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**The Role of Scientists in a Human-centered Society**

by

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**Abstract** (50-150 words)

Without forgetting the objective limitations of Science, always incomplete, scientists have an important role, not only avoiding inappropriate and dangerous decisions, but also advising the policymakers and other stakeholders about the best and wiser moves to do towards a human-centered society, fomenting scientific knowledge and enhancing cross cultural connections and joint research. With this purpose, we stress the importance of transferring knowledge among all scientific disciplines, using a transdisciplinary cross-talks approach. A few examples of how this may be done are presented.

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**Keywords**

science, interdisciplinarity, transcendence of reality, ethics

1. **Introduction**

Science and technology are essential tools for innovation. To reap their full social potential, we need to articulate and solve the many aspects of today's global issues that are rooted in the political, cultural, industrial and economic realities of the human world.

Our society is witness of an era of ever faster growing revolution at all levels, in an exponential spiral pace that some times may awake a feeling of vertigo. It doubtless goes towards objective improvements of the humanity and through the entire nature.

However it is not immune to eventual serious unintended consequences on the society, too. Scientists have to be alert, therefore, not only avoiding inappropriate and dangerous decisions, but also advising the policymakers about the best and wiser moves to do, because we cannot forget that to keep a human-centered society is in the advantage of everybody.

We should also not forget though some of the objective limitations of Science itself: it is still far away from its goal in searching for truth, always incomplete; even more, science is not the only way in search of the Truth. There are other valuable ones, such as philosophy, ethics, or religion, unfortunately limited too, because we always arrive to concepts of reality which are unintelligible by reason. Now or later, we will always find unintelligible mechanisms, being “left face to face with the awful mystery which is reality” (Dampier, 1971, p 501).

Before coming to these points, we will start clarifying some conceptual generalizations of interest in this context.

1. **Conceptual Generalities**

**What do we understand for Science?** Etymologically, Science comes from the Latin *scientia* (*scire* = to learn, to know), meaning a process of studing and knowing the fundamental laws of nature, through a dialogue between theory and experiment. It is one of the most remarkable inventions of humankind, becoming a source of inspiration and understanding, lifting the veil of ignorance and superstition, and being a catalyst for social change and economic growth, and saving countless lives.

The function of science is to expand continually our knowledge of the phenomena of nature, giving us an insight into the complex interrelations of phenomena, or rather between the concepts used to interpret those phenomena.

Whereas in other languages, like German (*Wissenchaft* = *Naturwissenchaft*  & *Geistigeswissenchaft*), the extension of the concept coincides with the one of the classical Greco-Roman times, in English the word “science” is limited to natural sciences, also known as “hard sciences”: something done in a laboratory; which involves making measurements with instruments, accurate to several decimal places; and controlled, repeatable experiments in which you keep everything fixed except for one of a few things that you allow to vary. Areas that often conform well to these stereotypes include chemists, physics, molecular biology...

They are traditionally divided between: a primarily **basic** science, which studies the fundamental laws of nature:, in a free search for progress of pure knowledge, from microcosmos (atoms) to macrocosmos (universe); and a secondarily **applied** science on how the power of thinking can be increased, pursuing useful purposes and eventual specific practical advantages: medicine, engineering, industry, cyberspace, economics, life quality, environmental and climatic changes…

A new call to abolish this traditional division comes from Venkatesh Narayanamurti, a previous dean of SEAS (Harvard's School of Engineering and Applied Sciences), in 2008, describing it as artificial, because it assumes a linear relationship between the two that doesn't always exist -discovery goes both ways: inventions draw on scientific knowledge and scientists gain insight from new devices and applications. Narayanamurti proposes organizing science as a cycle that moves from discovery to invention and back again, a highly nonlinear model, because they must feed on each other, in a cross and interdisciplinary work that breaks down disciplinary walls and encourages collaboration and that has been successful in some of the nation's top scientific institutions. Some of the world's most important inventions were made not by basic scientists and applied scientists working sequentially in isolation, but by scientists who teamed up, sharing ideas and insights and even sometimes switching roles in a cross- and interdisciplinary work. For instance, Bell Labs, home to many important discoveries, such as the development of the transistor in 1947, which laid the foundation for modern electronics, which earned eight Nobel Prizes, blurred lines between disciplines, talented personnel, ample resources, and leadership (Powell, 2017).

There are other disciplines, such as social sciences (sociology, economics, political science, history…), and human sciences (philosophy, ethics, theology, art, psychology, anthropology…), usually known as **soft sciences**. Do they really constitute science at all, and do they deserve to stand beside the hard sciences? A key problem is that the task of operationalizing their intuitive concepts is inevitably more difficult and less exact in the soft sciences, because there are so many uncontrolled variables... (Lang, 1975). Far from colonising the social science under the banner of natural science, some social scientists consider their disciplines as science, and others want to think that the robustness of the philosophical approach is even much more intense and trascendent than the so-called natural sciences, say, nuclear physics, because they offer achievements of great importance. Philosophy is forced to take account of science as the best available evidence, In its intent of achieving a complete construction of reality, philosophy focus on human origin & destiny, and its *Weltanschaung*, or project of live, even if it realizes its impossibility of achieving this purpose -solving all, because there is no human way of solving everything.

1. **Towards a transdisciplinary approach**

**in natural and social sciences**

The science of the 21st century is in most areas far too complex to be understood, let alone experimentally verified, by any one person. This necessity of knowing a thing in depth explains that the different specialties of knowledge become continuously more specialized, erecting barriers between disciplines, even if, in the end, these barriers between disciplines may block the possibility of judging and of doing better. This is why it is needed an interdisciplinar approach, a cooperative integration between all the branches of sciences, each one competent in a restricted field, but in contact with the rest, keeping all the subjects in permeating touch with each other, for better answers about being human and our single common Universe, because no single discipline can capture reality fully or claim to have the complete knowledge. "At the moment a problem of any kind is encountered, recourse is always made to interdisciplinary solutions” (Giarini, 2002,m p. 148). Moreover, conclusions from different disciplines cannot contradict one another. [Tooby & Cosmides, 2017]

These interconnections and comprehensive approaches are becoming more and more apparent at different levels:a)within a discipline, as thetranslational approach in medicine shows: “from field into the bench, and from bench to bed”, i.e. before applying the adequate therapy (pharmacology or surgery), we have to know its pathology (abnormal) and, previously, its physiology and structure (normal); and b) between all different disciplines of sciences and humanities, transferring knowledge gained in one discipline to others, with the very desirable goal of the integration of the human sciences, at some level, rendering coherent the areas of overlap of the various disciplines.

Sciences and humanities are actually not alternatives, but \*interdependent\* ways of getting to know the world. Both share a sense of reality that transcends time and place; hence their common interest in a fixed 'human nature'. This is tied to a way of thinking and a sense of knowing largely contemplative. As it may seem self-evident, and was regarded as important by Einstein, Bohr and the founders of quantum theory a century ago, and by Karl Popper, who argued that falsifiability was a hallmark of good science, “all our theorising and experimentation depends on particular philosophical background assumptions” about the world (Koch, 2004).

A specially good example of transferring knowledge gained in one discipline to others was the Viennese school, one of the most important intellectual schools of the 20th century, within that a mixture of classes and nationalities, faiths and worldviews, amid a babble of peoples and languages. Which was known the *Wiener melange*. They found universal forms of communication, discovering what people had in common. For instance, a) Ernest Dichter, author of “The Strategy of Desire”, using the tools of psychoanalysis to revolutionise business; b) Paul Lazarsfeld, the founder of modern American sociology, applied his expertise in data and quantitative methods (he studied maths in Vienna, completing his doctorate on Einstein’s gravitational theory) to opinion, or market “field research”; and c) political economy, where the “Austrian school” of men like Joseph Schumpeter, Ludwig von Mises and his student Friedrich Hayek, strongly influenced the revival of liberalism and conservatism in the West, overwhelmed by the collectivism and totalitarianism of the right and the left during the interwar years.

We would like to mention specially the greatest contribution of Hayek, who combined technical expertise in economics with a global breadth, publishing on law, sociology and more, to restore intellectual rigour to the free-market school, expositing in detail the “price mechanism” to show that socialist economics could not possibly work in theory, let alone practice. In 1947, he founded the Circle for liberalism Mont Pelerin Society (MPS), including Milton Friedman & Karl Popper (the “Chicago school” of economists was made up largely of MPS members) and, his ideas were taken up again by a subsequent generation of politicians in the mid-1970s, including Margaret Thatcher and Ronald Reagan.

Why the Viennese school has produced ideas so influential in the West? Because they articulate a more convincing defence of freedom, placing the lived experience of individuals—rather than the abstractions of class, race and nationalism favoured by their opponents—at the heart of their intellectual enterprises. “Instead of being interested in the behaviour of commodities, while they interested in the behaviour of people”, as Peter Drucker, the founder of modern management theory clearly stated after a lecture by Maynard Keynes (Economist, 2016).

We are aware, though, that bridging disciplinary divides cannot be easily attained, since the various disciplines model human behavior in distinct and sometimes incompatible ways; it requires a common underlying model of individual human behavior, specialized and enriched to meet the particular needs of each discipline (Gintis, 2003). There is a lack of shared language between disciplines; insights from one field can be lost on researchers in another because of terminology differences, incompatible standards of evidence. And also we may find practical differences in the funding of different disciplines, and strong incentives created by the academic promotion process to do disciplinary, rather than interdisciplinary work. As Silk (2004) explains, "drawing the line between philosophy and physics has never been easy. Perhaps it is time to stop trying. The interface is ripe for exploration."

Consequently, a new transdisciplinary approach cross-talks among all scientific disciplines, philosophy, art and theology included, can bring some badly needed insights probing the meaning of our very existence. As MIT President L. Rafael Reif has said, solving the great challenges of our time will require multidisciplinary problem-solving-bringing together expertise from science, technology, the social sciences, arts, and humanities. “We use the term the collective wisdom of MIT to solve a problem; now we’re talking about collective wisdom of the world,” working together to solve global problems.” (Berglof, 2012)

1. **Towards an integrated and comprehensive**

**technological revolution**

We stand on the brink of a technological revolution that will fundamentally alter the way we live, work, and relate to one another. In its scale, scope, and complexity, the transformation will be unlike anything humankind has experienced before. We do not yet know just how it will unfold, but one thing is clear: the response to it must be integrated and comprehensive, involving all stakeholders of the global polity, from the public and private sectors to academia and civil society, as Klaus Schwab, Founder and Executive Chairman of the Davos World Economic Forum, exposes in his *the 4th Industrial Revolution*(2016)[[3]](#footnote-3).

This Fourth Industrial Revolution is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres: ubiquitous, mobile supercomputing, artificially-intelligent (AI) robots, self-driving cars, neuro-technological brain enhancements, genetic editing… The evidence of dramatic change is all around us and it’s happening at exponential speed.

We cannot close our eyes to the information technology (IT) challenge, which diffusion is continuously spreading throughout the scientific world: every body is investing more in it and in high-tech, and each time more intelligently. IT is an authentic revolution, increasing the life quality: higher efficiency, more productivity and less transport expenses.

1. Internet, a ubiquitous and in exponential growing web, has become the first global social organization, linking and bringing together different people into a single global cultural community, affecting international relations (Choucri, 2013) and forging a common sense of humanity;
2. cell phones usage and internet access have exploited: social media are important, fundamental, connecting families across vast distances, needed for internet banking, education or medical reasons, or for market trading (80% smart phones; smart cities…)
3. artificial intelligence (AI) may help: improves our decision capacity, and unpicks the complexity of biology (producing drugs) and advanced human health (diagnose), given that living organisms are complex systems which process information using a combination of hardware and software (The Economist, 2017)
4. Internet of Things (IoT) is going to change business more than the industrial revolution did one century ago, encouraging innovation and offering predicting and preventing as one of its most valuable assets; it requires interoperativity among all the different systems and kinds of applications; for instance, a smart city with a digitable enabled ecosystem which includes citizens, universities, hospitals, companies, government…

Even if we cannot live out of IT, we should also not forget that its use is not free of risk: social media webs, so efficient for agglutination of attention, are not appropriate for a public discourse, given their volatility: they are uncontrollable, unstable, short-lived and amorphous, appear suddenly and disperse with the same speed, showing a lack of stability, consistency and credibility, as the Korean philosopher [Byung-Chul Han](http://elpais.com/tag/byung_chul_han/a) (2017) argues: digital communication enables instantaneous, impulsive reaction, being in fact responsible for the disintegration of community and public space

And suspicions about security have also risen, given the vulnerability of the present digital, connected cyber world (Ramirez & Garcia-Segura, 2017).

The most important comment, however, is that last decision belongs to humans, because we are the ones who have to know how to use these new concepts adequately, knowing how to discriminate in front of the eventual risks inherent to their above described wirl.

**5. Limits of Sciences**

The continuously appearance of new scientific discoveries –some ones by serendipity, like the usefulness of some drugs or the law of the gravity, after observing the falling of an apple- shows that **science has no borders.** It is famous the anecdote of Max Plank, when went to Munich to study Physics, in1875); somebody adviced him not to do it because “there was nothing left to be discovered”, when it is probably Physics the discipline that shows better the alive continuity of the knowledge (Zichichi, 1990; Weatherall, 2016). The desire to know the unknown is what inspires humankind’s search for knowledge; the more we know, the more questions we ask. We want a complete harmony of the understanding, never totally accomplished.

Science's quest for knowledge about reality presupposes the importance of truth, both as an end in itself and as a means of resolving problems. When we are doing science, we are trying to arrive at the truth. In many disciplines, we want that truth to translate into something that works. But if it's not true, it's not going to speed up computer software, it's not going to save lives and it's not going to improve quality of life. However, experience says that science can only disclose certain aspects of reality, but not all the truth. Universal truth is beyond the scope of any scientific enterprise. **Science is not synonimous of truth**. Let us base this assertion on a couple of arguments: the tentative nature of Science, by definition; the subjectivity of the perception, and the undeniable fact of the existence of many scientific studies subject to error and to fraud.

a) The **nature of Science is tentative** by definition, by a scientific self-limitation to only what is empirically verifiable, and not all what is real is measurable (Dupré, 2001); scientific concepts are not realities, but just models: it is a hypothesis which produces laws that, to be universally acceptable, do not have to have an over all contradiction, even when described from different coordinate systems. Examples of common assumptions, which have played significant roles in pursuit of truth: the laws of energy conservation and of entropy increase, causality, constant light velocity in vacuum…

Science expands our knowledge of nature, giving us an insight into the complex interrelations of phenomena, or rather between the concepts in which phenomena are expressed.

But these generalizations, even if may be universally accepted as ultimate scientific concepts, they often have proven to be mistaken; they are just inductions, which may be useful, only working hypothesis, drawing more or less probabilistic conclusions. Science thus is only a guide of to what is probable, an affair of probability, even if the odds in favor of much of it are very high, it is impossible to reach the exact complete knowledge. There are **no scientific dogmas,** there are no certainties in science: all science theory is open to challenge; scientific findings cannot be ignored nor treated as mere matters of faith.

b) **What is important is not the objective reality, but its subjective perception.** Even accepting the old escolastic dictum *nihil ist in intellectum quod prius non fuit in sensum*, science only give information about what is apprehended by senses, this does not imply that all we perceive is an objective reflex of the physical reality: we can never know what things are like 'in themselves', independent of how our minds format what we perceive, as Immanuel Kant's quite sensible contention asserted. This implies, for example, that what is true of the world for humans is probably different from what is true for an elephant or for an *E. coli*.

Our own experience tells us that the subjective perceived phenomena, the human sensations, are not reliable, because what is perceived cannot be separated from the perceiver; Knowledge is inevitably constructed by the knower in interaction with his nervous activity, and we should never forget that each scientist has his own values, priorities and may also have all sorts of cognitive biases, prejudices or unfounded speculations (Popper, 1932). Much of the public hears what it wants to hear. Thus, although science attempts to unify different ideas, prejudice and self-righteousness, based in the illusion from a particular viewpoint may cause struggles. Many things have to be scientifically understood. We are far from understanding the truth (Ameniya, 2017).

The same things may look different, if our viewpoint is different, as it is shown in the quite well known Indian tale about of blind men who touch an elephant to learn what it is like: The one who feels a leg says the elephant is like a pillar; the one who feels the tail says the elephant is like a rope; the one who feels the trunk says the elephant is like a tree branch; the one who feels the ear says the elephant is like a hand fan; the one who feels the belly says the elephant is like a wall; and the one who feels the tusk says the elephant is like a solid pipe. The different interpretations of the elephant imply that one's subjective experience is inherently limited by its failure to account for other truths or a totality of truth. At various times the parable has provided insight into the relativism, opaqueness or inexpressible nature of truth, the behavior of experts in fields where there is a deficit or inaccessibility of information, the need for communication, and respect for different perspectives. We cannot thus ignore the subjective experiences and the limitation of our faculties of perception, given that the human cognitive capacity is limited.

c) The daily experience also tells us that many scientific studies are **subject to error**: for instance, wine testers have a more sophisticated, sensations than ordinary people; the visual field does not perceive any blind spot, even if there is one, known as optic *papilla*, in the area of ​​the [retina](https://translate.googleusercontent.com/translate_c?depth=1&hl=en&prev=search&rurl=translate.google.es&sl=es&sp=nmt4&u=https://es.wikipedia.org/wiki/Retina&usg=ALkJrhiZaYtyGxH3r_zexcW6NcUgUlc3iA) where the [optic nerve](https://translate.googleusercontent.com/translate_c?depth=1&hl=en&prev=search&rurl=translate.google.es&sl=es&sp=nmt4&u=https://es.wikipedia.org/wiki/Nervio_%25C3%25B3ptico&usg=ALkJrhhVNmQdCznXMkQE3BALUqHnyGFNwQ) arises; the *phi phenomenum*, when two successive lights are turned on, a sensation of light movement is perceived, even if in reality nothing moves; or the *cryptomnesia*, or capacity of remembering something we are not conscious to remember, mixing real and imaginary memories.

d) Many aspects of scientific progress may also be inhibited by **fraud,** not unusual at all, mainly taking advantage that the scientific system is based on trust: some 14% of scientists say that they have witnessed it (Clark, 2017). For instance, given the logistical difficulties of providing visual evidence or replicating precisely remote field work, it leads to a number of irreproducible (and often poorly conducted) studies, which may foment dishonesty, inventing data that the research supposedly produced, but that in reality come from major data manipulation to outright fabrication

**6. Reality goes beyond the limits of Science**

**W**e have just asserted that science only gives information about what is apprehended by senses, but these senses do not reveal the Reality. This does not necessarily have to be restricted in physical terms, with suppression of its subjective dimensions, even if –we have to admit it- these observations are more subtle. If we want to understand what is the human being and the universe, science has a lot to say, but it is not the only test of validity. The uniqueness of a human mind, capable of thinking about things which do not fall under our senses. There are other ways of knowledge, but to see life steadily and in a whole, we need something that may overpass the limits of science, ethics, philosophy, art… and theology, all of them equally valid, and limited, like science.

Science has plenty to say about many aspects of the world -about art, drawings, paintings, poetry, sports, you mention…-, but it has nothing –or very little- to say about many other basic questions, such as: what was the beginning of the universe[[4]](#footnote-4)? what is the universe made of[[5]](#footnote-5)? might an alternative model of gravity remove its raison d'être?; speculation on steps to the origin of life on Earth; are we alone in the universe or there is a probability of life elsewhere in the universe? what is human nature? how much can the human life span be extended? how do organisms know when to stop growing? can cancer be cured or ageing be beaten? what genetic changes made us uniquely human? Is the "consciousness" present outside of organisms? is morality hard-wired into the brain? what are the limits of learning by machines? and so on (Weiss, 2005).

Given the enormous complexity of the reality, there will always be things unintelligible by the human mind. For instance, the existence of moral values, social institutions, God… cannot being subjects to en experimental tests, but it does not mean that they do not exist. Even more, we need them as pilots of our life and our social relations. The **vision of the human being** searching of a purpose to life, thus. **transcends the scientific knowledge.** *Ignoramus, Ignorabimus*

Faith (believe in what we don't know) is a normal part of human cognition, founded on our direct experience. Believe is a decision rationally as fundamental, and consequently at least as respectable, as no believe. I dare to say that **everybody has faith**. Obvioulsly, ‘believers’ may feel religious needs, seeing live in a transcendent world: “we need the apprehension of a sacred mystery, the sense of communion with a Divine Power, that constitute the ultimate basis of religion” (Dampler, 1971, XXII). Others, even if may be color-blind and have no religious sense, they still use faith in acceptance of science, because, otherwise, we would not accept any science that we had not personally studied ourselves and had become convinced of the evidence presented.

We would like to add to these considerations that there is a need of a **bridge between science and religion**, because both have things to say about the same subject matter. They are different ways of studying the same territory, that they have different kinds of things to say, that they are different phases in the human attempt to understand the world, and that they have each a strong contribution to make to the efforts of humans to cope with life. Some aspects of the world can be known through empirical observation; others, through religious thought. Science tells us more and more about how things work. Why they work, and what is the overarching reality, are issues of an evolving religion. Science without religion is soulless. Religion without science is superstition, or, as Einstein stated, “science without religion is lame; religion without science is blind” (Ake, 2001). Consequently, science and religion should not be seen as conflicting, but on the contrary, they have to progress have the same pedestal: science has to be inspired by values such as love for Creation, respect for life and promotion of human dignity.

In sum, recognizing the limits of scientific knowledge - science has not the last word- includes an explicit recognition of the tentative nature of science, combined with the fact that some things are, theoretically, unknowable scientifically. At the end, we seem to be brought to the theologian dictum of Tertullian, *credo quia impossible.*

**7. How scientists may help in a human-centered society**

In spite of the above mentioned limitations, scientists may play an important role in favouring a human-centered society. We suggest a few simple examples of how this may be done.

**7.1.** An international team of experts, after estimating that as much as 85% of the US biomedical research effort is wasted, has recently produced a manifesto with **master plan to improve the quality of scientific research**, “to perform good, reliable, credible, reproducible, trustworthy, useful science," (Ioannidis, 2017). Its goal is to increase the speed at which researchers get closer to the truth. including four major categories: methods, reporting and dissemination, reproducibility, and evaluation and incentives. Who are responsible for improving the quality of science? Not just the researchers, but also other stakeholders, such as research institutions, scientific journals, funders and regulatory agencies. Fomenting scientific knowledge and enhancing cross cultural connections and joint cooperative research has to be their main goal.

**7.2. Scientific cooperation in easing relations between governments:** Rachel Rothschild, analysing centers on the European-wide monitoring programme (EMEP), which was designed to investigate the pollutants causing acid rain and began operations under the United Nations Economic Commission for Europe in 1977, notes that the creation of the EMEP is evidence of how addressing global environmental concerns can pave the way for easing geopolitical conflicts. "EMEP's formation illuminates the importance of developing technological networks and international research projects on acid rain in furthering both détente among European countries as well as international research and policies for environmental protection" (Rothschild, 2016).

The impetus for cooperating across the Iron Curtain on air pollution monitoring came from a group of scientists and environmental officials in Norway working on acid rain. Despite security concerns over disclosing power plant locations and resistance on placing pollution monitoring stations within the Soviet Union, the Scandinavian scientists were eventually able to secure the commitment of the Communist bloc to a European-wide environmental research program -a breakthrough that resulted in limited technological cooperation. This development helped ease Cold War tensions, fostering subsequent political relationships, which culminated in the 1979 UN Convention on Long-range Transboundary Air Pollution.

This story clearly demonstrated thus that countries can achieve some scientific collaboration by working together, although it is less evident whether scientific cooperation can become a precursor for political collaboration, ie whether science would be a driver for peace, bringing peace to the region or viewing or just a wishful thinking. We hope it would too.

7.3. **Improving the public's understanding of socially relevant** **science:** The ubiquitous impact of science-based information and technologies in everyday life suggests that misunderstanding how science works can have serious consequences. Although fake news phenomenon in the context of science is not at all new, social media disseminate this kind of news much faster among online social networks.

Yet people's decisions and strongly held beliefs are often at odds with the conclusions and recommendations of empirical studies and scientific consensus; they can be influenced by unscientific mass media and widely-publicized interested campaigns providing inaccurate information via disconnections between human emotion and rationality.

In some cases, the implications of misunderstanding or rejecting science are more or less harmless, because what the public admires is a sense of wonder and fun about the world, or answers to big existential questions, such as the popularization of physics, of animal behaviour, of how brain works; or if someone believes the Earth is the center of the Universe. Does it really matter to our daily life?

In other cases, however, the questions that people face in their lives can be socially relevant, or even critical, like when focused on uncertainty perhaps under the label of environment or health, or over food. Here you have a few examples:

a) In the 60s-70s of the last century, the public opinion seemed to consider the nuclear energy as a panacea as a healer of illness such as cancer, heart insufficiency, lung emphysema… Top class restaurants were offering highly radioactive bottled water; we do remember a Bohemian spa, in Joachinsthal, next to a uranium mine, offering thermal water, radioactive from uranium mines. Nowadays we know that, used in high amount, they may be cancerigenous.

b) How to handle the anti-vaccination (anti-VAX) movement? anti-VAX is an emotionally-charged phenomenon distrusting healthcare based on a flawed debunking of a chronological (but not causal) relationship between vaccination and autism (f.ins., Andrew Wakefield's falsified and discredited study in 1998, fraudulently linking autism and vaccines), or an undervaluing of many vaccine-preventable diseases have become much less common, as smallpox and almost free of polio. The fact is that this vaccine refusal may implicate the disruption of local herd immunity, resulting in vaccine-preventable disease outbreaks (for example, a revival of pertussis, measles and mumps).

c) There is an increasing trend among many people, in favor of “clean", healthy diets, even if they have not been diagnosed from any intolerance. They prefer ecological and sustainable agriculture, choose containers or smoothies where is written “bio” or "detox***"***, and eat foodstuff without lactose, nor sugar, flour or palm oil… just because it seems healthy to them, and, on the other side, they worry about eventual toxins or artificial ingredients in processed frozen or junk food, which may reduce its nutritional value, lead to overweight, or event enhance the risk of diabetes or cancer, demonizing them as "pure poison". A few decades ago, the ‘danger’ was the saturated or trans fats; nowadays it seems sugar has become the main ‘devil’; the blue fish, which not long ago was quite advisable to eat because of the value of its omega 3 acids, now seems a little bit dubious given the presence of too many heavy metals; whereas some people suggest that coffee may be 'a bomb' within our organism, others, on the contrary, say that caffeine might cure cancer.

Scientists can influence what's being presented by articulating how this kind of science works when they talk to journalists, or when they advise policymakers. For instance, since as humans, we have all sorts of cognitive biases that come into play when we try to evaluate the risks posed by any decision, scientists should offer an alternative to bias-based decisions, enabling leaders to make more effective policies and avoid a "cure" that may be worse than the disease. We are aware that using inaccurate and false information in the context of science is much murkier and unclear, because usually there is not a clear dichotomy between fake news and real news, it challenges the position of science as a singular guide to decision making, and because it involves owning up to not having all of the answers all the time while still maintaining a sense of authority.

But if we want "to inoculate" the public against popular sticky misinformation campaigns, including the damaging influence of some fake news that circulates on scientific matters propagating myths about whatever topic, scientists have to improve the way that socially relevant science is presented to the public in popular media., providing a cognitive capacity to evaluate it in a coherent way that helps build up resistance to misinformation, presenting them accurate scientific statements and well-known facts (Klymkowsky, 2017; Makri, 2017; Nielsen, 2017; van der Linden et al. 2017).

Since journalists, besides of not being all well-trained to assess the validity of all studies (many of you may have already heart what is the different between a scholar and a journalist: a scientific is somebody who knows a lot about very few things, whereas a journalist knows very little a lot about many things.), are attracted by the human interest of a news and the hope-an attractive headline***,*** scientists, need to “break the echo chambers as much as we can***”,*** as Dominique Brossard (2017) says, engaging toward better science communicating, talking to journalists and people about the real facts, to help explain and contextualize the news and to stop the dissemination of fake news or bad reporting because people are going to use **that** science stories that fit better what they want to believe.

7.4. As scholars focused on university, we would like to add another consideration on how education may also facilitate our way towards a future human-oriented society. Students have as aim of their higher studies the leading to a career and to get the satisfaction of being able to apply recently acquired knowledge. Our model for learning should change from prioritising the memorising of the facts by repetition, to the ability to retrieve the information from wherever it is stored, relying fare more on “elaboration, reasoning, intrinsic motivation, critical thinking”, which is what trumps straight knowledge, as Andreas Schleicher, the creator of the Programme for International Assessment (PISA) wants us to learn (Aaronovitch, 2017). The main goal should not be so much to achieve information as its understanding, which is not the same thing, as it may be suggested by way of neuroscience’s favourite analogy: comparing the brain to a computer. Like brains, computers process information by shuffling electricity around complicated circuits. Unlike the workings of brains, though, those of computers are understood on every level (Pribram & Ramirez, 1980).  Many approaches in neuroscience, when used naïvely, analytically, may fall short of producing meaningful understanding of neural systems, regardless of the amount of data (Jonas and Kording, 2017). The implication in this human-centered era is that we must above all feel **not so much the width of information** **as the** **quality of understanding,**

1. **Ethical values of Science**

We do not want to close our presentation without a brief comment on one of the most important issues a scientist must face in his contribution towards a human-centered society: the relation of science with ethics.

Science has been a catalyst for social change and economic growth, and saved countless lives. But, even if *in se* science is not good nor bad, it is evident that there is always an eventual danger or evil in its application. For instance, a new anti-malaria drug dispenser of a drug called ivermectin kills mosquitoes *Anopheles*, the sort that transmit malaria, dosing it in malarious areas. But, in addition of helping in the eradication of this illness, protecting the people indirectly, by making their blood poisonous to *Anopheles, it* may alsocause other obvious ill effects in the digestive system, turning human beings into chemical weapons.

The atomic research, besides its deadly applications we all know (nuclear weapons), may also lead to peaceful applications, like the “tracer elements”, applied as a radio-active method of diagnose, radio-therapy of cancer, or effectiveness for fertilizers.

Besides the above mentioned invention of nuclear weapons, other discoveries have also done far more harm than good. To name just a few: massive blunders like fossil fuels, CFCs (chlorofluorocarbons), leaded petrol and DDT, and tenuous theories and dubious discoveries like luminiferous aether, the expanding earth, blank slate theory, phrenology…

But, even if choosing for good or for bad is not a scientific choice, **scientists cannot neglect their ethical responsibility concerning their work**. Society wants clear guidelines as to how these technologies have to be managed, but the factors that drive much of public sentiment are largely based on ethical and social concerns, rather than about safety or efficacy. Using the National Academy of Sciences report on gene editing, which he co-authored, Gary Marchant drows parallels between the public's concerns on that technology - in this instance it lies with the ethical aspects of tinkering with the human germline and enhancement engineering - and how best to proceed incorporating social, ethical and religious aspects into regulations. "As biotechnologies grow more powerful and increasingly raise more profound ethical issues, we can no longer leave these ethical and social dimensions off the decision making table.“ (Marchant 2017). Otherwise, it would be profoundly detrimental to the success of those technologies.

**Final message**: All stakeholders have to be conscious of the importance of investment in Science, fostering scientific knowledge through the interconnections between all its branches in an open mind, transdisciplinary approach, enhancing joint research and cross cultural connections, and providing funds not only focused on real life problems, but also on the fundamental tenets that will underpin the future of a human-centered society.

If development of science is important, what is even more important is human development, ie. development of human beings themselves, “growing up truly to “human beings, capable of governing themselves and the universe through the well-balanced development of science, art & religion” (Amemiya, 2017).

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1. <mramirez@ucm.es> [↑](#footnote-ref-1)
2. <jcayon@nebrija.es> [↑](#footnote-ref-2)
3. The First Industrial Revolution used water and steam power to mechanize production; the Second used electric power to create mass production; the Third used electronics and information technology to automate production; a Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century. [↑](#footnote-ref-3)
4. all we have are theoretical assumptions which have not been tested by experiment [↑](#footnote-ref-4)
5. until last century it was thought that universe was composed of atoms and the light; now we know that, besides the atoms, composed of protons, neutrons and electrons, there is the existence of dark energy, which has a gravitationally repulsive effect (without it, the experimental facts of the universe expanding at accelerating speed cannot be explained), and dark matter, composed of one or more species of sub-atomic particles that interact very weakly with ordinary matter, too (without dark matter, the revolting galaxy in which the solar system exists would be disintegrated by centrifugal force) (NASA, 2014; Ameniya, 2017) [↑](#footnote-ref-5)