

The antifragile surgeon

El cirujano antifrágil

Alberto Campos*

* **Correspondence:** Alberto Campos, MD

E-mail: alberto_campos@hotmail.com

<https://orcid.org/0000-0001-5811-1908>

Keywords:
COVID-19, surgery,
antifragile, resilience,
robustness.

Palabras clave:
COVID-19, cirugía,
antifrágil, resiliencia,
robustez.

ABSTRACT

In this article I discuss how, under uncertainty, our inferences can be optimistic without a firm basis and how induction creates a false confidence that prevents the anticipation of catastrophic events. I explain the qualities 'fragility', 'robustness' and 'antifragility' in biological and human systems. Finally, I discuss the surgeon's professional antifragility strategies to minimize harm and continue with his/her work.

RESUMEN

En este artículo discuto cómo, en la incertidumbre, nuestras inferencias pueden ser optimistas sin una base firme y cómo la inducción crea una falsa confianza que impide la anticipación de eventos catastróficos. Explica las cualidades 'fragilidad', 'robustez' y 'antifragilidad' en sistemas biológicos y humanos. Finalmente, discuto las estrategias de antifragilidad profesional del cirujano para minimizar el daño y continuar con su trabajo.

"Wind extinguishes a candle and energizes fire. Likewise with randomness, uncertainty, chaos: you want to use them, not hide from them. You want to be the fire and wish for the wind."
Nassim Taleb¹

INDUCTION: DERIVING THEORIES FROM OBSERVATIONS

We have the idea that scientific knowledge is derived from observations or experiments. However, it is not as easy as one might suppose to establish a scientific fact. It is first necessary to determine whether a set of observations is sound, whether the standards of proof are sufficient and whether they are accepted by the scientific community.

In the face of uncertainty, we find ourselves in the situation of the chicken or the egg, which observations will form a predictive theory or whether a theory—as a set of hypotheses—can be derived from observations that can then be generalized. At times, the researcher and the physician find themselves in this awkward situation.

What kind of orderly arguments allow us to go from observations to facts that we expect to deduce logically from them? Some arguments, taken as premises, are simple. For example, the syllogism (1) All men are mortal, (2) Socrates is a man, therefore (3) Socrates is mortal. The premises (1) and (2) are true, and the conclusion (3) is also true.

But real life does not have the logic of a syllogism. Consider (1) Some poetry books are boring, (2) this is a poetry book therefore (3) this book is boring. The conclusion (3) does not necessarily follow from (1) and (2), even if they are true.

The problem arises when the quantifier item 'some' is interpreted as 'all'. To the question why we believe that the Sun will rise tomorrow we can answer «because it rises every day». We could even add «always». We have that firm belief because the Sun has always risen in the past, and we infer that it will because we have observed the regularity of that phenomenon. We do not doubt that the Newtonian laws of motion will also be operative tomorrow, and we do not doubt it because they have worked so far.

Received: 12/15/2020
Accepted: 01/24/2021



How to cite: Campos A. The antifragile surgeon. Cir Gen. 2021; 43(1): 60-66.

'All' and 'always' are *universal* quantifiers that we apply intuitively to cases, without considering that there may be exceptional cases. For example, an asteroid of about 10 kilometers in diameter hitting the Earth at more than 90,000 kilometers per hour, spewing millions of tons of ash into the atmosphere, returning as incandescent rain, and then obscuring it until it prevents sunlight from reaching the surface, thus creating a night that extinguishes most life. The catastrophe happened 65 million years ago in Yucatan. Improbable and impossible are not synonyms.

Experience seems to show that the repetition of a regular succession of events would be the *cause* of such events, when that repetition only causes our *expectation* that they will happen one or many more times. This association of ideas produces in us a habit consisting of creating general laws known as «inductive inferences»; that is, by a mechanism of induction we make, based on past experiences, conclusions for the future.

The first reference known as «the problem of induction» refers to David Hume in his *Treatise on Human Nature* (1739) and then in the *Inquiry Concerning Human Understanding* (1748). Induction creates an effect of confidence that makes us ignore the possibility of extraordinary events, especially when encouraging observations are numerous.

But with observations that are based on our sensory perception we can only make limited predictions. When it comes to biological phenomena, such as this pandemic, cause-effect relationships do not have the immediacy of physical phenomena. Moreover, the idea of pandemic and its consequences is, to say the least, very unpleasant. That is why a layman can still refuse to believe that it exists.

It is the case that I will call *The Inductivist Turkey*. In Bertrand Russell's original example,² it is a chicken that makes the mistake, but Taleb's turkey is more fun. The turkey knows that every day man feeds him, so he infers two conclusions that acquire belief status; (1) *based on evidence* (sounds familiar?), it infers that man will *always* feed him; (2) based on his *inductive thinking*, it infers that man loves him.

The induction appears to be correct until the day when, at the peak of its confidence, its prediction fails. On Christmas Eve he will correct his belief *in extremis*, just before the man twists his neck.

The Turkey went from many true observations to a false conclusion (induction). Experience leads us to believe that the Sun will rise tomorrow, but we are in no better position of certainty than the turkey (or the chicken).

Thus, our expectations persist despite being misleading. Our beliefs about the future are supported by past cases whose validity have not been examined closely by us. We will then have to refine our future expectations based on past regularities, asking ourselves whether there is a reasonable basis for giving them some weight, or question their validity. This is what happens with the large number of articles published in the face of urgency without proper peer review.

The mistake is a daily one. We confuse, like the turkey, the absence of evidence since there is nothing aggressive in the behavior of the farmer because he is always smiling, with evidence of absence on the intention to fatten him up for Christmas. That intention may well have been the cause of the farmer's smile, misinterpreted by the turkey. Inductive thinking can neither be proven nor invalidated by our previous experiences. Nor do we have any reason to believe in the so-called «regularity of nature». With some frequency we have incomplete data, with no evidence of its present truth or future validity.

FRAGILITY, STRENGTH, AND ANTIFRAGILITY

Whoever has seen a multitude of white swans could argue that according to his data it is *likely* that all swans are white. If a black swan appears, it means that it *can happen*, even though it is improbable that black swans exist. But improbable and impossible are not synonymous. The neck-twisting event was for the farmer a white swan, another baked stuffed turkey Christmas, but it was a black swan for the turkey, who mistook improbable for impossible. By the way, not all turkeys are black.

Black swans are large-scale events with massive unintended consequences. They

are improbable events of extreme impact, predictable only in retrospect, when the pieces of the catastrophe fit together *after the fact*.

Complex economic and social processes, such as devaluations, street protests and politicians' statements, have the volatility of randomness.³ Zoonoses also have the volatility of randomness. These processes may *appear to be stable* for a long time, without extreme variations, like currency quotes and politicians' statements. But when subjected to large variations they can become chaotic, such as stock market crashes, epidemics or, even more so, this pandemic.

This pandemic is a black swan. For years the health system resisted with precarious stability despite, among other things, budget cuts, lack of supplies, shortage of doctors and the increasing demand of patients who for economic reasons increasingly resorted to public health services, along with the increasingly difficult conditions imposed by insurers and the high costs of private services.

Before Black-Swan-CoV-2, the robustness of Mexico's healthcare system was overrated. That reminds me of the song about the white elephant that was swinging on a spider's web. As he saw that it was resisting, he went to call another elephant... .. And as it resisted, throughout different administrations it was left to its resilience, the ability to withstand tensions and return to the previous state. Indefinitely.

Since it was resistant, it was not thought that erosion would end up collapsing it in the event of a catastrophic event. The possibility of such an event was dismissed. Its complex consequences include, among others, a spike in contagions, increased mortality, loss of jobs, increased extreme poverty and pressure on interdependent social systems.

But it is also an illusion to think that planning and budgets alone solve emerging problems. They do not. The incidence of future events cannot be measured since they have not happened. Risk cannot be measured either; it can only be estimated.

The fragility of the system could have been measured by comparing the gradual increase in the demand for services against the availability

and capacity of care centers. Shortcomings could have been remedied.

However, a robust healthcare system would not have been sufficient to avoid the tipping point of a large random event and contain its effects. Resilient hospitals are once again having problems due to a lack not only of ventilators and trained personnel, but also of drugs to treat the sick.^{4,5} In the face of an extreme random event, robust and resilient are not enough.

BIOLOGICAL ANTIFRAGILITY

Since robustness is not possible at all, complex systems require, for their preservation, mechanisms that can continuously self-regenerate. In this way they can become *antifragile*.

In nature there is no complacency but rather *redundancy*, a property of living systems against risk. The body has two kidneys, two lungs, alternating cerebral circulation (the polygon of Willis), hepatic sinusoids, and so forth. The various «layers of redundancy» are a fundamental property of natural systems. Redundancy «may seem like a waste if nothing unusual happens. Except that, usually, something unusual happens».⁶

The biological systems and processes of living beings are exposed to the challenges of an ever-changing environment. To adapt, they create variants that give them antifragility. This is how they evolve. One example is proteins with flexible regions, which can undergo functional alterations in response to environmental stress. In this way, they achieve «improvised repairs», or self-maintenance through simple repairs.⁷

This is how biological structures become difficult to inactivate or destroy. Although in any case, when their processes reach the point of no return, their fate is sealed. Either they harden for a while (becoming robust) or they remain the same (fragile) and degrade. As examples, in a few months, cancer cells defeat chemotherapies; in a few days of insufficient treatment bacteria become resistant to antimicrobial drugs.⁷

The emergence of new conditions requires adaptation, such as those bacteria that have

adapted to use Nylon® from our industrial waste as a source of nitrogen and carbon.^{8,9}

The SARS-CoV-1 coronavirus became antifragile during the 2003 epidemic by creating a new surface antigen from a genome that formed a common pattern.¹⁰ Coronaviruses tend to recombine and mutate very frequently.

The antifragility of SARS-CoV-2 is not surprising. The virus itself is fragile; it is easily destroyed with soap and water, or with alcohol-gel in appropriate concentration. But the information encoded in it during mutations makes it antifragile; it can do more than react through mutations. It has «a built-in property [literally, the flexibility of its proteins and processes] that allows it to find solutions in the face of adversity».⁷

RESILIENCE AND ROBUSTNESS ARE NOT ENOUGH

On the contrary, human-designed systems seek economy, simplicity, and *elegance*, say the mathematicians. Nothing missing, nothing surplus, nothing redundant, nothing spare. Usually resilient or robust systems are not damaged by the volatility of disorder, until they reach the point where their capacities are overwhelmed.

Given the increase in hospitalizations, Mexico has had to call for interns in social service (students in their last year before graduation), whose only requirement is to present their letter of completion, the *Letter of Internship*, with the promise to offer them «*high quality* personal protective equipment and *intensive training* in the *comprehensive* management of patients with covid» (my italics), according to the call.¹¹ What experience can a medical undergraduate student have? What kind of care can they offer with this very brief «*intensive training*»?

There are two perspectives to be considered here; that of the State that summoned them and that of the students who accepted, with no little exaltation. As for the first perspective, let us recall the military use of child soldiers during World War II by Germany, Japan, Russia, Poland, and the United Kingdom. As the conflict progressed, more and more youngsters

were recruited; they were 16, 15, 14 years old. In Mexico, recruitment quickly shifted from specialists to general practitioners to interns, to fill the shortage.

From the second perspective, an anonymous source told me that some of the interns enthusiastically enlisted to treat patients with COVID-19. In the effervescence of the rush, and before the vaccination program began, the impetus of these young, not yet medical doctors, could well be due to some extent to the *glamour*, poorly thought out, of the commonplace of the hero who is not afraid of anything.

This reminds me of the expeditions known as the Children's Crusade, which left Germany (Cologne) and France (Vendôme) for the Holy Land in 1212, probably around Easter or Pentecost (an interesting trigger for the action) in search of the Holy Cross. Some sources refer to «*eodem anno fuit iter stultorum puerorum*» («that same year was the way of the foolish children»)¹² Some authors are inclined to ascribe the movement to divine inspiration; others, who knew of its sad end, conceive it as the work of the devil.

Many perished of hunger and thirst without reaching their destination or were stripped by the Lombards. Of those who left by sea, some were shipwrecked, others were sold as slaves by pirates, and the maidens were raped. Few returned home and some managed to reach Rome. According to the medievalist historian Dana Munro, although the children wished, in their enthusiasm, to join the various outposts, «it is difficult to explain the acquiescence of their parents or the favorable opinion of learned clerics». Munro also mentions a quotation from Pope Innocent III, the exclamation «these children have put us to shame, for while we sleep, they hasten to recover the Holy Land».¹² These two analogies show how, in the face of a catastrophic event, a fragile system tries to reinforce itself with resources that are also fragile.

But let's go back to the present and do a thought experiment now. We know (we know about) the disease, but we don't know how our body will react. What kind of turkey induction would we apply to decide, in the face of *our* worsening symptoms? The availability of

beds? The best equipped hospital? The best managed or the closest? The reputation or the distance? The cost? The intensity or the speed of evolution of the clinical picture as a function of distance? The advice of a colleague? Or the wait and see approach?

In addition, we would need the luck that the nearest public hospital had some robustness, available beds, medicines and supplies, and an adequate staff. If it is a private institution, availability would be needed, but also that the insurance would fully cover the costs, which have ranged from \$433,000.00 MXN (\$21,936.00 USD) for hospitalization to one million pesos in case intensive care is required and up to 3.67 million (\$185,917.00 USD) in case of intubation. «The case with the highest amount of compensation reported has had a cost of 25.52 million pesos (\$1,292,806.00 USD)»¹³ (exchange rates are as of December 2020). Incidentally, one of several terms for 'luck' in Latin is 'alea', whence 'random'.

PROFESSIONAL ANTIFRAGILITY

The *illusion* of robustness has the effect of tranquility and routine; it comes from the *desire* to maintain stability. Illusion and desire are particularly strong as the surgeon grows older and relies on his experience of white swans.

The Inductivist Surgeon was calm, he had always done things this way and they had always worked out well, but the voice of his experience has put him at the mercy of the Mexican health systems, public and private. *The Inductivist Surgeon* cannot remain, however, on the moon. If there were a Sea of Tranquility on Earth, it would not cease to be a sea. The Pacific Ocean is anything but peaceful. Tranquility reduces the capacity to adapt and respond, produces complacent and dysfunctional individuals in the face of the «new» reality, which is not new but always changing.¹⁴ Heraclitus already said that «the Sun is not new every day, but continually new».^{15,16}

On the other hand, resilience and robustness can allow us to rise from the ashes, but only up to a certain limit. In mythologies, the indestructible

exist, but not in real life. The surgeon cannot stop operating. As a psychotherapist, he cannot resign himself to giving virtual consultations. He must become antifragile; it depends on his art, the *ars chirurgica*.

The anti-fragile surgeon will have to forget the stable era since we no longer live in it. In addition to making up for the limitations of a fragile State, he/she will have to accept the adaptive measures of private institutions, which will not look after their welfare (they are not healthcare institutions, they are businesses). They will protect themselves to the detriment of the parts (the medical corps and other personnel) that cease to be functional (that fall ill or die); those that, from being assets (that have value, that generate profit) become liabilities (that mean expenses). A sick surgeon who cannot work, loses monetary value; for «his» hospital and his family he is a liability.

The first step towards antifragility is to cushion the fall; the emotional damage of loss aversion. What is lost is lost. This involves taming emotions that, like uncertainty, cannot be eliminated. I do not say it's easy, no one is immune and there are no recipes; emotions are part of rationality. But what is broken tends to remain broken, and fragility punishes just like a terminal illness.¹⁷

As a second step to avoid remaining at the mercy of the system, the surgeon will have to perform damage control and design survival strategies; relying on his ability to improvise, which has allowed him to resolve adverse trans-operative events in the past. It will be indispensable to *accumulate redundancy* of resources to continue operating, redundancy in equipment and backup structures, such as personal protective equipment (Tyvek®), masks (N95, KF94, FFP), face masks, gloves, and others; and to keep a list of reliable suppliers. In addition, virtual communication platforms and the corresponding computer equipment with several levels of data storage, external and in different sites or clouds are essential items today.

The surgeon is at a disadvantage when faced with the rising cost of materials and services on which he/she relies to provide service and generate his/her income. But what

is redundant when there is no need becomes indispensable when there is a shortage. What seemed to be liabilities become assets. It is better redundancy than lack, especially when the free market reduces stocks and manipulates prices to the detriment of its revenues, a large part of which it will now have to allocate to anti-fragility if it wants to remain operational.

The third step toward antifragility involves peer support structures and networks. This is where cooperation to share changing information comes into play. Information is an input. The isolated surgeon is fragile.

Not least important, is that the best asset is oneself, the robust and antifragile surgeon who invests in his own health, improving his/her quality of life, his/her self-knowledge, turning pandemic confinement into that honest and deep introspection for which he/she had no time before. That's where he/she will get the resistance.

To become antifragile, the surgeon will have to consider this pandemic as a very long trans-surgery. He/she will have to become an expert in strategies of changes and adjustments, of improvised repairs, and constant re-evaluations.

And even when the pandemic becomes endemic, we will have to keep in mind Albert Camus' *The Plague*, since there have already been several episodes of decreasing contagions during which people go out to celebrate as if nothing had happened, an emotionally understandable but rationally inadequate attitude. I would like to end by quoting the ending of his 1947 novel, which I think is still valid:

«Listening, indeed, to the shouts of joy that went up from the city, Rieux [the doctor] remembered that this joy was always threatened. For he knew what this joyful crowd ignored and which can be read in books, that the plague bacillus never dies or disappears, that it can remain for decades asleep in furniture and clothing, that it waits patiently in rooms, cellars, suitcases, handkerchiefs and papers and that, perhaps the day would come when, to the misfortune and teaching of men, the

plague would awaken its rats and send them to die in a blissful city.»¹⁸
(My own translation.)

REFERENCES

1. Taleb NN. The Souk and the office building. In: *Antifragile: things that gain from disorder*. New York, Random House; 2012. p. 15.
2. Russell B. On induction. In: *The Problems of Philosophy*. 2nd ed. Oxford, Oxford University Press; 1998 reprint. 2001. p. 33-38.
3. Taleb NN. The Souk and the office building. In: *Antifragile: things that gain from disorder*. New York, Random House; 2012. p. 20, 97-115.
4. Ximénez-Fyvie LA. Call to authorities to immediately solve the widespread shortage of basic medicines to help COVID patients. Twitter [Internet] 2020 07 26. Accessed 2020 11 08. Available in: <https://twitter.com/lximenezfyvie/status/1287394294656045059>
5. Colectivo Cero Desabasto. Drug shortages in Mexico: 2nd quarterly report 2020. Mexico City, October 2020. Twitter [Internet] 2020 10 26. Accessed 2020 11 08. Available in <https://twitter.com/cerodesabasto/status/1320824870377279488/photo/1>
6. Taleb NN. Overcompensation and overreaction everywhere. In: *Antifragile: things that gain from disorder*. New York, Random House; 2012. p. 55-65.
7. Danchin A, Binder PM, Noria S. Antifragility and tinkering in biology (and in business) flexibility provides an efficient epigenetic way to manage risk. *Genes (Basel)*. 2011; 2 (4): 998-1016. doi: 10.3390/genes2040998.
8. Negoro S, Taniguchi T, Kanaoka M, Kimura H, Okada H. Plasmid-determined enzymatic degradation of nylon oligomers. *J Bacteriol*. 1983; 155: 22-31. doi: 10.1128/jb.155.1.22-31.1983.
9. Ohno S. Birth of a unique enzyme from an alternative reading frame of the preexisted, internally repetitious coding sequence. *Proc Nat Acad Sci USA*. 1984; 81 (8): 2421-2425. doi: 10.1073/pnas.81.8.2421.
10. Yap YL, Zhang XW, Danchin A. Relationship of SARS-CoV to other pathogenic RNA viruses explored by tetranucleotide usage profiling. *BMC Bioinf*. 2003; (4): 43. doi.org/10.1186/1471-2105-4-43.
11. Valadez B, Rios C. In Mexico City, even interns are recruited to treat covid-19 in the face of hospital saturation. *Diario Milenio* [Internet] 2020 11 30. Available at: <https://www.milenio.com/politica/reclutan-medicos-enfermeros-pasantes-cdmx-covid-19> [Accessed 2020 12 01].
12. Munro DC. The Children's Crusade. *The American Historical Review*. 1914; 19 (3): 516-524. At: <https://www.jstor.org/stable/1835076> [Accessed 2020 12 01].
13. Mendoza-Escamilla V. Insurers warn of saturation of private hospitals due to Covid-19. *Forbes Mexico*. [Internet] 2020 12 04. Available at: <https://www.forbes.com.mx/negocios-covid-19-saturacion-hospitales-privados-aseguradoras/> [Accessed 2020 12 07].

14. Campos A. Reconstructing some order in the chaos. *Problems of the COVID surgeon*. *Cir Gen*. 2020;42(2):176-181. doi:10.35366/95378.
15. Heraclitus of Ephesus. In: Diels H. *Fragmenter der Vorsokratiker*. (2nd ed.) Vol. 1. Berlin, Weidmannsche Buchhandlung; 1906. p. 62-64.
16. Heraclitus of Ephesus. In: Mondolfo R. *Heraclitus. Texts and problems of his interpretation*. (13th ed.) Mexico City, Siglo XXI editores; 2007. p. 31-32.
17. Taleb NN. On the irreversibility of broken packages. In: *Antifragile: things that gain from disorder*. New York, Random House; 2012. p. 178 ff.
18. Camus A. *The Plague*. Paris, Éditions Gallimard; 1947. The quotation is from the Folio Collection; 1987 p. 279. Spanish version: *La Peste* (tr. Rosa Chacel). Barcelona, Editorial Edhasa; 2005. English version: *The Plague* [Translated by Stuart Gilbert]. The Modern Library, Random House, Inc. 1948. p. 254.

www.medigraphic.org.mx