# The impact of cognitive bias in safety

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Bias surrounds us every day. Everything we look at has a lens of our experience colouring our perception, and everyone has their own lens. This impacts how we share and receive information. So why is this important for process safety? Cognitive biases cover a range of aspects, each of which can have an impact on process safety. They range from; what we remember, to coping with too much information, to a lack of context and meaning or a need to act with great haste. There are many identified specific cognitive biases, not every one of them impacts on process safety, but many can and have. This paper will review several process safety type incidents that had cognitive bias as a factor and discuss ideas on how to manage the bias, so we do not fall into its trap.

Keywords: bias, learnings, case histories, culture

## 1 Cognitive bias

Cognitive bias is defined as a systematic deviation from norms or rational judgement, a way of creating a subjective based reality based on an individual's perceptions (Haselton, D, & PW, 2005). While on the surface this sounds like a pitfall in human decision making, our cognitive biases allow us to make quick decisions. This can be advantageous when time is of the essence, provided the bias does not lead us in the wrong direction. Making decisions based on biases, or heuristics to estimate outcomes is a faster way to make decision than rational decision making, and it also fits in with the idea that we have two mind systems, system 1 and system 2. "System 1 operates automatically and quickly, with little or no effort and no sense of voluntary control. System 2 allocates attention to the effortful mental activities that demand it, including complex computations." (Kahneman, 2011, p. 20). The problem with system 1 is that it is sometimes wrong, and unless we use system 2 to override the wrong answer, we can end up with the wrong decision. Take for example Figure 1. Quickly glance at it an decide which line is longer, A or B. Your system 1 would have said line B.


Figure 1 – Which line is longer?

If you were to engage your system 2, and take a ruler and measure the lines you would see they both the same length. System 1 was misled by a perspective perception. The challenge for managing bias is to engage system 2 prior to making critical decisions.

Another concept to describe this System 1 thinking is called "thin slicing". This "refers to the ability of our unconscious to find patterns in situations and behaviour based on very narrow slices of experience." (Gladwell, 2005, p. 23) It can be summarized as that initial gut decision we may feel in an instant.

### 1.1 Most common biases

There are 188 identified different cognitive biases (Benson, 2017), though they can be grouped into the 4 categories of:

- What should we remember?
- We need to act fast
- Too much information
- Not enough meaning.

Common biases that can have an impact on safety are:

- Anchoring
- Confirmation bias
- Framing
- Hindsight bias
- Status quo bias
- Sunk-cost bias (Hersing, 2017)
- Halo effect
- Curse of knowledge

Table 1 shows the linkages between the groups, sub-groups and biases as categorized by Benson (2017). Note none of the biases discussed in this paper fit into the "What should we remember?" group.

Table 1. Groups, sub-groups and biases (Benson, 2017)

| **Group** | **Sub-group** | **Bias** |
|---|---|---|
| We need to act fast | To avoid mistakes we aim to preserve autonomy and group status to avoid irreversible decisions | Status quo bias |
| | To get things done, we tend to complete things we've invested time & energy in | Sunk cost fallacy |
| Too much information | We notice when something has changed | Framing |
| | | Anchoring |
| | We are drawn to details that confirm our own existing beliefs | Confirmation bias |
| Not enough meaning | We project our current mindset and assumptions onto the past and future | Hindsight bias |
| | We imagine things and people we're familiar with or fond of as better | Halo effect |
| | We think we know what other people are thinking | Curse of knowledge |

## 2 How biases impact decision making

System 1 is the part of our mind that makes decisions quickly, and without active thought. It is doing this based on our past experiences and various cognitive biases that exist for each of us. This means that our biases have an effect on our decision making when our system 1 is in control. Each bias is explained int eh section below with incident examples. The incident descriptions are illustrative only for more detail on each incident see the references.

### 2.1 Status quo bias

This is a tendency to want things to remain the same as they have been, an avoidance of change (Hersing, 2017). An everyday example here may be remaining with your current mobile phone carrier even though a competitor may offer better rates or service. It may appear easier to just remain with the current carrier, rather than go through the work required to change. This type of bias can become an issue if the current way is not working or has unmanaged or unidentified hazards in it. A process safety example for status quo bias is the Columbia Space Shuttle. Over the years that the space shuttle program had been running, NASA has normalized foam strikes as a part of launch, resulting in the status quo being maintained. It was determined that foam strikes were not a safety of flight issue, and therefore there was no need to change the status quo (Columbia Accident Investigation Board, 2003).

### 2.2 Sunk cost fallacy

This is a tendency to want to continue with a course of action, even when evidence suggest otherwise, in an attempt to recoup losses (Hersing, 2017). It can occur when large sums of money or effort have been invested in something and it has not shown the expected rewards. There can be a tendency to invest more, even though evidence suggest that it will not be successful or indeed hazardous to continue. An everyday example here could be to 'double or nothing' in a game of chance. The odds of winning have not got better, but an attempt is made to win back previous losses by betting higher amounts. This type of bias can become an issue where it is potentially not safe to continue. A process safety example for sunk cost fallacy is the Bhopal tragedy. The Bhopal facility had a history of financial losses and equipment failures resulting in leaks. The facility had been shut down for a period of time and a decision was made to restart it to consume the feedstock, rather than incur costs to dispose of it. During the final operation the toxic cloud was released. The decision to undertake the final produce run is an example of the sunk cost fallacy, continuing to run the facility, when it should have been shut down (Bloch, 2016).

### 2.3 Framing

How information is presented can change how the information is interpreted (Hersing, 2017). An everyday example here may be that a yoghurt brand markets it product as 90% fat free, the corollary to this is that the product is 10% fat. If you are conscious about the amount of fat in your food you would more likely choose the 90% fat free rather than the 10% fat product. This type of bias can become an issue where data is presented in a misleading way. It may also have an opposite effect when some data is presented in a way to prime the mind so that it is more likely to make a favourable decision when caught up in the "thin slicing" stage of thinking (Gladwell, 2005). A process safety example for framing is the Challenger Space Shuttle. The temperature criteria had not been established for the solid rocket booster o-rings, but there was concern that the o-rings were brittle at low temperature. The initial framing suggested that the temperature effect was inconclusive, leading to concerns about the potential blow by of the o-rings being discarded (Rogers, 1986).

### 2.4 Anchoring

This is based on placing more emphasis on the first information received, even if subsequent information shows it to be false (Hersing, 2017). An everyday example here might be when shopping and seeing a marked down price – 'was £200 now £150'. Seeing the first price of £200 may make you think that £150 is a good deal, because your expectation is anchored at £200. This type of bias can become an issue where the first piece of data is incorrect, and should be discounted from the decision making process. A process safety example for anchoring is the Texas City Refinery explosion in 2005. During the start up of the ISOM unit, the Raffinate Splitter Tower was filled with heated raffinate. The level indicator in the tower only covered the bottom section of the tower, and was also providing faulty readings. The operators became anchored to the level indicator results, not realizing the tower was in fact over filling (CSB, 2007).

### 2.5 Confirmation bias

This relates to placing more emphasis on data that supports your initial conclusion (Hersing, 2017). It can lead to the discounting of contrary data or searching for data that confirms your thoughts. An everyday example here is related to social media algorithms. We are presented with streams that typically confirm our own beliefs and we do not see counter information, which can lead us to believe that our thoughts are the same as the broader community. This type of bias can lead us to make the wrong decision because we do not accept data that disagrees with our initial thoughts. A process safety example of confirmation bias is the Macondo well blow out. During the abandonment activities a cement barrier was installed. At the time it was believed that the installation went well and therefore the barrier would work. This led to test results being misinterpreted when assessing the barrier integrity. The belief that the barrier installation had been successful led to confirmation bias discounting the failed test results as incorrect (CSB, 2016).

### 2.6 Hindsight bias

This bias "is defined as the belief that an event is more predictable after it becomes known than it was before it became known" (Roese & Vosh, 2012, p. 411). Hindsight makes it difficult to understand why a person took the action they did when it led to an incident occurring. We are left asking questions like 'why did they do that; they must have known what would happen?' An everyday example here is preparing to go away for a camping trip, and on arrival realizing that an important piece of equipment was left behind, only to exclaim 'I knew I would forget something!' If this was actually known ahead of time it could have been prevented. This type of bias can lead us to believe that an incident could not happen to us, because would not make that kind of mistake that led to an incident. Hindsight bias often inhibits our ability to learn from an incident, because "the very outcome knowledge which gives us the feeling that we understand what the past was all about may prevent us from learning anything from it." (Fischhoff, 2003, p. 311) In summary, we do not believe we would make the same mistakes. This phenomenon has led the IChemE Safety Centre to develop interactive case studies, where an attempt is made to remove the hindsight related to an incident, by telling the story without disclosing the outcome. Anecdotally these case studies appear to create an incident experience for the participant, without the consequences, which may assist with the learning being retained (Kerin, 2018).

### 2.7 Halo effect

This is a tendency to like everything about a particular person, even aspects of them you have not observed (Kahneman, 2011). It can lead to following the advice of a person because you do not consider that they may be wrong. The opposite of this is the Horns effect, where you do not believe the advice of a person because you do not believe they could be right. An everyday example of this may be thinking that your favourite actor must be a very nice person based on their attractive physical appearance, even though you have never met them. This type of bias can lead us to make an incorrect decision based on the opinion of others. A process safety example of the halo effect was the Dreamworld ride tragedy. The Halo effect can exist when a junior or inexperienced worker is working at the direction of a more experienced person or being trained. As the junior person does not have the knowledge themselves, they will often do as they are told, deferring to the experience – the halo. The junior operator was told during her training she did not need to operate the emergency stop as that was the senior operator's role. When the raft became stuck on the rails there was a delay in initiating the emergency stop, allowing the following raft to collide with it. Four people were killed when the second raft flipped as a result of the collision (Coroners Court of Queensland, 2020).

### 2.8 Curse of knowledge

This is the trap of thinking we know what someone else is thinking, or believing that they have the same background knowledge as we do. This can appear in a similar way to hindsight bias, but can also have different outcomes. An everyday example of this might be when we are watching a quiz show and are shocked that a contestant got an answer wrong, because

it was the sort of answer that "everyone would know". We fall victim to the belief that if we know it, then others must too. This type of bias can lead us to provide incomplete or insufficient instructions because we believe the person already knows the information. A process safety example of the curse of knowledge was the Buncefield explosion and fire. The curse of knowledge played a part in this incident because there may have been an assumption by the supplier of the independent high-level switch (IHLS) that people understood the need for the padlock to prevent the test lever from moving during routine operation. The operators, maintainers and installers were not aware of this fact, believing the padlock was an anti-tamper device. Because this was not seen as a critical function, the padlock was not installed, rendering the IHLS inoperable (COMAH Competent Authority, 2010).

## 3 Ideas to avoid bias

The term often used for addressing biases is called "debiasing". When considering the idea of system 1 and system 2 in our minds, to effectively debias we need to learn to engage system 2 as required to verify, correct and override where necessary our system 1 response. System 2 can be engaged by being asked questions that require thought, as this engages it to start to process. It has been found in studies that frowning while undertaking a task can increase the vigilance of system 2. This is because frowning usually occurs with cognitive strain, and this strain can be induced by frowning (Kahneman, 2011). There are several ideas that can be tried to counter biases shown in Table 2.

Table 2. Ideas to counter bias

| **Bias** | **Ideas to counter it** |
|---|---|
| Status quo bias | Appoint a person in the discussion to have the role of challenging the ideas, ensuring they have psychological safety to speak up without fear. This is akin to the "black hat" idea (de Bono, 1985). In this way there is someone free to ask questions about why the status quo exists as it is. The exploration of the status quo may highlight aspects that need changing. |
| Sunk cost fallacy | Engage someone from outside the issue, a co-worker who is not tied to the outcome, to challenge what the next steps should be. They can help establish the pros and cons for each action, leading to a risk-based decision on progression or not. |
| Framing | Reframe the data and discuss both aspects, identifying the counterfactual and assess both sides. From a priming aspect, it is possible to place subconscious thought in the mind prior to making decision (Gladwell, 2005). An example might be that prior to undertaking a high-risk task, the hazards and examples when things have previously gone wrong are specifically discussed. This act may prime the mind to look for and identify similar patterns. |
| Anchoring | When a decision needs to be reached, instead of a free discussion, have each person write down their initial ideas first. This way they have their thoughts that are not influenced by others during the discussion, avoiding group think anchoring to one idea. |
| Confirmation bias | Engage someone from outside the issue, a co-worker who is not tied to the outcome, to challenge what the data is telling you – do they reach the same conclusion without the background confirmation? |
| Halo effect | Attempting to slow down the thought process can assist with the time to look for more data to draw a conclusion from. If you are aware of the halo effect, you can try to think of different impressions of the person. This may be done by asking questions to try and establish a better understanding of them. |
| Hindsight bias | Attempt to understand the context in which decisions are made, not just the decision. This is useful during incident investigation, understand why an action was taken rather then what the action was. When we understand the context of decisions, we have the potential to see how it occurred instead of dismissing and thinking we would not have done it. |
| Curse of knowledge | When providing instruction or direction to someone, especially if they are not familiar with the task, take time to check their understanding. Have them explain back to you what you have asked for, allowing them to express it in their own words. The use of their own words will help show they have understood the |

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|---|---|
| | instruction as well as allow you to confirm it meets your intent. It is also important to ensure requests are made with complete information. A useful acronym to remember to achieve this is BOARS. The author has adapted this concept for a memorable acronym (Jaques, 1989). It covers the following items:<br>Background – ensure people understand the context of the request<br>Objective – make sure the objective is clear in the request<br>Amount (Quality and Quantity) – what are you actually after in terms of quantity and quality?<br>Resources – what resources area available for people to undertake the task?<br>Schedule – when is the task needed to be completed? |

## 4 Conclusion

All actions and decisions we make are subject to biases, and we are often not aware of them. While most of the time this does not have an impact on the safety at a facility, sometimes the biases can lead to decisions which cause or impact incidents. For this reason, it is important to understand the biases that may be present. WE need to understand how our minds work with system 1 and system 2 and develop strategies to check if our system 1 decisions are likely to result in or escalate an incident. This paper has tried to explain some of the most common biases that impact process safety with everyday and incident examples. It aims to provide options and examples of how some of these biases may be overcome in the workplace. It is not a definitive list, but hopefully gives the reader ideas that may work to prevent incidents in their facilities.

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