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Reality is a Human Construction

Brain–
Centric

How our Mental Space
builds our realities

Editions Sarina

Reality is unique to man

Some thoughts on the upcoming book (2021)

Brain-centric, how the mental space builds our realities.

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The most dangerous hypothesis are the ones we make without noticing.
Henri Poincaré

In the 1980s, the neuroscientist Benjamin Libet showed that it was possible to predict what choice a subject would make 300 milliseconds before he consciously takes his decision by “reading” signals directly from the brain with electrodes. The process of volition is therefore initiated unconsciously in the brain, questioning the notion of free will and of conscious voluntary choice. Consciousness would not then be more than an illusion occurring after the fact. The experiment was great noise at the time and has been often reproduced since. At the moment of conscious perception and before the motor act corresponding to the choice, a delay of 100 milliseconds can be observed. During this brief moment, consciousness can intervene and modify the spontaneous unconscious reaction. This 100 millisecond delay is what allowed the development of human civilization. We have 100 milliseconds to think rather than just react. A series of factors other than biology then began to influence our evolution, bringing us face to face with the greatest of mysteries: conscience and freedom of choice.

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1. A New Enlightenment

I was born in Cairo to a Jewish family but do not actively practice any religion. Over the years, however, I perceive more and more the influence of my Mediterranean roots, they certainly permeate this text.

The question of the existence of gods must be distinguished from our interest in narratives, arts, and religious traditions, these are essential to understand the evolution of human thoughts and soul.

Our progress towards rationality and technologies should encourage us all the more to cultivate and study our traditions as a healthy and balancing discipline for the mind. Traditions give landmarks, they situate us in a time frame that goes far beyond the immediacy of everyday life. They strengthen social cohesions and connect us in depth to our collective soul. It is illusory to think that our life is strictly ours; through us live a multitude of biological stories and clusters of cultural stories.

These stories transcend completely the scope of our awareness of the moment and connect us to a past that we have not consciously known. Organic or cultural, both currents shape our behavior and our thoughts making us ultimately who we are.

The world is changing, man is becoming more and more dependent on his technologies, he creates and adapts to his

creations running the risk of getting lost in a self-referencing loop.

Movements, such as transhumanism, with their prophets imbued with a digital culture where computers play the central role, foresee a robotic and mechanical future. The brain is grafted with chips and “downloaded” into the machine, thought and feelings are algorithms, artificial intelligence grows exponentially and takes precedence over humans. The machine is no longer seen as a tool at our service; soon, they say, it will be conscious, make its choices and decide for itself the good and the evil. We would have to adapt and finally give way to it, in this scenario.

Today the question is no longer “what is *possible* to build” but has become “what is *desirable* to develop.” Apart from technical issues, we must evolve towards ethical questions. But responding to these questions is much more complex, and requires in-depth, lived knowledge of our human soul and therefore of our history, our arts and our diversity. It involves an understanding of our relationship with nature, a long-term vision and a clear picture of what we should become. One cannot acquire these elements under the dominant pressure of short term economic profitability. In medicine, education, biotechnology for example, pure economic criteria can be socially catastrophic.

“What means to succeed?” asked Krishnamurti, “when one lives in a sick society”.

We are at a turning point which requires imagining “Values” that the profit and loss account cannot reflect. We will have to imagine a society that doesn’t force us to close our eyes to injustices and that opens the world’s doors while preserving our diversity. A society concerned with the consequences of its choices on the individual and on our environment. We will have to gradually give up some of our ways of doing and thinking.

How will we find the right balances in these clusters of contradictory constraints? How to reconcile the tensions between the short and the long term, between the individual and the collective? How to adapt such diverse ancient traditions and customs to a common existence? How to enrich knowledge while maintaining the balance and diversity of our planet? Our brain, the freedom to think finding the gap that Libet’s 100 milliseconds offers us, is our only hope and our only tool. And education is our way of learning how to use them in a mindful way.

If the telescope and the microscope were the source of the Enlightenment, let’s hope that the understandings and openings that our latest discoveries allow us will, in turn, initiate this same type of reflection. It is necessary and it is urgent. Now.

Since new technologies can lead us to a new Enlightenment, we must succeed in overcoming the centralizations of information and powers favored by the economic system and now strengthened by digitization. Many pitfalls are to be avoided. Optimizing complex systems like human societies is a continuous challenge which often opposes the optimization of some system's agents.

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2. Beyond logic

Age allows me a certain detachment. Over the past few years, stunned by the world I saw around me, I have sought to discover my own understanding. Find descriptions that I would feel more sincere, deeper or more “true.” As a young student, I had imagined that mathematics had to be a “projection” of the human mental space. Fifteen years ago I was fortunate to be able seriously get down to studying the brain. My friendship with an exceptional Brazilian neuroscientist would greatly refine my outlook.

Questions, more than answers, stimulate thought. Good answers are often the ones that generate further new questions. I am wary of answers that close all doors of future reflections by giving final or authoritative responses. Thinking makes no place for arrogance. Few of us realize, for instance, how much digitalization can be a disaster. Most of us are still dazzled by its fantastic potentialities and close their eyes to the numerous downsides.

The brain is essentially analog and human thought transcends logic alone, it does not feed only on data and measurements, but is rooted in our emotions to go beyond the measurable and stir up our creativity. If the digital computer feeds only on numbers, which it handles much better than us, it does not know what a number is. Contrary to us, a computer doesn’t understand, it’s a machine, it calculates. It applies algorithms,

it does not create. It proposes a future result based on past data. It does not know how to ask good questions, it just follows rules and gives results. To compare human and computer intelligence is just ridiculous¹. As ridiculous as to compare a man to a car. A mechanism and an organism are two very different things. A famous artificial intelligence guru recently responded to an old lady who claimed that feelings are not programmable: “Madam, give me a precise definition of your feeling and I will program it.”²

Our ability to know is limited, it is already miraculous that we can know “something and not nothing.” Our memory is analog, contextual, fleeting and imprecise, the very opposite of the digital “memory” of the computer. Our brains did not develop to grasp the “true,” or to be “realistic,” but rather to help us survive in the environment where *Homo sapiens* lived most of their existence. It favors interpretations of sensory signals that involve a risk. So a primitive man, seeing a branch sticking out in the tall grass, will interpret it as “a lion’s tail” and flee. Natural selection has long eliminated those who took the time to think and interpret, “correctly.” Even today, ancestral

¹ Intelligence is never in the tool, but in the designer of the tool. Computer scientists have always used names of human qualities to describe functions of their machines. This can create significant confusion.

² If something is perfectly defined, it can obviously be programmed. The problem is that essential things like feelings cannot be perfectly defined without losing some of their substance.

emotions interfere with perception and obscure the 100 milliseconds gateway to thought. Immediate self-interest wins over reflection, and the truth is drowned in minds ready for interpretation. Thinking is difficult, too often we rely on ready-made models.

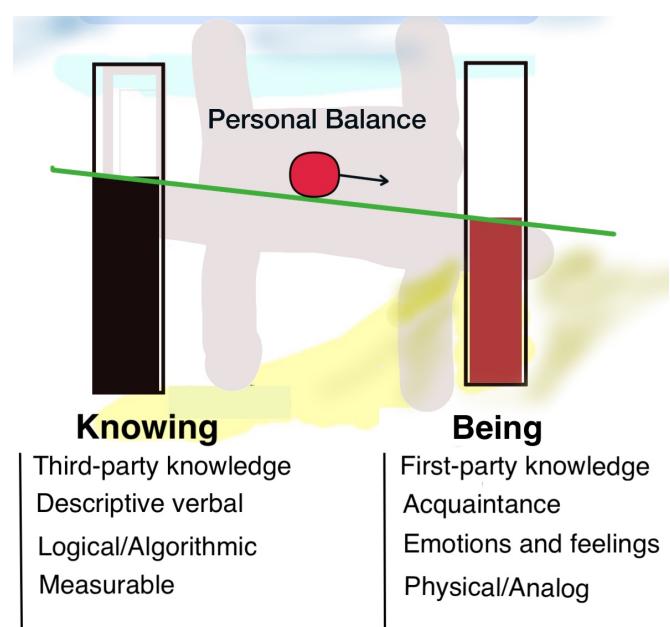
Once an idea, a “knowledge” inhabits our brain, we tend to see “reality” through it. A “Knowledge” can close doors, preventing us from perceiving and thinking in other directions. What we know can imprison us in a tunnel where we only learn things perceivable in this tunnel and neglect what does not fit with what we already know. Knowledge is thus built like an inverted pyramid resting on its point, a new floor can only include rooms that connect with the previous floor. In general, the less knowledge we have, the more we cling to certainties. We forget that the certainties of one era will make future eras smile.

This binding tunnel is the paradox of education! To know too much can close the mind to knowledge of a different nature. Avoiding this paradox is only possible by teaching doubt, critical thinking, constant questioning and above all the historical and human context. Otherwise, education which has already mechanized behavior would end up completing the total mechanization of brains. Algorithm’s final triumph over creativity.

If the important thing is to get there, it is better to follow a clear route, but if the important thing is to create, innovate or learn, it is better to think outside the box. By staying on the trunk, there is nothing to discover, the unknown is on the most fragile branches. Education must therefore compose teaching us the existing algorithms but encouraging us not to always follow them and seek our own solutions.

Pythagoras, if he remains famous for his theorem, taught in his school two complementary aspects of Human Development. On the one hand, knowledge, as we know it: numbers, data, technique. But on the other, his teaching was about the “being,” that he considered necessary to use the “knowing” positively. His students used to spend months meditating on each number. The idea that we are developing on two parallel lines: “knowing” and “being” was taken up during history by many thinkers. “Knowing” is a product of the human’s past, it is essentially made of algorithms and measurable data.

But to make knowledge one's own, one has to



work on the “being.” Developing the knowing, without developing the being risk leading the individual to personal imbalance and society to the pursuit of destructive and unmastered technologies. Develop the being without dealing with the knowing leads to inability to act.

Dispositions on the line of being are non-algorithmic, they are beyond the words which express them. Among these qualities, doubt, humility, gratitude and the search for truth are essential to the human mind. To be constantly aware of our place in the universe, to marvel at every moment of the miracle of our existence and our awareness of this miracle, to marvel at the unexpected, are attributes at the very heart of what it means to be human. Remain humbly aware of our ignorance, driven by the quest for the beautiful and the true, never letting go the friendly hand of humor.

Lacking these feelings at every second, we miss the most primordial aspect of our humanity. We start mechanizing and risk focusing only on measurable knowledge, causing wounds and disasters.

Particularly today, it is necessary to distinguish the *world of show* from the *world of substance*. The world of show, largely favored by our economic structures, seeks to distract us and to prevent us from thinking, it is made up of slogan, shortcuts, facilities and lighting effects. To be seen and known is important, regardless of the substance. The world of

substance is, I believe, the one that, deep down, we all seek; even if it is more restrictive, it alone will ultimately ensure our survival.

It terrifies me to see that the world of performing, of appearing, of making believe has infiltrated every nook and cranny of human activity. Even at the heart of science. We are taught that to be successful we must show off, and showing off means renouncing being oneself.

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3. Integrated into the Universe

I like to take a walk in the nature. Whether it's the forest, the desert or the mountain, I need to see, feel, touch. I need to observe the stars, to be a part of it all, to know that this is my world, the one that created me and that unfolds through my senses. I like to think that one day I will be able to make sense of this vastness. I need silence and great expanses that drag my mind away, telling me to wake up, and that I don't have to live so small. Reminding me, I am part of the thousands of generations of women and men who have pursued this quest. Not to receive an answer, but simply for this universe to exist.

To see yourself as isolated in space and time is just an illusion. When we rationally explain our actions and thoughts after the fact, we are constructing an incomplete, fragmented, pieced together picture. A mechanized image, assembled out of prefabricated linguistic elements. We transit from life to the verbal world. Language for 10,000 years has changed our universe. We now live in words. Words inspire our fears and image our hopes. Words have become our swords and shields, and data has taken precedence over being. Language marked our first step into the digital age, transforming our world and reshaping our cortex.

Language separates "out there as a whole" into independent entities. It imposes its own division and its own individuations. It has become our reductionist means of apprehending,

describing and understanding a wholeness that escapes us. A tree is not the sum of roots, trunks, branches, leaves and green. Language fails at painting the nature of a whole by adding words. The tree is more and different than the sum of its parts. Its “nature” has no parts, only its linguistic description is built that way. An engine is made of parts, it’s its nature, it can be dismantled and reassemble, but not a tree, nor a human brain. An organism is different from a mechanism. However the language describes both using the same grammatical patterns.

Representing reality by cutting it out in parts is an illusion that deeply troubled the great physicist David Böhm who was concerned with fragmenting in science. This same fragmentation has contributed to the illusion and ultimately the failure of recent projects to model the brain on a digital computer³.

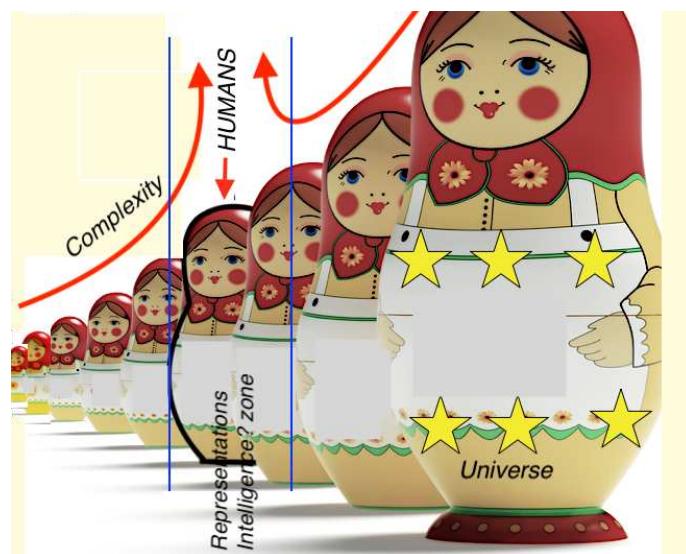
Immersed as we are in the world of the noun, we do not know how to do otherwise than to fragment. To answer the question, “what is this?” We explain what “this” is made of, we break down into parts something who may be indecomposable. Our verbal map does not correspond to the territory out there.

³ I participated for 5 years in the first steps of the Blue Brain / Human Brain Project at EPFL. My french book The Computer Will Not Digest The Brain predicts the failure of the project and the basic reasons for it. The book we wrote with Miguel Nicolelis, The Relativistic Brain, How it works and why it is not Simulable on a Turing Machine, gives biological, neurological and mathematical arguments that prevent simulating the brain on a digital computer.

Fortunately, our analog brain understands beyond words. There is verbal knowledge, but behind it is the being. Fortunately, there is music, literature and the arts. Let's be careful not to be just specialists and to keep a broad perspective, the questions we are going to have to answer will need a deep and global vision. As we age, a man's field of consciousness gradually expands, he begins to take into account a variety of factors which, when he was younger, escaped him. Likewise, the field of collective consciousness of our society will have to expand.

At all levels, we are integrated into the surrounding nature without which we cannot exist. We are one species among billions of others in an ecosystem bubbling with complex interactions; these billions of species in turn interact with the entire universe. Change just one link and the whole system readjusts itself. From top

to bottom and from bottom to top of the dimension scales, from particles to the entire universe, actions and feedback flow constantly. This makes us one of the Russian



dolls, fully integrated into the chain, powered by and reacting to flows of energy and information from above and below.

But our location in these vast chains is interesting and unique. We are located at that exact position in the doll chain where complexity is maximal. Bigger or smaller entities cannot have a sufficient complexity for the development of our type of individual intelligence.

But it is not only on the physical and biological level that these exchanges of information and energy take place. Our thought too is part of a chain connecting us to a collective unconscious, to a culture and ultimately to all other humans that have existed. Newton said he was only able to innovate because he sat on the shoulders of the giants who came before him. Miguel Nicolelis developed and studied in the laboratory the concept of “brainnet” and showed how brain-to-brain communication enables the creation of a “collective brain” and ultimately the development of civilizations.

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4. Mental space and perception

For as long as I can remember, I have been suspicious about “reality.” So, in the gymnasium, when we studied Plato’s cave, it was like a revelation. What we believe to be reality is not the real reality, there is something else behind it and Plato confirmed it. I had to find out, I had all my life to do it.

A mental representation is the abstract mental entity that represents an object, a feeling, a word, a memory, an expectation, ... The sum of all these mental representations and their interactions are called the “mental space.” The mental space feeds on sensory information reflecting “out there” as well as bodily emotional information that combine to “fabricate” its interpretations. The mental space combines memorize, abstracts, interprets, and generates information non-stop. This activity corresponds to what we call thinking or feeling, or remembering... All of what we know is generated and located in our mental space. The object of neuroscience is to study how the underlying physical space, the brain, generates the mental space. The links between the brain and the mental space, the nature of consciousness, which already posed a problem for Descartes, remain mysterious⁴. Our existence takes place in our mental space which constantly

⁴ How does something intangible and abstract act on a material object? In Brain-centric, How the mental space builds our realities, I describe in detail the solution that Miguel Nicolelis and I propose.

interprets, decides, coordinates and acts on “out there” and, according to these interpretations, modifies its own representations.

The only links between this mental space and “out there” are through sensory information and perception. Understanding the mechanisms of perception then becomes a central question to understand reality. When the mental space analyzes itself, a “blind spot” phenomenon appears (the camera is never on the photo it takes). This phenomenon is due to infinite regression and stems from the absence of an external reference. A mental representation of the mental space must contain a mental representation of the mental space and so on, like an image reflected in two parallel mirrors. This “blind zone” will also affect languages which necessarily contain undefined primitive words, they are generally essential words.

The central nervous system and the brain have developed to coordinate the animal’s response to its environment. The central theorem of cybernetics assures us that the only way to ensure body regulation is by generating an internal image of what is “out there.” The more precise and detailed this image is, the more efficient is the regulation.

The brains of evolved animals are today described as “anticipating machines.” The sensory signals are used to confirm these anticipations. We are constantly predicting what

might happen next, and we search through sensory information elements that confirm our expectations. This anticipatory activity occurs at all levels of mental space. When an expectation is unconfirmed, we are surprised and disoriented, while our central nervous system calls for a better-adapted memorized expectation.

Up to the beginning of last century, the prevailing idea to explain perception was that it is initiated at the level of the external phenomenon. Our senses pick up a signal from the phenomenon and offer us a representation. What we perceive is therefore similar to what “is” out there. Like a camera, our representations are images of the object they represent. This concept has gradually been abandoned because it presents too many inconsistencies. It would not allow the development of an adaptation at the individual level sufficient to justify our personal intelligence. Living species that do not use the anticipated expectation system to perceive, like insects, survive by adapting at the collective level. The individual can get caught up in looping behaviors from which he cannot escape, repeating the same inadequate choice until death. Furthermore, photographic-type perception leaves open the famous “binding problem”: how could sensory information reaching the brain from different sensory organs via neural paths of different lengths, at different times, coordinate into a coherent representation? .

It is now accepted that perception is initiated in the brain by expectations memorized from experiences. The “plasticity” of the brain constantly allows generating and adapting expectations⁵.

Perception by expectation is perhaps one of the most significant recent scientific advances. Its scope goes far beyond the framework of neuroscience and finds essential applications in sociology, physics, epistemology and philosophy.

We cannot know the nature of reality out there. All we know are our representations. Empirical science repeatedly experiments and makes precise measurements, it collects data, numbers. But it is a human brain that interprets the meaning to be given to these numbers, according to its expectations. The brain establishes a model and the corresponding mathematics. For instance, Newton's gravitation. This model is then used to make predictions. In the case of Newton, his mathematical model was confirmed for more than 200 years, until 1919. Eddington was able to measure that year that Albert Einstein's brand new General Relativity gave more precise results. In most cases, the gap is minimal and Newton is still used today. But here's what's interesting in our context, Newton describes a universe of forces acting at a distance while Einstein uses a

⁵ See for instance Miguel Nicolelis's book: Beyond Boundaries

space curved by masses. The numerical results are very close, but the interpretations on the nature of reality are very different. The Greeks believed that the planets revolve around the sun by the will of the gods, Newton attributed this movement to a gravitational force, Einstein to the curvature of space-time. Whatever interpretation we choose, it remains in the verbal world, the interpretation is “about” out there, not out there. Planets continue to orbit and know neither the Gods, nor the laws of Newton, nor even Einstein.

What, however, makes the difference between the interpretations is only in the mathematics: the quality of the predictions.

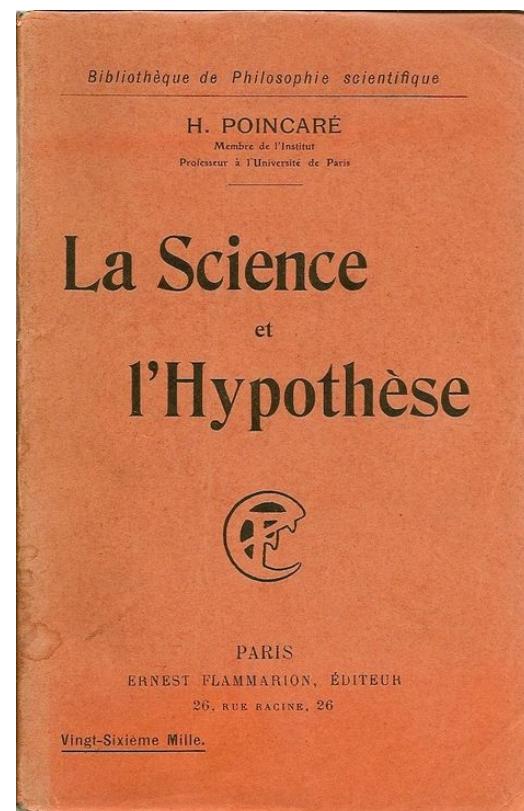
Reasonably, any intelligent alien species also uses an anticipatory perception system. But since their environment could be very different from ours, their chemistry and physiology will be very different as well. Their mental space will not necessarily resemble ours, so they will live in a different “reality.” Neither they nor us will be right about the nature of “out there.” To be correct does not matter, only survival matters.

Meeting an intelligent alien being would be a major event. What kind of intelligence will it be? What will their reality be? Will we be able to communicate with them? No experience could teach us more about ourselves, the universe and life

than being confronted with beings with a mental space totally different from ours.

In 1902, the great mathematician Henri Poincaré published a small work intended for the public and entitled “Science and Hypothesis.” In it, he asserts that mathematics does not study objects, but the relationships between objects. One can therefore easily replace one object by another. (The interpretation is thus not constraint by the mathematics.) He gave up the Newtonian idea of absolute space three years before Einstein. He asserts that the two propositions: “*The Earth rotates*” and “*it is more convenient to assume that the Earth rotates*,” have one and same meaning; there is nothing more in one than in the other.

But beyond these brilliant anticipations, Poincaré affirms that the totality of scientific knowledge is the result of conventions between humans. No absolute truth.



5. Truth and lies

Rabindranath Tagore, the Indian poet and Nobel Prize winner, visited Albert Einstein at his home in Caputh, near Berlin, on July 14, 1930. Their discussion, which was recorded, focused on the nature of reality. **Einstein:** There are two different views on the nature of the universe—the world as a unit dependent on man and the world as a reality independent of the human factor. **Tagore:** When our universe is in harmony with man, we know it as true and feel it as beautiful. **Einstein:** It's a purely human conception of the universe. **Tagore:** The world is a human world. The scientific vision is that of men, science is human science. Therefore the world separate from us does not exist; it is a relative world, dependent for its reality on our human consciousness...

Truth or lie only exists in the verbal world that humans have developed over the past 10,000 years⁶. Truth is about the fidelity of a verbal proposition describing an event “out there,” outside the verbal world. Lying or cheating indicates a voluntary lack of fidelity or loyalty in giving the best possible description of the event out there. Nothing is true nor false out there. Only our mental representations can be accurate or misleading. Lying is only made possible by the use of language. A text maybe wrong, not what’s out there.

⁶ Structured language was introduced gradually, 10,000 years ago is a very rough estimate of when the first structured languages appeared. The roots of language formation in primate brains are much older, recent study traces it back several million years

Language allows a man to gain power in his group through the use of wrong descriptions, we quickly learned to use it for these purposes. The remedy for lies is observation, but language often deals with unobservable entities such as feelings, intentions, intangible things, past events... It took thousands of generations for the meaning and importance of truth to emerge. Aristotle realized how much lies can destroy societies, how much they inspire conspiracy theories ultimately leading us in catastrophic directions. Exasperated by the rhetoric of the Sophists that used speech to touch the emotions of crowds to gain power, he tried to pin down truth by structuring language with its logical principles. Aristotelian logic is still the one we use daily and seems obvious to us. However it was not enough. The Sophists ended up destroying Athenian democracy. Two millennia later, Leibniz was also concerned by the disagreements and wars that ravaged Europe. All his life he dreamed of a language in which one could only express truth, an Arianne threat for thoughts. A language which, like in mathematics, would make it possible to verify and “prove.” It would be sufficient to sit around a table and, by communicating through this language one could discern the true and the false. Leibniz explains this dream in *“De arte combinatoria”* in 1666. To build his language, he was inspired by the geometry of Euclid and the al-Khwarizmi algebra written in 830 but whose Latin translation had reached

Europe much later. He invented the binary notation and built a mechanical computer, whose final version was presented in 1710. But his enterprise failed, lies and discord continued to pollute mankind.

Voltaire pointed out to us that: “*Those who can make you believe absurdities can make you commit atrocities.*”

At the beginning of the 20th century, the need to structure language to express truth was to shake the very foundations of mathematics. The great mathematician Gottlob Frege was finishing the second volume of his book on “The foundations of arithmetic” when he received a letter from a young British student telling him he had spotted an inconsistency in the first volume. A contradiction in mathematics is a catastrophe which threatens the whole edifice. The contradiction was a variant of the liar paradox, and the student’s name was Bertrand Russel. That gave rise to the biggest crisis in the foundation of mathematics. A gigantic enterprise, rewriting all mathematics in formal language, was initiated by David Hilbert, its scope was to make sure that every step of every deduction was solidly grounded and avoid any inconsistency.

In 1931, the Austrian mathematician Kurt Gödel put an end to the idea that anything that was true could be logically proven. His indeterminacy theorems showed that for any coherent⁷formal system there are true propositions which cannot be

⁷ Coherent: that contains no contradictions

proven true within the system, and that such a system could not prove its own coherence. Syntax and semantics are two different territories. Leibniz's dream is impossible.

Five years later, Alan Turing would show that an infinite number of problems are “uncomputable” in other words, they cannot be solved algorithmically. His work would quickly lead to the realization of the digital computer as we know it. While artificial intelligence continually shows us that many problems can be solved by the computer, the fact remains that the infinite majority of them will remain uncomputable⁸.

The circularity and self-reference of our mental space and of some verbal definitions of primitive words generates blind areas where logical reasoning no longer applies. Certain questions will therefore remain forever without a formal answer. Some primitive words, the meaning of which we humans understand well, will remain indefinable by description. However, without defining them verbally, we understand them “from the inside.” Of course each of us then understands them in his way. They don't have that fixed rigidity of words carefully defined by the dictionary, but they are nevertheless the most interesting words because, as Noam Chomsky said, it is its imprecision that gives language its richness.

⁸ Please see my book with Miguel Nicolelis, *The Relativistic Brain, How it works and why it cannot be simulated by a Turing Machine*.

The dictionary cannot define the first word for which one would need concepts not yet introduced. Verbal knowledge must initially be based on acquired knowledge to develop. Until around the age of seven, most knowledge is thus learned by the child by imitating, by associating feelings with perceptions. Even adult learning by acquisition is essential, try to learn verbally how to ride a bicycle or play the piano. Knowledge that we do not forget is always acquired in this way, its basis is non-verbal. It is deeply associated with emotions.

Although mathematics is a purely verbal activity and relies on reasoning, good mathematicians associate, in their heads, mathematical objects with images and emotions. These associations will allow them to familiarize themselves with mathematical objects and to tame them. Seeking and discovering then becomes much easier: it is about imagining the history of familiar things that you understand as you understand your best friend.

The most commonly used indefinable words are, for example time, space, love, living things, ... Another essential word falls into this category, the word “to exist.”

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6. Physical or mental existence

I'm not asking for a theory to match reality, because I don't know what reality is. Reality is not a quality you can test. What concerns me is only that the predictions of the theory match the results of the measurements. (Discussion in 1994 between Stephen Hawking and Roger Penrose at Cambridge University.)

Poincaré claimed, the two propositions: “*The Earth rotates*” and “*it is more convenient to assume that the Earth rotates*,” have one and same meaning; there is nothing more in one than in the other. This means that we cannot distinguish verbally between “*something is out there*” and “*It is convenient to assume something to be out there*. ” There is no way to certify that a mental representation effectively represents something “out there,” or that this representation is a simple convenient mental hypothesis to describe, “out there.”

Claiming that something “exists” depends fundamentally on our perceptions, on our senses and on our central nervous system. We now know that perception operates by expectations. The conjunction of these remarks raises questions on the meaning of the concept of existence: is existence mental or physical?

We understand “to exist” by acquisition. Something exists to the extent that we can touch it, see it, smell it, hear it... However, physicists have had to extend the concept of

existence. They needed to qualify as existing entities escaping all direct observation. Indeed an object may be “too small” to be illuminated whatever the frequency of the wave illuminating it, for example. Thus elementary particles such as electrons, neutrons, photons or even atoms are not visible, their size is much smaller than the wavelengths of visible light. Other physical objects also escape direct observation, such as black holes or the Big Bang. Their “existence” is accepted on the basis of a theory and observation of the consequences of that theory. Thus general relativity opens up the possibility of the existence of black holes which are by definition unobservable directly. However, the accretion disc that forms around the black hole, which is also predicted, is observable. Likewise, observations made in particle accelerators are never direct observations, they involve a theory, the Standard Model and an indirect observation of a consequence of this theory.

Physicists have therefore agreed that something “exists” if the hypothesis of its existence is useful in explaining a phenomenon, which is observable to it. “Physical existence” is no longer truly distinct from a mental operation.

The boundary between physical and mental existence is disappearing. The last step is to realize that all we can know is always purely mental.

Out there the mental world we live in does not exist:

Outside there is no music, no sound, no picture, no lake and no house. There is no Paris or New York. There aren't even any sun or stars. No molecules or atoms. No space conquest, no human beings or Burgundy wines. No Proust or Hemingway, no time or space. No love or hate... For all of this to exist, there needs to be human mental space.

Darwinian evolution has ensured that our mental representations are good enough to have supported our survival, but nothing tells us that they provide us with an accurate picture of what is out there.

If our reality is then purely mental, what about experimental verifications?

Experimentation only provides us with figures that support or falsify our theories, the descriptive entities and the theory itself remain productions of the human brain.

Does this mean that there is no objectivity?

The notion of objectivity changes its meaning a bit, instead of pretending to describe what is out there, it becomes our effort to generate the theory most compatible with the measured data.

The questions raised above have been the subject of over ten years of discussion and research with my friend Miguel Nicolelis. This resulted in a new approach to how the brain generates and manages information. In addition to the digital

information classically defined by Claude Shannon, we have introduced the notion of Gödelian analog and physical information, we have proposed a hybrid computation model and suggested the possibility of physically building such computers capable of solving questions who are uncomputable in the Turing/Von Neumann model. Miguel recently published a book called *The True Creator of Everything: How the Human Brain Shaped the Universe as We Know it*, which I highly recommend to you. For my part, I have titled my coming book: *Brain-centric* with the subtitle *How Mental Space Builds Our Realities*.

You cannot be a mathematician without having the soul of a poet.

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