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The Uncertain Certainty Of a Pandemic


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How can we measure uncertainty? How can we know what we don't know? Strictly speaking, it's impossible, and we can only approximate this kind of knowledge. In this article, I will cover some approximations in the field of neurobiology and cognitive theory to explain how we deal with uncertainty and how that can help us understand our individual and social behavior in the face of unexpected, minimally certain events such as the COVID-19 pandemic.

At some point between 50,000 and 100,000 years ago —and we don't know if it was gradual or sudden— human beings developed a kind of consciousness that allowed them to acquire a concept of self-identity (their selfhood) and the concept of time. Human beings have a narrative consciousness that requires semantic, and finally linguistic, capability. That is how uncertainty emerged as the perception of the partial or complete ignorance of one of the two extremes of identity —and therefore, of existence—, whether it be the past or the future. This state of uncertainty had to be reduced to a minimum, which seems to be explained by the evolutionary need to save valuable energy resources used to reverse the disorder produced by adapting to the environment. The best representation of the latter are states of "surprise," that is, the appearance of unexpected events. It is always better for the brain to avoid surprises, which are very costly.

By the nineteenth century, German physician and physicist Hermann von Helmholtz proposed that some of the principles that were valid for thermodynamic systems might also be applicable to biological systems. From then on, it became evident that the organization of certain tissues like the human brain did not fit in with the second law of thermodynamics, according to which every energy system tends to disorder (entropy). So, to be able to maintain stable organization, a system must minimize its "free energy," which, in the case of the brain, is none other than its state of uncertainty. However, for most of the twentieth century, the empirical proof of these hypotheses was limited to registering electrical impulses in the brain, given the impossibility of accessing neuron functioning in real time.

The prevailing model for brain functioning conceives it as an apparatus that receives a series of perceptual stimuli (visual, auditory, etc.), with which it constructs a mental image of reality, based on which it issues a response (behavior). This model, which moves from the sensory to the motor system, underlies many of the hypotheses proposed to explain psychological phenomena and predominates in the popular idea of mental functioning.

Nevertheless, this approach has been questioned by the free-energy principle, given that it requires too much additional energy to achieve equilibrium. In light of the new evidence that has emerged in recent decades derived from the use of new technologies for accessing brain functioning in real time, such as functional magnetic resonance, a new theory about the way the brain minimizes uncertainty has been proposed. This theory posits that the brain is the generator of *a priori* hypotheses about reality. Our

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mind is predictive. Our predictions are based on the experiences of the past deposited in the episodic memory, which makes the narrative identity of one's self coherent, and in the perceptual and motor memory. This creates a prior probability of an event that could happen in reality, which may be accurate —the event actually happens— or not —the prediction was erroneous. In this model —also called allostatic—, the function of the brain is to reduce predictive errors to a maximum, whether by changing predictions or the predicted sensorial inputs through action. This means that, in the quest for minimizing uncertainty (erroneous predictions), beliefs may be adjusted in accordance with experience (bottom-up processes), but also, to the contrary, experience may adapt to beliefs (top-down processes).

It is interesting to observe that the same logic used in the preceding paragraphs applies to the old scientific debate in the field of statistical inference among the so-called frequentists and the Bayesians. The former consider that one decides that statistical hypotheses are true or false according to the estimate of a parameter, which occurs with greater frequency if we suppose that an event can be repeated "n" times. In this scenario, you calculate an objective probability independent of the observer. For the Bayesians, the only thing that can be estimated is the extent to which the certainty of a prior belief about a group of data about reality can change; that is, what is calculated is a subjective probability. In Bayesian methods, the "weight" of reality for changing our beliefs will be relative to the prior probability. Thus, it does not matter that evidence shows a high probability, since if my prior belief is not very probable, the subjective probability will *a posteriori* continue to be low.

This is why it is said that we have a "Bayesian" brain. Many brain functions can be explained in light of these principles. So, learning can be formulated as a mechanism for optimizing predictive mistakes through the codification of causal regularities. This means that motricity is a form of adjusting perceptions that, in turn, modify predictions. In short, the brain constantly develops predictions about the world, and, to do so, uses the rules of Bayesian statistics. It is important to point out that, because of what I will explain further down, the prediction itself becomes a variable to be introduced into the model and that an *a posteriori* probability automatically turns into an *a priori* probability for other events.

Once again, the starting point is the *a priori* probabilities, a kind of subjective perception about the probability that something will happen according to prior experience. In our day-to-day experience, we have the perception that things exist that have a certain probability of happening. Let's use the climate as an example. During the rainy season, perhaps on a day that it traditionally, or "always" rains —for example, in Mexico, people say that it always rains on June 24, Saint John's Day—, we leave our house in the morning with a high expectation of rain and so carry an umbrella, regardless of the fact that the weather forecast says that the probability of rain is low and that no clouds are visible anywhere. This means that, even though the objective evidence predicts that it will not rain, the *a priori* probability is so high that our *a posteriori* probability does not change, even if the data are solid. The opposite happens in early March when "it never rains" and, therefore, we leave the house without an umbrella despite seeing a cloudy sky. In his book *The Black Swan* (2007), Nassim Taleb proposes that the past should not be used to predict the future, given the role that chance plays and which is often underestimated both by science and everyday intuition. He explores the occurrence of highly improbable events, deemed so because they have occurred only seldom in the past, but that can have devastating consequences. One example of this would be the COVID-19 pandemic.

The appearance of a pandemic related to a respiratory virus with its origins in another animal species had been considered something that "could happen sooner or later," after the experiences with the SARS, H1N1, and MERS epidemics (2002, 2009, and 2012, respectively). The coronaviruses were ideal candidates given the distribution and behavior of bats, their most common hosts. The current risks of propagation of such a virus were also known, taking into account human beings' intense, rapid mobility around the planet spurred by globalization. Despite all this knowledge, however, which was public, when SARS-COV-2 appeared, we were all taken unawares: governments, institutions, companies, and families.

For Nassim Taleb, history is full of "black swans": improbable events but that, when they do occur, have a high impact. In his view, the best strategy is not to count on an *a priori* probability and to be prepared for anything, which he calls the construction of an anti-fragile system, that can resist catastrophic events. This is applicable, among other areas, for financial, political, and biological systems.

For his part, at the beginning of the pandemic, Karl Friston, of London's University College, one of the neuroscientists who has developed the principle of free-energy for explaining mental states, proposed applying similar statistical models to those, so to speak, that the brain uses to make predictions, in order to explain the pandemic's behavior. Most of the projections that had been constructed by summer 2020 had failed to predict the peak and end of the pandemic. Along the same lines of what Taleb proposes, for Friston, this is because even tiny variations in the parameters with which traditional models are constructed led to very different results. The compartmental models that had been used in the past to explain the evolution of epidemics did not work in the same way with COVID-19. In Taleb's terms, what we were dealing with was a model that does not work in fragile systems, with "fat tailed" distributions, where the catastrophic event is situated on the extreme.

According to Friston, the other reason that predictive models were insufficient can be explained using the Bayesian principle that states that once the *a posteriori* probability of an event has been calculated, it turns into the *a priori* probability for the following one. As an example, let's say that an optimistic model is constructed that predicts the epidemic will be controlled in the next six months. That same prediction will affect how the event evolves. Paradoxically, optimistic models lead politicians to relax protective measures, which ends up worsening the initial scenario based on which the predictive model was created.

For these authors, the exposure, susceptibility, contagiousness, and deadliness, not to mention the variants of the virus itself, are too heterogeneous to be able to establish really predictive models, given the impossibility of having a reliable *a priori* probability. As a result of this reasoning, they propose always acting according to the "precautionary principle," fundamental for constructing anti-fragile systems.

In terms of day-to-day intuition, this means abandoning the construction of certain expectations that have been fed by an era based on the notion of nations' progress, especially with regard to their economies. In particular, the global economic system is very sensitive to catastrophic events, since it does not take into account that sooner or later, some events of this kind, considered improbable, will, in fact, occur. The same can be said for people in their individual life experiences. We construct narrative projections of our lives without taking into account the appearance of unpredictable events, such as the death of loved ones, illnesses, and accidents, which are due more than we believe to chance. It is very difficult for us to accept that most of life's events are outside our control, and for that reason, we should always act according to the precautionary principle. To do that, the proliferation of belief systems that artificially increase *a priori* probabilities of success and that include the fact that simply having them influences the result does not help.

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Nothing is new under the sun. For thousands of years we have constructed fantasies of control as an adaptive mechanism in a predictive system of energy and reproductive needs. And they will continue to be so until this becomes untenable. At some point it is probable that climate-change-related catastrophic events will occur that we are unprepared for, despite the information predicting them, which is public and unavoidable. The question is, what will the cost be in terms of human suffering? VM

Further Reading

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