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Opinion

Who owns science, owns society

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Abstract: The fundamental base underlying scientific empirical principles is currently at high risk of collapse or extinction. Under threat from pseudo-science and technologies which are advancing faster than philosophies can accompany them, and in a grey zone of masqueraded ethical principles, the schools of thought that were once thought to be the omnipotent cornerstones of the scientific institute of knowledge are now doomed to become historical relics. Increasing polarisation of rich versus poor, subsidised versus not, Impact Factor vs non-Impact Factor, paid-view versus open access, and a whole host of other conflicting concepts is further dividing the elite minority of the global scientific community from its silenced majority. Awareness constitutes the first step on the road to constructive change. Shrouded in quasi-ignorance, scientists from Beijing to Belfast are fast being locked in a cycle that may revolutionise the world of science as we know it, blindly, but not painlessly. This small opinion paper is meant to be a nutcracker of sorts intended to initiate a cascade of counter-measures to stem the inevitable tide.

Keywords: empiricism, fallibilism, pragmatism, rationalism

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Note: Terms in ***bold italic*** type indicate new terms coined by the author for the purpose of enlightenment in this article.

AN OVERVIEW

The pillars of society have always redefined themselves over time, either in response to an inductive cue or naturally. A few centuries ago, one would have said that the religious institution and the state (synonymous to religion and the rule of law) would have constituted the two fundamental pillars of society despite its Jeffersonian separation [1]—at least in the Western world, and possibly so within Islamic societies [2]. Law, religion, science and culture have always been the most influential driving factors in moulding societies, and whoever held a reign of power on any one of these—even only one—would most likely succeed in establishing and maintaining a strong (hold on) society. However, unlike natural evolution, social change has been moulded almost exclusively by humans. As currency evolved from trading and bartering and postal mail evolved into e-mail and texting, so too is society unrelentlessly and rapidly evolving. One could almost say that human society has perhaps evolved much more over the past 10-20 years than it has in the past century, if not millennium. Although this claim might be hotly disputed, the philosophical power struggle within and for modern society underlies the changes that science (and thus society) are now undergoing. A recent socio-economic and political assessment of China considers 8 pillars of Chinese society: emancipation of the mind; balancing top-down and bottom-up; framing the forest and letting the trees grow; crossing the river by feeling the stones; artistic and intellectual ferment; joining the world; freedom and fairness; and from Olympic medals to Nobel prizes [3], although a close examination of these (as well as a conversation with the Chinese and a trip to China) would simply indicate that the *id* [4] *Sinica*, ***neo id*** or pluripotent ego is being enhanced with the purpose of capturing the attention of the world and perhaps much, much more. Kuran [5] tries to bring sense to the delay in the economic trend in the Middle East: "Islamic legal institutions, which had benefitted the Middle Eastern economy in the early centuries of Islam, began to act as a drag on development by slowing or blocking the emergence of central features of modern economic life including private capital accumulation, the corporation, large-scale production and impersonal exchange," and "low trust, rampant corruption and weak civil societies—all characteristic of the region's economies today and all legacies of its economic history—will take generations to overcome." A profound assessment of the evolution of society and the role which science plays in that process would be almost impossible. Thus, this small viewpoint takes a broad look at how science has indeed become a power tool in the development and evolution of selected modern societies, independent of culture or creed.

In their day-to-day survival mode, people tend to quickly forget how deeply their lifestyles are determined by, enveloped in, and to a certain extent controlled by science. To understand the depth of this link, one would have to step back and attempt to understand the definition of science. It would then be important to understand how science affects our everyday lives in real, tangible terms. Finally, through my personal interpretations, I wish to show how some sectors of society are strongly determined by science, and how this will to a greater extent affect all scientists and ultimately members of society. This opinion paper will attempt to draw some of those links.

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WHAT IS SCIENCE AND CAN IT BE CLEARLY DEFINED?

Most likely many scientists would not be able to provide a concrete or succinct definition for the term 'science', and most likely the definition provided by a scientist would be quite different from that by a non-scientific member of society. Indeed, Gieryn [6] summed up the lack of demarcation between scientific thought and other intellectual activities: "Thus, 'science' is no single thing: its boundaries are drawn and redrawn flexible, historically changing and sometimes in ambiguous ways." The demarcation of science may thus have been equivalent to defining what constitutes quality in science, pure or applied. A broad definition would indicate that science consists of a root system of knowledge bases or truth centres which have emerged from natural laws which themselves have become established from pure and fundamental trial and error. Knowledge in its purest form constitutes science, as would be confirmed by its Latin equivalent, *scientia*. The ability to question an unknown and to attempt to discover the cause of its existence through explanations or predictions would be the defining of scientific principles. Being able to observe or identify, investigate, provide theoretical models and use different methodologies to prove or disprove theories would constitute the scientific methodology at the heart of science, although different schools of thought as briefly and broadly described next would attempt to dissect this basal truth. Much to Aristotle or Pliny's horror, the outcome might not be necessarily logical or rational. Finally, being able to describe what has been challenged and observed constitutes one of the most important elements of the descriptive process underlining empirical science. Effective science writing has led to the historical chronicalisation of a fact, big or small, open to debate and dispute. The person who conducts science even as an art is a scientist or a scientific artist.

More simplistically but very realistically, science is everything and is in everything. Even religion is science and so is art, although not all religious persons or artists are or can be scientists (see brief notes on ***neo***- or ***pseudo-cientistas*** later on).

SCIENCE SCHOOLS OF THOUGHT: SURREAL GROUPING

Empiricism is a philosophical state in epistemological science that claims that knowledge and understanding emerge from experience as perceived by the five senses through which experience leads to evidence, as obtained through methodological experiments, failure and success. In this school of thought, hypotheses and theories are established, and observations lead to concurrence or refutation of what was initially claimed. Markie [7] highlighted the differences between empiricism and rationalism (concept-based thinking) while another school of thought, pragmati(ci)sm, would most likely have tried to find common ground between the two, with Pierce claiming that rational concepts can be meaningful since their reach is beyond the data provided by empirical observation. Most likely what has set in in most laboratories around the world is a blend of Pierce's three forms of reasoning (inductive, deductive and abductive), padded by logical empiricism and phenomenalism. The Rubik's cube would be the Golden Triangle of empiricism, rationalism and pragmatism, being a finite combination of choices where six faces lead to only one end-point solution through a maze of 6^6 permutations. How then can it satisfy the pluralistic basic that the empirical path of scientific thought is based on fallibilism (see next) where one choice would, in theory, tend to infinity?

Pierce's approach presupposes that (1) the objects of knowledge are real things, (2) the characters (properties) of real things do not depend on our perception of them, and (3) everyone

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who has sufficient experience of real things will agree on the truth about them. According to Pierce's doctrine of fallibilism, the conclusions of science are always tentative. The rationality of the scientific method does not depend on the certainty of its conclusions, but on its self-corrective character: by continued application of the method, science can detect and correct its own mistakes, and thus this eventually leads to the discovery of truth [8]. Popper's critical rationalism rejects classical empiricism and its birth child, the classical observationalist-inductivist account of science. Popper believed that scientific theories, which are abstract in nature, can only be tested indirectly when their implications are considered. His scientific theory claimed that human knowledge is hypothetical, based on a creative imagination in order to solve problems. Such an imagination would have emerged from socio-cultural settings [9-10].

SCIENCE AND TRUTH: THERE IS NO UNIVERSAL TRUTH

Once we have assumed that science or the study of science is empirical, this would mean that a truth is always open to questioning or falsification (fallibilism). That means that anything and everything that surrounds us might be false, or a questionable truth [11]. This might have evolved from the monism-dualism dichotomy. While the former claims unity in a field of inquiry, stemming most likely from Hinduistic beliefs [12], the latter provides two alternatives while pluralism would provide multiple alternatives. In ontological dualism, the mind (or spirit) and matter are disconnected. This fundamental dichotomy would allow a scientist to seek the truth if the scientist was disconnected from the spirit. Monists, however, feel that reality is constituted by one kind of substance and accordingly there is a potential causal interaction between any one segment of reality and another despite spiritual unity [13, 14]. In a state of dualism, it is possible that we do not have the capacity to extrapolate too much beyond what our senses perceive. So, to say that gravity does not hold objects down would be an inconceivable challenge to Galileo and difficult to comprehend, especially since, when we drop an apple, it does after all 'fall down'. However, if we hold to our empirical definition of science, gravity does not exist, until proved. Since it was proved, it now remains to be disproved and perhaps re-proved once more; herein lies the essence of fallibilism. Popper [9], using the term 'falsifiability', claimed that if a theory cannot, in principle, be 'falsified' (i.e. refuted) by empirical data, then it is not scientific. In Popper's logic, even if an infinite number of positive outcomes at the level of experimental testing can confirm a scientific theory, a single counterexample is logically decisive because it shows that that theory, from which the implication was derived, is false. The term 'falsifiable' does not mean, according to Popper, that something is false; rather, that if it is false, then this can be shown by observation or experiment. Darwin perceived theory as a necessary prerequisite of empirical investigation: "Without the making of theories I am convinced there would be no observation." [15]. Marshall [16] quoted and endorsed Schmoller's belief: "Induction and deduction are both needed for scientific thought as the left foot and the right foot are both needed for walking."

The proof of reality is a miracle of science and if sufficient evidence exists to support a claim, the science of disproof becomes gradually more difficult. Although such a challenge may sound ridiculous to some, it does constitute the basic fundamentals of science and its empirical lifeline. Extrapolated, not everything we see, hear or feel might be what we have been told it actually is. I would suspect that this might be hotly contested by a theologist, who would most likely challenge all

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natural science beliefs with metaphysical interpretations. As we observe the scientific institutions that are now increasingly mastering the art of business science, we are forced to look beyond the crafted factors that impose quality and begin to erode away the empirical base of science. That discourse, despite its fundamental links, lies beyond the border of this opinion paper.

SCIENCE AND HUMANS: THE PHILOSOPHICAL BARRIERS

A few hundred years ago, the terms philosophy, science, philosophical science and natural philosophy might have been interchangeably used. Although there has now been a clearer artificial separation into the fields of natural science and philosophy, there is no doubt that all science requires philosophy, but not vice versa. Comte [17], in the evolutionary law of three stages, distinguished positive science from metaphysics and theology and indicated that science used 'reasoning and observation' to establish laws of 'resemblance and succession.' Consequently, not all philosophers need be scientists, although there is a fundamental philosopher in each and every scientist. This article does not wish to delve too much into the details behind artificial categorisation of science, which can be examined or contested on Wikipedia, but will assume it in its broadest form. The empirical nature of science, namely the ability to observe, test and prove or dispute a phenomenon (natural, synthetic or unnatural) overrides the man-made divisions of natural and social sciences. There are different levels of scientific reasoning [18]: 1) the ontological level (assumptions about the nature of reality), 2) the epistemological level (how knowledge is gained and justified), 3) the heuristic level (how problems are framed), and 4) the methodological level (theoretical explanations and their construction). The classification into empirical or formal sciences thus also loses relevance in the broader discussion that follows. A factor explaining why the public at large might not be able to appreciate the extent or importance of genetically modified organisms, stem cell research or cloning, for example, might be ontological dualism [18]. This is because the fundamental ability to assess facts underlying these fields of study might, purely and simply, not exist. In other words, scientific reasoning among the general public at one or all four levels simply does not exist or is hibernating. Despite this, most humans would follow a natural thought ontology: we live in a world of change; change leads to novelty and creativity leads to diversity, indispensable for socio-economic development [19]; novelty drives technological and institutional evolution, but because its nature is unpredictable [9] evolution is temporally unidirectional. Increasing ontological complexity involves causal interactions between several varied entities [20] which overall interact in a non-linear and chaotic way, further limiting predictability and creating the possibility of emergent properties and further novelties, often irreversible [21]. The ability to conceive, for example, that a transgenic plant might contain a mixture of viral, human or fish genes to mass-produce a vaccine, medicine or nutrient might be philosophically impossible to assimilate if histological development had not been accompanied by ontological development alluded to by Pasteur: "...dans les champs de l'observation, le hasard ne favorise que les esprits préparés" (In the field of observation, chance favours only the prepared mind) [22], hence the ravine that lies between science and society and their inter-comprehension.

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SCIENCE AND CULTURE: WHERE IS THE SCIENTIFIC GARDEN OF EDEN?

There is a somewhat misinformed perception that somehow science was born in Europe. To provide such a geographic starting point to the birth of science would be like saying the hamburger was invented or created in the USA simply by basing on its level of exposure or consumerism at that moment of time in history. To state that Science was born in the Renaissance or to father its birth on Pliny or Aristotle would be no less than a humanitarian and historical crime. Science owns no mother, is not limited to any crib, nor is it cubed by the laws and restrictions that define quotidian lifestyles. Science as we know it may have had its origins in the first time a rock was struck against the other to create a spark. It may have begun when the sediment of salt water (salt) was added to food to create a new taste, or when a piece of wood was floated and could be used to carry humans or goods on both fresh and salt waters. Science may have begun when someone first remembered their dreams or when they first tried to understand their conflicts with fellow humans. Science has no owner, no origin, no path or destiny. Scientific thoughts and reasoning are held in the minds of humans and their clues and keys are tied up within nature. Pure, basic science involves the purest form of the quest for knowledge. Applied science would then recapitulate what was learnt in pure science in more 'usable' forms in a search for solutions to practical day-to-day problems. Applied science is not a modern concept at all and would have evolved hand-in-hand with pure science, although most likely with a tailing trail. The Neanderthal who struck the rocks and created the spark might have noted that his source of heat, light and possibly cooking instrument could be so easily extinguished by rain.

Therefore, to attempt to doctor the birth of science, its value or its qualitative nature is a vile disregard of its origin and freedom.

SCIENCE, LANGUAGE AND RELIGION: IS ENGLISH THE UNIVERSAL LANGUAGE OF SCIENCE?

Without a doubt one of the most fundamental puzzles for humankind is how all sorts of life came to exist. However, the beauty of science is its ability to unify conflicting theories– evolutionary or religious. Religion, language and culture are inextricably interwoven and perhaps the modern day factors affecting this tapestry are technology and the Internet. Among English-speaking Western scientific culture, there is an incredibly gross misconception that English is the dominating and universal language of science. Plato most definitely would not have agreed 16 centuries ago, and neither would have Boethius, Mendel or Pasteur. Fate would determine that the age of Christian and scientific discoveries would be played out among the European nations, leaving out other major religions such as Buddhism, Hinduism or Islam in their quest for expansion, only to culminate in the eventual global linguistic colonisation by Britain. Since then, English has become an overpowering force of communication and (regretted by some while convenient for others) the leading language for the communication of science. If it were not for the complexities of Chinese characters, Chinese might have been considered the linguistic tool that would accompany the neo-colonialisation now currently in progress, which would have added a 9th pillar to the Naisbitt and Naisbitt theory [3]. However, to elevate achievements using only one language while marginalising others amounts to no less than a neo-usurpation of science of modern-era proportions and a refusal to consider cultural or linguistic background in a serious light, but rather as a dispensable ramification.

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WHO OWNS SCIENCE, OWNS SOCIETY

Rees [23] states, "progress in scientific understanding and technology have been synergistic and vital to one another." When we open our fridge and forget to close the door, the detector that beeps away alarmingly is developed, thanks to science. When we eat yoghurt, the fermentation process and lactobacteria that lie therein that give better intestinal functioning are based on science. When we draw money from an ATM and balances, debits and credits are calculated in a split second or when bullish stocks bust on Wall Street in the time it takes to blink an eye-lid, all these and other economic, currency and trading variables are based on empirical scientific principles. Even the bleaching of hair, the miniaturisation of bonsai, or the separation of oil from water are based on scientific facts. Space, the final frontier, has now become the new frontier between science and society. Who owns space or its access and the ability to survive there, owns a treasure chest to countless and boundless unknown wealth—material or intellectual. A lifetime of effort and happiness lost through a greed-filled oil spill brought about by poor scientific principles and saved by oleophiles; economies destroyed by unstable oil prices, unsteady natural reserves and political instability and stabilised by harnessing the power of the sun's rays; the ability to create massive global social networks that can access and inform (or misinform) billions in the time it takes to click a mouse—all of these, without exception, have fundaments in science. Pure science is used to explore and discover. Applied science is used to perfect and expand. Open to use (and abuse), modern (>2010) science has now become not only a street-wise tool, but a kick-the-can toy for the marketing world.

In most of these cases, what we see and what is tangible have emerged from an empirical testing of experimental conditions, leading to a 'techno-socio-eco-econo-logical' development. The knowledge that may have underlain that science may have emerged from a sea of ignorance whose unknowns required correction and re-correction. Such an explanation would feasibly explain a prototype and its subsequent improved versions: the iPod® leading to the iPad®. The hunger for filling that gap of knowledge or encroaching on the void of ignorance is no longer in the scientist, the image of a bench-top worker and laboratory-mongering, coat-clad person. The ***neo-cientista*** or ***pseudo-cientista*** of the 21st century has emerged as an average 'Joe the plumber' who is capable of seeking a market based on the thought-pattern and desire of consumers. Such an emergence of the ***neo-cientista*** would put into total disarray Gould's ideas that anyone who wants to become a scientist must assume the uniformity of laws and processes across time and space [24]. This abridging of empiricism and rationalism, with nuances of instrumentalism—theories as instruments for explaining and predicting phenomena [25]—held by ordinary men and women of society who are street-, web-, tech- and market-wise, merits a new term in the school of thought and in the philosophy of science.

The power of the mass media, whether tweeting on Twitter®, texting on Blackberries®, scrolling down on iPads®, posting on YouTube®, linking socially on Facebook® or scientifically on Linkd®, is posing an existential threat to the very basis of the core concepts of science and scientists, threatening theories that have held for centuries. The power of mass-data collection on megacomputers or an expanded www2 is challenging the limits of puritan scientific thought, relegating scientific philosophy to 'gutter thinking' and elevating pseudo-science, fringe or junk science [26] to Nobel-level hype. Within science publishing itself, the freedom to choose between

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rigorously reviewed journals and those that literally publish on submission is feeding the neo-culture of pseudo-science. When simplistic confirmation substitutes refutation, ***neo-*** or ***pseudo-cientistas*** grip comforting beliefs, overgeneralise and seek thought-unifying gratitude through 'YouTubian' resemblances rather than empirical cause-effect thinking.

Without a doubt and without exception, science affects the way we live our day-to-day life. Science stares society in the face from dawn to dusk. Science affects the way in which societies function (or to some extent determines their dysfunctional patterns), and the entities who hold the keys to science will be (already are?) the forces of social and political empowerment of the future. Publishing companies who hold copyright on millions of papers of intellectual achievements and who charge for their access are artful masters of the science chess game at the expense of only one entity: the scientist. Such media giants or possible government agencies may begin a trend in which science begins to slip from the hands of the creators, the true scientists, into the hands of the wrong entities, independent of culture or geographic barrier. Such a power play of science would certainly result in a historical rift between those that believe and those that do not, and between those that have and those that do not—not too unlike the social barrier that once defined medieval societies. What if those entities begin to determine what is good or bad science, what is ethical and unethical science, and what is open or closed science? We must then begin to question who owns science and what power is held within that science, or within society. To slip into a new era of scientific ownership is to enslave science itself and to deprive it from the freedom to question, explore and express the findings that the science forefathers would have liked to see, and see being expressed. To give it incorrect ownership, independent of correct accreditation and acknowledgement, is to doom science to a historical relic and to take one step back in the evolution of humankind.

Who owns science *does* own society, or at least is beginning to do so. That ownership needs to be re-evaluated and carefully monitored, assessed and addressed.

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