthink mentally. Along with the political and social pressures at the time, these confirmation biases play a role in the false decision-making process during the challenger's launch, which in itself is a black swan event. This leads to an importance in the prevention and recognition of cognitive biases, which requires strategies.

Keywords: cognitive bias, black swan events, 1986 challenger's case

1. Introduction

The Challenger space shuttle disaster of 1986 is a tragic event that shocked the world. The explosion of the space shuttle just 73 seconds into its flight resulted in the deaths of all seven crew members on board. The disaster was a black swan event, an unpredictable and rare occurrence that had a profound impact on the space industry and NASA's reputation. This event highlighted the importance of risk management and the need to identify potential failures in complex systems. The Challenger disaster has been extensively studied from various perspectives, including engineering, management, and organizational behavior. One aspect that has received relatively little attention is the role of cognitive bias in the prediction of black swan events. Cognitive biases are systematic errors in thinking that affect our judgment and decision-making. They can lead to overconfidence, confirmation bias, and other forms of irrational thinking that can obscure or distort the evidence.

In this essay, we will explore the extent to which cognitive bias played a role in the prediction of the Challenger disaster. Specifically, we will examine how cognitive biases may have influenced the decision-making process leading up to the launch and the subsequent failure analysis. We will also consider the implications of these biases for the prediction of future black swan events. This will help prevent and raise awareness about the future cognitive biases.

2. Black Swan Events

When there is a very wide discrepancy between what we know and what we believe we know, a “Black Swan” results [1]. It usually shows uncertainty. The black swan events have three main characteristics [2]: 1) It is an outlier that is always out of people’s expectations, 2) It is able to cause extreme effects, for example, the outbreak of COVID-19 plunged the world economy into recession, and 3) Human nature may makes us generate some reasonable explanations for the occurrence of such black swan events, after the fact, and making it seems explainable and predictable [3].

Black swan events can be categorized as three different types:

“Unknown unknown”, which means that people may not even have a concept of the event due to their lack of knowledge. For example, young children probably don’t know what dice are, so they may be unable to predict what numbers are thrown. “Unknown known” refers to the events in which someone may have information about it, but others do not. For instance, in the “911 terrorist attacks”, the terrorist planners knew in advance that this was going to happen, and thus it was not a black swan event for them. But for most people, this is an “unknown known” black swan event that causes serious damage to the economy. In other words, this means that the information about these events is available before it actually happens, but the probabilities might be low. “Known known” is a type of black swan event that people think the probability of occurrence of such events is negligible, thus they do not believe this will occur [4].

3. Cognitive Biases

Cognitive bias refers to the systematic errors in thinking or processing information that can lead to inaccurate judgments, interpretations, and decisions. These biases arise from our brain’s natural tendency to simplify and make sense of complex information by relying on mental shortcuts and heuristics. While these cognitive shortcuts can be helpful in some situations, they can also lead to errors and distortions in our thinking.

There are many different types of cognitive bias [5], which can be categorized based on the type of mental shortcut or heuristic that is being used. Some of the most common types of cognitive bias include:

Confirmation bias: This bias occurs when we seek out or interpret information in a way that confirms our pre-existing beliefs or hypotheses, while ignoring or discounting evidence that contradicts them.

Anchoring bias: This bias occurs when we rely too heavily on the first piece of information we receive when making a decision or judgment, even if it is not relevant or accurate.

Hindsight bias: This bias occurs when we believe, after an event has occurred, that we would have predicted or expected it to happen, even if we had no reason to believe it at the time.

Framing bias: This bias occurs when the way information is presented or framed can influence our judgment or decision-making, even if the underlying information is the same. For example, people may be more likely to choose a product if it is marketed as 95% effective rather than 5% ineffective.

Cognitive biases arise from a combination of factors [6], including evolutionary and environmental influences on our thinking processes. Evolutionarily, our brains have evolved to prioritize quick and efficient decision-making in order to survive in a fast-paced and uncertain environment. This has led to the development of mental shortcuts and heuristics that can help us make decisions quickly, but can also lead to errors in judgment. Environmental factors, such as social norms and cultural influences, can also contribute to cognitive biases. For example, people may be more likely to exhibit confirmation bias if they are part of a social group that values conformity and loyalty over critical thinking and open-mindedness.

In addition, cognitive biases can be influenced by individual differences, such as personality traits and cognitive styles. For example, people who are more open to new experiences may be less likely to exhibit confirmation bias, while people who are more prone to anxiety may be more likely to exhibit a negativity bias (a tendency to focus on negative information). Cognitive biases can have significant consequences, both on an individual and societal level. At the individual level, cognitive biases can lead to poor decision-making, misunderstandings, and missed opportunities. For example, confirmation bias can prevent individuals from considering alternative viewpoints or taking in new information that may challenge their beliefs. At the societal level, cognitive biases can contribute to discrimination, prejudice, and inequality. For example, stereotyping is a form of cognitive bias that can lead to prejudice and discrimination against certain groups of people. It is important to recognize and address cognitive biases in order to promote fairness, accuracy, and equity in our decision-making processes. The consequences will be further explored using the case study of Challenger's launch later in the essay.

4. Summary the Case of the Challenger

To give a summary for the Challenger's case. The launch of Challenger was involved in the Space shuttle program operated by the US National Aeronautics and Space Administration (NASA). This program was created in 1958, and it aimed to rely on the reusable space crafts to explore civilian space and also reduce the costs. In total, there were five orbiters constructed during the program. And the Challenger was the second one.

The Challenger disaster happened on 28th January 1986 and broke apart 73 seconds into its flights, killing all seven crew members aboard. It is referred to as a "black swan event", since before it actually happened, no one can accurately predict this event. It was out of people's expectations and caused extreme effects. The influence of it includes the reputations of NASA, the public's trust, the death of seven crew members and so on.

Additionally, after it happened, people would try to find a reasonable explanation for this, which is also another characteristic for the "black swan event". Discoveries found that the failure of this launch was caused by the primary and secondary O-ring seals in a joint in the shuttle's right SRB. Then, the providers of SRB (engineers from MT) determined that the cold temperature could cause the loss of flexibility in the O-rings that decreased their ability to seal the field joints. Consequently, MT engineers, led by Allan McDonald and Roger Boisjoly were trying to investigate the effectiveness of O-rings. They recommended that the temperature at the time of launch should be above 53°F to guarantee the validity of O-rings. As a result, on 27th January 1986, at the night before the Challenger shuttle launch, MT engineers and NASA managers had the teleconference to decide whether they should delay the launch or not.

Moreover, it may be considered as an "known known" type, because MT engineers already knew that the O-ring could fail at low temperatures, causing the Challenger to crash. But managers believed the correlation is small, and that a very small probability of the accident did not affect normal launch. This may show that during the teleconference, participants were affected by the cognitive biases and also other concerns (such as financial pressure and NASA's reputation), finally leading to an unsuccessful decision [7].

5. Effects of Cognitive Bias

The main reason that NASA proceeded with the launch was due to various cognitive biases [8]. For NASA, the delay of launch will have a major impact on its reputation and lead to a significant loss of public trust, as it faces intense scrutiny from the media and the public, thus the groupthink mentality arises. Groupthink occurs when a group of people prioritize consensus and agreement over critical

evaluation of alternative options. In the Challenger case, there was a strong sense of groupthink among the Morton Thiokol engineers, as they were under significant pressure to meet the launch schedule, which created a strong pressure to conform to the group's decision, even if it went against their own beliefs.

This pressure was further compounded by the confirmation bias, where individuals seek out information that confirms their pre-existing beliefs and ignore information that contradicts them. In this case, the main cause of the O-ring failure that led to the Challenger disaster was the unusually cold weather conditions on the day of the launch which causes the o-ring material to become hard and brittle, but still, the engineers were overconfident in the safety of the launch due to prior successful launches and the fact that they had not encountered any major issues in the past.

Furthermore, the sunk cost fallacy was present in the decision-making process, where individuals continue to invest resources into a decision even when it becomes clear that the decision may not be the best course of action. The cost of the Challenger launch itself was estimated to be around \$1.2 billion in 1986, which included the cost of the Space Shuttle Challenger, the payload, and other associated expenses. The group had already invested significant resources into the launch, and this may have influenced their decision to launch despite the potential risks associated with the O-rings.

Overall, People may become complacent when things are going well, and they have experienced a long period without any major unexpected events. This can lead to a false sense of security and a failure to consider the possibility of a black swan event. When a black swan event does occur, the overconfidence and lack of preparation can exacerbate the consequences. It can also lead people to overlook warning signs and dismiss evidence that suggests a black swan event may be imminent. This can result in a failure to take necessary precautions or prepare for the unexpected [9].

6. Strategies to Prevent Biases

6.1. Diversity in Group as Well as Sources

Diversity among the decision makers will reduce cognitive biases. Because a diverse group of people have different backgrounds and different perspectives of thinking, they are more prone to having a well-rounded perspective on issues, which reduces groupthink. In a diverse group, it is also easy to start debates and promote critical thinking as people express their own view on issues. Furthermore, when there is diversity in a group, it can lead to an increased understanding and empathy towards different cultures, backgrounds, and experiences. This can help prevent the fundamental attribution error, where people overemphasize personal characteristics when interpreting the behavior of others [10].

6.2. Deductive Thinking (Critical Thinking)

As The philosopher and mathematician René Descartes says, it's always better to think deductively, finding the flaws and trying to disprove your own argument, rather than looking for clues to support your argument, which promotes cognitive biases. Deductive and critical thinking involves analyzing arguments to determine their strengths, weaknesses, and logical consistency. This can help prevent the anchoring bias, where individuals become fixated on a particular idea or solution. As people search for more sources of evidence, and questioning assumptions, evaluating evidence, analyzing arguments, considering alternative perspectives, and making informed decisions, individuals can overcome cognitive biases and make better decisions.

6.3. Recognize That Cognitive Bias Exists

Some common cognitive biases include confirmation bias, overconfidence bias, anchoring bias, halo effect, gambler's fallacy and groupthink effect. In order to minimize the effects of these cognitive biases, it is important to first acknowledge that cognitive bias exists. So that we can better avoid them in our daily life. For example, every time when people are making a decision, go through these common cognitive biases in the mind to see if we are affected by them. This not only helps us avoid bad business decisions, but also helps us reduce losses in our lives, such as the gambler's fallacy.

6.4. Open and Transparent Work Environment

An open and transparent work environment allows participants to better exert their abilities. And it also avoids groupthink effects to some extent. Groupthink means that people tend to follow the crowd and are afraid to express their own opinions, especially when class divisions are very clear. In other words, this also increases the diversity of inputs, since more people have the chance to express their own opinions.

6.5. Reflection and Peer Evaluate

Since everyone has different life experiences and beliefs, regularly reflecting on us and asking others for their opinions can go a long way toward avoiding confirmation bias. Confirmation bias is our tendency to concentrate on information that matches our own experiences and statements. So, when someone else is giving advice, there are more inputs for us to think and can let us think in different ways. Consequently, people are less likely to focus solely on the evidence that supports their opinion. Also, this can reduce people's overconfidence bias. For example, if NASA managers can reflect on themselves more frequently, and ask others advice, they may be less concentrated on the evidence supporting "low temperature may not affect the erosion of O-rings significantly", thus the Challenger disaster may be avoided.

6.6. Decision Making Framework

When people are making decisions, it would be better to have a good leader. Because the leader can help us better define the framework of the decision-making process, prevent the topic from going astray, so as to make the right decision. At the same time, it can prevent people from being influenced by framing effects when thinking. The framing effect refers to a cognitive bias that people may react differently to something depending on whether it is presented as positive or negative. In the Challenger case, the "framing" of the conversation changed, leading to the wrong outcome. Initially, the question it should have been trying to answer was "Prove to me that we should launch". But at the end of the teleconference, it was obvious that people were trying to answer, "Prove to me that we shouldn't launch".

7. Conclusion

Black swan events can have a significant impact on individuals, communities, and the whole economy. Scientists have tried to predict the occurrence of these black swan events in order to avoid unintended harm. In addition, cognitive bias is a study that combines psychology with economic management, and it may affect the way people think. Learning cognitive bias can help people better avoid falling into the error of cognitive bias and carry out rational and objective analysis. But understanding of the effects of cognitive bias is still limited. The extent to which cognitive biases affect people's ability to think rationally remains to be seen. It is our fervent hope that individuals will

become increasingly adept at mitigating cognitive biases and enhancing their ability to accurately anticipate black swan occurrences in the coming years.

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