



Short Communication

The black swan paradox: from fallen towers to devastating viruses

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A B S T R A C T

In his 2007 bestseller *The Black Swan*, Nassim Taleb defined a “black swan event” by three criteria: it is rare and unpredictable, it has an extreme impact and it is retrospectively considered as wholly predictable (while it was not predicted). Events like the 2004 Pacific Tsunami and 9/11 attacks fit this model. Many have labeled the Covid-19 pandemic as a black swan, given its unexpected global devastation. However, Taleb himself rejected this categorisation, arguing that Covid-19 was “wholly predictable”. This disagreement raises questions about black swan theory’s application and definitions. First, Taleb’s “wholly predictable” argument ironically aligns with the third criterion, “retrospective bias”, which calls into question the usefulness of this criterion. Secondly, identifying “rare and unpredictable” events demands objective criteria, as seen when comparing 9/11 to Covid-19. Thirdly, confusion persists about whether the “event” refers to the viral outbreak or its global consequences. Finally, debates about expertise and authority in defining black swans suggest the world may better reflect shades of “grey swans” rather than binary black or white options. We argue that this might perhaps be more a matter of subjectivity than objective evidence. This perspective invites a shift from categorical judgments to a psychologically informed continuum of perceived unpredictability and impact.

1. Introduction

The Black Swan is an impactful essay, sold several million copies and translated into over 30 languages, setting out a theory of how we perceive rare and unpredictable events (Taleb, 2007). Taleb explains that a black swan event has three characteristics (Taleb, 2007). First, it is rare, unpredicted because nothing in the past can convincingly indicate its probability of occurrence. Second, it has an extreme impact (severity). Thirdly, it is retrospectively considered totally predictable (while it wasn’t). The Pacific Tsunami of December 2004 or the 9/11 attacks are considered as prime Black Swan events (Taleb, 2007). Had they been expected or predicted, they would not have caused the damage they did, Taleb explains in his prologue.

Covid-19 has been described as a black swan event by many observers in the media (Diamond & Cook, 2020) and scientific literature to describe the impact of the pandemic on microbiology (Cheng et al., 2022), preventive medicine (Fiorini & La Gioia, 2021), the adverse effects of vaccination (Fan et al., 2021) or mental health interventions (Wind et al., 2020). Some authors even refer to the “black swan virus” (Wind et al., 2020). However, Nassim Taleb, argued in newspapers that the Black Swan should not be merely used as a cliché for unpleasant surprises and that “the pandemic was wholly predictable” (Gopnik, 2020). The disagreement over the use of the term “black swan” in the context of the coronavirus crisis raises at least four major issues regarding black swan theory, its use and its suitability for categorizing large-scale impactful events.

2. Four vague ideas on a single swan’s back

As a first issue, the argument used by Taleb to dismiss Covid as a “black swan event”, namely that «the pandemic was wholly predictable» (Gopnik, 2020) - creates a kind of circularity, a form of definitional paradox. Indeed, it makes Covid a perfect candidate for designation as a «black swan » event, as it fits perfectly with Taleb’s definition of the third criteria, retrospective distortion. This situation poses a conceptual challenge: the criterion of retrospective predictability seems to be self-validating. It is used to illustrate retrospective bias following genuinely unforeseen events, as well as to disqualify anticipated events. In this sense, the framework embodies what might be termed the ‘heads I win, tails you lose’ problem: the same interpretive mechanism can be used to explain the presence or absence of predictability depending on the outcome and perspective adopted. This circularity undermines the criterion’s diagnostic power and, consequently, its usefulness. Therefore, a clearer distinction must be drawn between a priori anticipation, supported by actionable foresight, and a posteriori rationalisation, shaped by cognitive and emotional reinterpretation. While cases with solid pre-event predictions allow for such clarity, this distinction remains difficult to achieve in many real-world scenarios. This is very clearly illustrated by a quote often attributed to the Nobel Prize winner in physics, Niels Bohr: “It is difficult to make predictions, especially about the future”. Forecasting the future, this would fit the definition of a convincing prediction perfectly.

As a second issue, but intrinsically linked to the first definition issue, we need to clarify what we mean by “rare and unpredictable events” (first black swan criterion). Are there objective criteria defining “convincing predictability”? If this were not the case, it could be an

indication that these criteria may have more to do with individual subjectivity than with collective, generalizable objectivity. When it comes to compare different events like 9/11 attacks and Covid-19, the pertinent question, then, is whether, prior to the actual outbreak of the covid-19 pandemic (December 2019), it was really more convincingly predictable (or predicted) than were the 9/11 attacks (on September 10)? To provide some elements of answer, we can compare what was actually known in the period leading up to these two separate events.

On the one hand, let's go back to the 9/11 attacks, the Black Swan (Taleb, 2007), what was known on September 10, 2001. It was certainly unexpected, we were unprepared, but was it really any more so than the Covid-19 pandemic? The World Trade Center had already been attacked in 1993, and hundreds of hijackings had taken place before September 2001. Hadn't Islamist groups already planned to use civilian aircraft to attack monuments of Western culture. In 1994, Prime Minister Édouard Balladur revealed that an armed al-Qaeda group had hijacked Air France Flight 8969 from Algeria with the intention of crashing it into the Eiffel Tower, but they were stopped by the French GIGN (Institut National de l'Audiovisuel, 1994). A few months earlier, in the summer of 1994, Tom Clancy's novel *Debt of Honor* told the story of a suicide bomber who crashed a Boeing 747 into the Capitol in an attempt to destabilize the country. On the film front, *Executive Decision* was released in 1996 and depicted the use of a 747-200 by an Islamist group to carry out an attack on American territory. It's as if 17th century Europeans had written a futuristic book about explorers discovering colored swans in Oceania. Not yet met or seen, but at least imagined. With regard to the 9/11 attacks, a 328-page document from the French secret services (DGSE), presented by the French daily *Le Monde*, reveals that, in 2000, Uzbek spies informed them that Osama Bin Laden was planning to hijack planes in the United States (Le Monde, 2007; Associated Press, 2007). Other journalistic sources have stated that the Bush administration was informed that "Al-Qaeda's intention is the destruction of the United States" (Sanger & van Natta, 2001). Admittedly, it's true that the 9/11 attacks were unforeseen, but given the information available to the secret services, the history of hijackings and the fictions presented above, it's difficult to accept that they were completely outside the realm of the possible, unimaginable or unthinkable. In probabilistic terms, however, they were indeed difficult to predict.

On the other hand, with regard to epidemic threats, it is important to note that of the thousands of epidemic alerts issued by WHO over the past 25 years (World Health Organization, Archives), none (out of tens per month) has had such an extreme, rapid and deadly negative impact on health and economic systems worldwide. Although some strains were sometimes identical to other highly lethal pandemics (H1N1 1918 vs. 2009). It is therefore fair to say that, despite frequent viral outbreaks, lethal pandemics are objectively rare, unpredictable and could be considered rare (outlier) events. Apart from seasonal influenza, which kills up to 650,000 people every year (World Health Organization, 2017), the world has not been confronted with a deadly pandemic affecting one million people so quickly since the late 1960s (Hong Kong H3N2 influenza). "It's just a flu" became the usual reassuring mantra, people have become indulgent towards warnings that were previously considered dangerous (Daalmans, 2013). It seems that crying wolf undermines the credibility and effectiveness of the precautionary principle. With the Spanish flu of 1918, the plague in the Middle Ages and Terry Gilliam's *12 Monkeys* in 1995, we can probably agree that pandemics are part of human history and imagination.

But how convincing is the argument that the Covid-19 was (un)predictable? Was the Covid-19 convincingly predicted? The answer is no, using Taleb's argument from his prologue: if it had been expected or predicted, it would not have caused the damage it did. However, in subsequent statements (e.g. Gopnik, 2020), Taleb claims that he and others anticipated such a crisis. He cites an article published in late January 2020 (Norman et al., 2020), which was released almost two months after the first reported case of Covid-19 (Huang et al., 2020). This highlights a key ambiguity in the reasoning behind black swan

events. Describing or modelling an event as it unfolds does not necessarily equate to a strong prediction involving precise, prior anticipation and actionable warning. In this case, evoking early warnings seems closer to modelling a current threat than to predicting an event before it occurs. A useful metaphor might be identifying and tracking a tsunami wave using binoculars a few minutes after an undersea earthquake has occurred. While this may enable a short-term response, it does not constitute a prior prediction of the disaster itself. Similarly, even in their January 2020 paper, Taleb and his colleagues expressed uncertainty about how the epidemic would evolve, noting their doubts about the effectiveness of China's containment measures (Norman et al., 2020). This suggests that even among those aware of systemic fragility, the spread of the pandemic and its global impact were not fully anticipated. The result is a blurring of the theoretical boundary between plausibility and prediction, or between recognising a general risk and predicting a specific event. This blurring lies at the heart of the black swan paradox, whereby the retrospective attribution of predictability might be shaped by the emotional, epistemic, and institutional expectations and backlashes of the event itself. It is undeniable, even to virus specialists, that compared to its 2002 cousin SARS-CoV1, SARS-CoV2 2019 was spreading faster and wider, has killed far more people worldwide, and required a vaccine, "showing just how unpredictable viruses can be" (Scarpino & Petri, 2019; MacIntyre, 2020; Mervosh & Tompkins, 2020). What should we really think about the consequences of this pandemic and its likelihood? It probably depends on what the white swan events are for each of us, what we took for granted on New Year's Eve 2020 or on September 10, 2001? This comparison could lead to the claim that the consequences of the pandemic may have exceeded normal probabilistic expectations, or at least not much less than the 9/11 attacks, which might be debatable.

The third issue addresses misunderstandings about the operationalization of a 'black swan' event. Some discussions focus on the viral epidemic itself (SARS-CoV2), which could be considered a predictable white swan (given the number of WHO alerts), while others focus on the disease/pandemic, which could be considered a rare and unpredictable black swan. Indeed, the previous viral alert involving a SARS-like respiratory virus in 2002–2003 gave rise to widespread fears of a pandemic, as evidenced by some statements among the medical profession at the time, but its impact remained largely confined to China (Scarpino & Petri, 2019). This discrepancy highlights the difficulty of categorizing events without a rigorous and precise definition of the event in question.

The fourth and final question we want to address is who has the power/authority to decide this 'black swan' issue and to apply the decision criteria, if any? Do we have to be specialists in the field (here epidemiology/virology) to decide whether it was (not) predictable, whether the likelihood was calculable? In other words, who has the right to decide whether the event was really (un)predictable?

3. Toward a black swan paradox: a new lying barber

The central paradox is that Taleb dismisses Covid-19 as a 'black swan' because it was predictable, which ironically fits with his own definition of hindsight bias. This paradox proves that the criterion of retrospective predictability becomes both an argument for including the event in the black swan category and an argument for excluding it. This illustrates a classic logical dilemma: a criterion used to define something can, under certain conditions, turn against the definition itself, making the analysis or categorisation of certain events infinitely subjective, impossible, contradictory or circular (Sorensen, 2003, pp. 83–99). For example, the liar's paradox is based on a simple but puzzling sentence: "This Sentence is false". If we take this sentence to be true, then it correctly states that itself is false. But if it is false, then it lies by saying that it is false, which means that it is actually true! So we find ourselves caught in an endless loop: the sentence is both true and false at the same time. Another example comes from Russell's paradox, also known as the Barber paradox includes a condition that refers to itself in a

contradictory way. If we consider “a barber who only shaves people who never shave themselves”, then an intriguing question arises: who shaves the barber? The answer is contradictory, because the barber should both shave himself and not shave himself. According to the definition, if the barber shaves himself, he should not shave himself (since he only shaves people who do not shave themselves). But at the same time, and for the same reasons, if he doesn’t shave himself, then he should shave himself. These logical paradoxes highlight one of the limits of logic: certain propositions can be so complex or self-referential that they defy simple evaluation as “true” or “false” because they create logical contradictions.

4. Two too subjective remaining criteria

While the criterion of retrospective bias can no longer be used to distinguish a true from a false Black Swan event, the following two criteria remain: the perceived severity of the event (its extreme impact) and its rarity or unpredictability. These two criteria appear to be highly subjective and, in many respects, influenced by individual and collective factors.

First of all, as we have already mentioned, there appear to be no objective standards for defining rarity or unpredictability. To declare an event “rare and unpredictable” intrinsically implies that it falls outside the models and expectations established by the culture or by the individual, which makes it precisely difficult to predict. Paradoxically, trying to predict such an event can introduce a self-referential paradox: the more we try to anticipate an unusual event (like a pandemic), the more we pay attention and the more we internalise it as a plausible scenario. By considering it as a real possibility, we unconsciously modify our mental frameworks, thereby integrating the event into our knowledge base while reducing its perceived rarity. This phenomenon could explain why some experts have declared a posteriori that the pandemic was ‘wholly predictable’, even though it had not been concretely foreseen. Even five years after the emergence of the Covid, the debate is still raging over its precise origin, the laboratory leak hypothesis (Kaiser, 2024) continues to coexist in the scientific literature with the Wuhan market hypothesis (Mallapaty, 2024).

Finally, the criterion of severity or extreme impact also appears to rely heavily on subjective judgments. The perception of an event’s impact is shaped by a mix of individual characteristics (such as personality, personal experiences or cognitive biases) and collective, social factors (like media coverage or cultural context). For instance, mass media can exacerbate stress and extend the impact of collective trauma beyond the individuals or communities directly involved in the traumatic events (Holman et al., 2014). Moreover, an event perceived as catastrophic in one society may be viewed as less significant in another, depending on its historical experiences and resilience to crises.

5. Mental frameworks for understanding black swan perception

While the paradoxes in Taleb’s model reveal the conceptual weaknesses of the Black Swan criteria, it is equally important to examine how psychological theories can illuminate the subjective processes that influence the perception, interpretation and retrospective labelling of such events. Rather than viewing the Black Swan as a purely epistemological challenge, we argue that its perception is influenced by well-documented cognitive, emotional and motivational mechanisms. Classifying events as “unexpected”, “catastrophic”, or “retrospectively obvious” depends not only on statistical improbability or expert consensus, but also on how individuals experience and cognitively process uncertainty, risk, threat, and disruption.

One avenue of psychological inquiry concerns the cognitive mechanisms that influence how people process information in uncertain situations. Hindsight bias is central to Taleb’s third criterion, yet simultaneously undermines its utility as an objective marker. Fischhoff (1975) demonstrated that individuals systematically overestimate their

ability to have foreseen outcomes, particularly following emotionally charged or high-impact events. In the same vein, the normalization bias (Mileti & O’Brien, 1992), the tendency to believe that things will always function as they normally have, may inhibit anticipatory reactions to crisis scenarios. This bias can explain why early warnings about pandemics or terrorist threats are often dismissed or downplayed cognitively, contributing to the perception of ‘unforeseen’ disasters despite the availability of indicators.

Emotional and motivational variables also play a significant role. For instance, the theory of motivated social cognition (Jost et al., 2003) demonstrates that individuals’ political ideology, need for closure and threat sensitivity systematically bias their interpretation of complex events. For instance, conservative orientations are often associated with heightened threat perception and a preference for order and predictability, factors that can influence whether an event is perceived as a manageable anomaly or an existential rupture. These affective and ideological filters not only color how people respond to crisis events in real time, but also how they subsequently reconstruct the plausibility and causality of such events.

At a fundamental level, unpredictable, catastrophic events can destroy core beliefs about the stability, fairness and predictability of the world. According to Janoff-Bulman’s (1992) Shattered Assumptions Theory, trauma can undermine basic beliefs about the world’s benevolence, the meaningfulness of life events and one’s own self-worth. This process can be further amplified by media exposure, which disseminates the event and can intensify its psychological impact, which can lead to higher levels of acute stress than exposure to the event itself (Holman et al., 2014). In such situations, recovery involves not just emotional regulation, but also a deeper cognitive reconstruction of meaning and belief systems.

A final relevant mechanism for understanding variations in the perception of the black swan is Protective Conspiracy Framing (PCF) (Vermeulen, 2025). This is the rhetorical and cognitive tendency to dismiss non-dominant views as “conspiracy theories”, not because they are irrational or have been scientifically invalidated, but because they challenge dominant narratives during periods of uncertainty. This framework serves to preserve institutional stability and a coherent worldview by supporting consensus and marginalising divergence. Although PCF is often intended to protect scientific credibility, it can lead to Type 2 epistemic errors, such as the premature rejection of legitimate warnings or hypotheses that challenge the status quo. In the context of disruptive events, this defensive mechanism acts as a form of epistemic blindness, filtering out information that is likely to create ambiguity or threaten social cohesion. By enabling a sense of control over events, PCF complements other psychological responses, such as hindsight bias and motivated reasoning, by shifting attention from the content of predictions to the status and acceptability of those who make them.

Taken together, these theoretical and empirical contributions emphasise the need to consider “Black Swan” perception not as a neutral, objective designation, but as a psychologically constructed judgement deeply embedded in the cognitive and emotional architecture of the human mind. Instead of being merely epistemic anomalies, Black Swan events emerge as psychological fault lines, revealing our coping mechanisms in the face of rupture, our ability to assign meaning to chaos, and our capacity to construct order amidst the unforeseen.

6. Beyond binary: towards a psychological continuum of black and grey swans

While Taleb’s tripartite definition of a Black Swan provides an evocative framework, the binary nature of the definition, an event is either a Black Swan or it is not, poses challenges both conceptually and practically. As mentioned previously, the third criterion in particular (“retrospective predictability”) creates a paradox whereby an event’s classification depends on the judge and the timeframe. This binary logic

cannot accommodate the wide range of complex, high-impact events that are neither fully unforeseeable nor fully modelled in advance. To overcome this, we propose a continuum-based approach that is grounded in psychological and interdisciplinary reasoning. This approach distinguishes between Black Swans, Grey Swans and White Swans. These are not considered as separate categories, but rather as subjective positions along a dynamic epistemic gradient.

This proposal is supported by recent interdisciplinary literature, particularly the work of [Gonzales Martinez \(2024\)](#). He critiques the rigidity of Taleb's model from the perspectives of complexity theory and international business risk. He proposes a spectrum of catastrophes, in which « grey swans » occupy a middle zone: events with potentially devastating consequences that are low-probability but not epistemically opaque. While these events can be anticipated to some extent through scenario planning, weak signal detection or complex systems modelling, they are often filtered out due to institutional blind spots or psychological biases.

Building on this perspective, we suggest that psychological factors, such as emotion, ideology, trust and memory, modulate how individuals and groups interpret where an event lies on this gradient. For example, two observers may attribute different positions to the same event, depending on their personal sense of control, prior exposure to risk or their belief in randomness versus determinism. Furthermore, during times of crisis, the desire for coherence and threat reduction may cause individuals to retrospectively perceive grey swans as predictable, or alternatively, to disregard early warnings in favour of a Black Swan narrative that absolves responsibility. Beyond its conceptual usefulness, this gradational model could be used in risk governance to help institutions calibrate their responses and public messaging according to varying levels of perceived uncertainty and psychological readiness.

This psychological construction of the swan spectrum is neither purely subjective nor relativistic, but rather reflects the interaction between probabilistic reasoning and motivated cognition and affective appraisal. Therefore, our model integrates the epistemological insights of complexity theory with the psychological realities of perception and response. Rather than proposing a new taxonomy, we advocate a conceptual map in which events are situated along two intersecting dimensions: (1) perceived predictability and (2) perceived impact. Within this framework, swan's color is not a binary label, but rather a spectrum of uncertainty and perceived exceptionality that evolves as individual and collective evaluations change over time. This model recognises grey swans as core elements of our psychological engagement with uncertainty and risk, not as conceptual leftovers.

7. Conclusion and open questions

This article examines the conceptual paradoxes within Taleb's Black Swan framework by integrating insights from cognitive, affective and social psychology. Rather than viewing « Black Swan » classification as an objective, post-event determination based on statistical rarity or expert failure, the analysis highlights how such categorisation is shaped by psychological processes, including judgement under uncertainty, motivated reasoning and worldview maintenance.

To overcome the limitations of the binary classification model, the article proposes a continuum-based framework that encompasses White, Grey, and Black Swans. This dimensional approach considers the interplay between perceived predictability and perceived impact, as well as the influence of psychological factors such as hindsight bias, ideological orientation or Protective Conspiracy Theory that offer complementary explanations for how individuals and groups defend themselves against uncertainty and reconstruct meaning after high-impact events.

Reconceptualising Black Swan events as psychologically mediated judgements rather than ontologically fixed categories may provide a more realistic basis for understanding public responses to crises, the construction of collective memory and the dynamics of anticipatory

thinking in situations of uncertainty. The gradational framework proposed here has therefore a practical value. Recognising the psychological and perceptual continuum between white, grey and black swans can support more effective crisis communication, enhance institutional responsiveness to early warning signals and foster psychological preparedness, as it acknowledges that uncertainty and threat are rarely experienced in binary terms. To conclude, as far as the color of the swan is concerned, the main question might be whether we should all adopt the same convictions. This question applies in particular if the retrospective bias criterion cannot guarantee the presence (or absence) of a black swan event. What if everyone was simply allowed to express their knowledge, as we do with our feelings? Feelings are neither true nor false, they just are. Or should we trust someone who asserts their position as an expert? A multiplicity of grey swans might better correspond to the multiplicity of plausible individual certainties. As far as the theory is concerned, we need at least to clarify the three characteristics that define a «black swan», the retrospective paradox and determine who is entitled to decide what is a rare and unpredictable or unpredicted event.

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There are no data.

Declaration of AI use

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