From a Scientific Point of View

From a Scientific Point of View:

Reasoning and Evidence Beat Improvisation across Fields

By

Mario Bunge

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PREFACE

When dealing with a problem one adopts, explicitly or tacitly, some point of view or other – ordinary or learned, religious or secular, egocentric or acentric, practical or theoretical, dogmatic or scientific, computational or foundational, and so on. This book deals with the scientific point of view. Moreover, I will argue that this viewpoint can be profitably adopted in all fields, from agriculture to medicine, the law, management, policy-making, and even incarceration.

I will also argue that, though young and far from guaranteeing success, the scientific point of view is the best because it is the most demanding and the most open of all. Indeed, it shuns improvisation and freewheeling, demands argument and corroboration, encourages poaching on whatever discipline promises to be helpful, and solicits criticism, preferably of the constructive kind.

Last, but not least, the scientific point of view favors bringing science and technology close to philosophy, as it places problems and their proposed solutions in their broadest context – that of the most general and deepest assumptions about the world and our knowledge of it – and it endeavors to render philosophy more rigorous.

For example, the detection of gravitational waves in 2016 suggests replacing the subjectivist philosophies of space with Einstein's idea that space is a physical entity. And the worldwide rise in income inequalities, along with the cuts to public services, corroborates the epidemiological finding that human welfare, in particular health, depends critically upon economic security. Common sense suffices to understand that the ancient Roman saying *If you want war, prepare for war* is sheer folly. In contrast, the claim that the *liberty-equality-fraternity* political triad is weak unless it it rests on the *jobs-health-education* tripod is a solid result of the scientific approach to social issues. In short, science or bust.

1. THE SCIENTIFIC WORLDVIEW

Unlike seeing and hearing, which can be involuntary and unbiased, looking and listening are purposeful and can be biased. So much so, that sometimes we look or listen for something that may not exist, and that we tend to ignore impartiality (though not objectivity) in what matters most – health, human relations, and politics.

Worse, many a policy is designed from an unscientific point of view. For instance, most school principals and factory managers favor an early start of the schoolday or the working despite the strong finding that sleepy children are slow learners and fast forgetters, and sleepy workers tend to be clumsy and accident-prone (Walker 2017). Likewise, economic policies are usually designed in the light of bankrupt economic theories like monetarism, or even ideological slogans, rather than sound economic research, with dire consequences for the economy and public services. Thus Alan Greenspan, who designed the American monetary policies during two decades, followed the advice of his mentor Ayn Rand – the pop philosopher and champion of right-wing libertarianism – and favored the further income inequalities that harm everyone under the top one percent (Stiglitz 2012).

Outlooks or points of view are supremely important in all fields because everything is looked upon or thought about from some viewpoint or other – objective or subjective, religious or secular, vulgar or learned, sophisticated or simplistic, theoretical or practical, critical or dogmatic, scientific or unscientific, and so on.

These and other points of view or stances are mutually inequivalent and often incompatible with one another. For example, the scientific and the religious stances are mutually incompatible, even though religious believers can do good science provided they check their dogmas at the door of science. Overall consistency is desirable but hard to attain. Thus Niels Bohr, the grandfather of quantum physics, is said to have kept a horseshoe above the door to his country cottage, claiming that it was supposed to bring luck even if one did not believe it.

To acknowledge the adoption of a viewpoint is not the same as placing the inquiring subject at the center of the world, the way Berkeley, Kant and the positivists did. It is just to remind ourselves that, although the world did not wait for humans to emerge, *pace* Popper (1972), there is no knowledge without a knowing subject. In other words, objectivity does not demand obliterating the subject, but only abstaining from including an image of the artist in one's picture of the universe (Rescher 1997). If scientific, a worldview will not assume either that the universe is ego-centered or that some supposedly holy writ contains all there is to be known.

All the ancient Greek philosophers, from the pre-Socratics to Aristotle, held worldviews or *Weltanschauungen*, that is, comprehensive conceptions of the cosmos and man's place in it (see Aerts *et al*. 1994, Dilthey 1911, Bunge 1993, Duhem 1913-59, Matthews 2009, Rescher 1985). Suffice it to recall three of the most influential ones in antiquity, namely Epicurus', Plato's, and Aristotle's – all of them conceptual, secular, and impersonal. By contrast, most modern philosophies have been subject-centered as well as suspicious of ontology, and thus indifferent or even hostile to the very idea of a worldview or "grand narrative", as Jean-François Lyotard (1979) called it contemptuously in his postmodernist manifesto.

In particular, phenomenologists call themselves *egologists* for they, like St. Augustine, were inward-looking and therefore disinterested in cosmological matters. Likewise pragmatism, centered as it is in human action, as well as ordinary-language philosophy and French postmodernism, are glossocentric or word-centered. For example, the French postmodernists call politics *le discours politique*, or the political narrative – which suggests that they conceive of politics as a purely verbal contest.

As is their wont, most philosophers study worldviews in themselves, whereas anthropologists place them in their social settings. For example, the kind of job affects behavior and belief in the Chinese districts where different kinds of agriculture are predominant (Talhelm et al. 2014). Growing rice, which is predominant in Southern China, requires people to work in crews. This occupation fosters cooperation as well as consideration for the coworker, and sustains a holistic worldview. In contrast, growing wheat, which is the main cultivar in Northern China, can be done by individuals or couples, and it goes together with an individualist worldview. In short, worldviews tend to match lifestyles.

Typically, doing philosophy is a solitary occupation, whereas doing science calls for teamwork or at least discussion in seminars and journals. The record for scientific collaboration was set on August 17th of 2017, when the collision of two neutron stars that occurred 130 million light-years away and produced a short but intense burst of electromagnetic radiation was studied by 3674 astrophysicists from 953 institutions (Cho 2017).

Unsurprisingly, me-centered doctrines have flourished only among philosophers. Three examples come to mind: classical empiricism, Kantianism, and logical positivism. All three are egocentric since they focus on phenomena (appearances) and our study of them, and consequently are disjoint from all worldviews. In the present book I will argue that scientific research presupposes a worldview, namely that of science, which is acentric, in particular impersonal or objective, as well as genderless and nonracial.

The vague and somewhat suspect notion of a viewpoint or approach may be elucidated as follows. An approach A to a cluster P of problems consists in dealing with P in the light of a worldview W, in accordance with a certain method M, and in view of a definite goal G. In short, $A = \langle P, W, M, G \rangle$.

Different choices and combinations of those four items will yield different kinds of approach. We are particularly interested in the following kinds of approach:

ordinary if no expertise is involved in learning either P, W, M, or G;

scientific if the problems concern knowledge, the worldview is plausible in the light of the scientific background, the methods are duly checked conceptually or empirically, and the goals are both attainable and disinterested though nontrivial. If any of these conditions fail to be satisfied, as in the cases of navel gazing, intuitionism and hermeneutics, the approach will be deemed to be *unscientific*;

technological if its problems or issues are practical, the woldview scientifically plausible, the methods reliable, and the goals practical or utilitarian;

moral if the problems concern the welfare or the rights and duties of others;

political if the problems concern the rights and obligations of the citizens or the governance of the commonwealth;

philosophical if the problems transgress disciplinary divisions, the worldview is comprehensive, the methods purely conceptual, and the goals are clarity, depth, or systematicity.

If the problems to be studied are either bogus or narrow, the worldview absent or wild, the method esoteric or consists in verbal juggling, and the goals are to support an ideology or just to pass off extravagance for originality, then the approach deserves being called *pseudophilosophical*. Existentialism is the perfection of this genre. In particular, the existentialist dicta are either trivial or nonsensical, so that they do not help solving any problem other than meeting the grocer's bills. Suffice it to recall Heidegger's claims that "Time is the maturation of temporality," and "The essence of truth is freedom."

Note that every one of the six approaches listed above can be practiced in more than one way – for instance, by adopting different methods, or with somewhat different goals. In particular, the scientific viewpoint is consistent with both reductionism (or single-level ontology) and emergentism (or multilevel ontology).

Scientism is not the same as reductionism, in particular the attempt to reduce wholes to their parts (microreductionism) or to higher-order entities (macroreductionism). Both strategies have worked in a few cases, but have failed in most. For example the magnetism of an iron bar is explained as the alignment of the magnetic moments (or spins) of the individual iron atoms; and social psychologists have explained certain individual inclinations or preferences in terms of the individuals' positions in social groups such as classes or ethnicites, but have ignored key individual traits such as curiosity and creativity, whereas the fashionable rational choice theories, such as those of decision and game, have failed in attempting to account for large-scale social processes such as economic slumps and wars.

Most reductionist attempts have failed because they have ignored the emergence and submergence of properties that accompany the agglomeration of individuals as well as the disintegration of wholes, as in freezing and liquefying, marriage and divorce, recruitment and demobilization. Families, firms and armies have global properties that their components lack. Optics does not explain colors because these occur only in brains, which are very special living organs. And material entities, or "its", are not bundles of "bits", or information-theoretic units, because the latter have no physical properties and occur only when analyzing information-processing artifacts. In short, the design and assessment of scientific research projects and their products should not ignore the existence of different levels of organization – microphysical, macrophysical, chemical, biological, microsocial, and macrosocial (see Bunge 2003a).

The scientific stance is characterized by a modicum of philosophical awareness along with curiosity, disciplined imagination, cogent argument, the search for pattern and evidence, and moderate or partial skepticism. It is thus the opposite of dogmatism, in particular authoritarianism and radical skepticism, or the questioning of everything at the same time. A moderate skeptic will question item *A* on the strength of *B*, which in turn can only be questioned by assuming *C*, and so on. There is no presuppositionless inquiry, for the very statement of any problem takes some assumptions or data for granted.

For example, biologists take mathematics and chemistry for granted. And although philosophers are not competent to criticize particular physical findings, they should be able to spot and question some philosophical assumptions of physicists, such as the operationist definition of time as whatever timepieces show. In short, scientific skepticism is not total but partial and stepwise.

Notice that there are two kinds of moderate skeptics: those who admit, and those who reject the possibility that science may eventually tackle and solve certain problems, notably those of the existence of God and of consciousness.

The former are prepared to listen to arguments purporting to confute theism, or to prove the occurrence of conscious mental processes.

Since belief in the supernatural is a belief among others, a scientific account of the formation and spread of beliefs should settle the question of religious beliefs as so many human inventions. In fact, a branch of scientific psychology deals with beliefs both grounded and groundless (see e.g. Alcock 2018). In particular, religious beliefs are being studied scientifically, whereas any religious approach to science is bound to shrink or distort it, for it admits the existence of a supernatural and omniscient being that we cannot fully conceive of.

It is also well known that expertise in a given scientific field is compatible with religious affiliation. For example, Christians can do excellent work in chemistry – though perhaps not in cognitive neuroscience, anthropology, or history. The belief in the superiority and universal appliccability of the scientific point of view is called *scientism* (Schöttler 2013, Bunge 2017).

As for consciousness, let us start by admitting that it comes in several varieties (Bunge & Ardila 1987). These various concepts of consciousness share the idea that a subject experiences a conscious mental event whenever she thinks of it. In a cognitive neuroscience perspective, a subject is conscious whenever one part of her brain monitors what goes on in another part of it (Bunge 1980: 174-181). An electric network's voltmeter, a car's dashboard and a steam engine's Watt regulator are similar. But of course radical skeptics or mysterians, like Noam Chomsky (2009), will repeat the old dogma that mind and matter are and will always remain mysterious, just as the International Flat Earth Society keeps admitting new members. Meanwhile, both conscious and unconscious mental processes are being successfully investigated by psychologists (e.g., Edelman & Mountcastle 1978, Dehaene *et al*. 2017).

The scientific stance is compatible with the technological and philosophical viewpoints, to the point that sometimes it is indistinguishable from them, as in the cases of experimental ethics and general systems theories. The scientific stance is likely to elicit the hostility of the "humanistic" or hermeneutic psychologists and social students tied to the armchair (non-experimental and non-mathematical) approach typical of literary studies, such as the Wittgensteinian Peter Winch (1958), who denied the very possibility of a social *science*.

The scientific stance is particularly unpopular among the gatekeepers of the humanities. Thus, the philosophy editor of the most prestigious American university press stated clearly his preference for submissions that reject a mode of thinking that "quantifies and commodifies the world around us to the exclusion of spiritual values." Presumably, he would reject any social studies using the UN human development index, while buying speculations by armchair social students belonging to the Frankfurt school (or "critical theory"), French structuralism, or hermeneutics.

The explicit and consistent adoption of the scientific viewpoint is bound to affect numerous choices and decisions in all fields. For example, scientifically minded people will be skeptical about alleged cases of telepathy, clairvoyance, precognition, ghosts, psychics, zombies, spoon bending at a distance, haunted homes, and the like. Some skeptics will try to reproduce them in a laboratory, explain why some people are more gullible than others, or even why some people seem to need belief in such fantasies (see, e.g., Alcock 1981, Randi 1980).

For instance, in 2011 a psychology professor retired from Cornell University claimed that, if properly trained, ordinary children can acquire precognition, that is, the paranormal ability of seeing the future (Bem 2011). The proscience debunkers reacted immediately, holding that brains cannot feel effects before their causes for, if they could, the individuals with that ability would be able to act so as to affect the future – for instance, by preventing it from causing such extraordinary phenomena.

The psychological community recently heaped scorn on the otherwise reputable journal that published a piece on precognition, and vowed to strengthen the prevailing standards of scientific rigor. It is not enough to criticize published errors: gatekeepers should try and prevent serious errors from being published, by using scientificity criteria, such as compatibility with the bulk of current science, or by demanding corroboration by an independent research team.

The scientists who search for extraterrestrial intelligence (SET) belong to an utterly different kind. They neither assert nor deny the existence of "aliens": they just search for signs or indicators of life in one of the many planets beyond our solar system discovered since 1992. The estimates of the probabilities of their existence, such as Drake's formula, are purely speculative, but it is generally hoped that some organisms will eventually be found in some galaxy or other. This hope rests on the abiogenesis hypothesis, according to which the earliest organisms emerged spontaneously eons ago from ordinary molecules, and were subject to evolutionary forces, chiefly mutation and selection. This problem is the subject of *The Origin of Life* journal, which has been published since 1968. This journal will reject wild speculations but will admit sound ones. (See Bunge 1983c for the difference between wild and sound speculations, and Bunge 2011 for the notion of bogus knowledge.)

In contrast, the belief in intelligent design is typically unscientific because it assumes the existence of a supernatural creator, whereas evolutionary biology is a strictly secular discipline dealing with spontaneous biosynthesis, mutation, and natural selection (Ayala 2010). A first step in the creation of life in the lab was the synthesis of the first complete gene, a yeast tRNA, achieved in 1972 by Har Gobind Khorana and coworkers. Several companies are selling gadgets to manufacture genes of various kinds by just mixing a number of inorganic precursors: the synthesis process starts and proceeds spontaneously. No *élan vital* (vital spirit) or *Bildungskraft* (constructive force) guides such synthesis. Contrary to Plato's belief, that only the soul is *autokineto*, matter is anything but passive. For example, planets do not need to be pushed by angels. Not in vain, the core statements of scientific theories are equations of motion, reaction equations, and evolutionary change formulas, none of which refer to supernatural agencies.

Scientific findings are expected to be original, yet compatible with the bulk (not the whole) of the extant scientific knowledge. Breakthroughs, even revolutions, do occur once in a while in every discipline, but none of them involve the revision of all the previous knowledge in the same field. For example, the discovery of compounds of "noble" gases like xenon was unexpected, but quantum chemists eventually explained it. Likewise, the discovery of toolmaking crows suggests dropping the definition of "human" as "the tool-making animal," but has not removed toolmaking from the list of traits jointly peculiar to our kind.

The scientifically minded person is neither a know-it-all nor a radical skeptic or know-nothing: she seeks plausible answers to interesting questions, trusts only scrutable methods, and keeps trying until hitting on what looks correct in light of the extant knowledge – which may be corrected by further research. In other words, she is a seeker but not a seer, and fallibilist but not defeatist. Further, she is not content with refuting errors, but hopes for new findings.

While some findings of scientific research are final solutions to some problems, others are approximate solutions, and still others are unexpected new problems. Consequently, as it enriches our fund of knowledge, scientific research also poses fresh problems. These features of science suggest replacing the classical definition of knowledge as "warranted true belief" with the description "mixed bag of data and researched approximate truths."

The same features also guarantee that, far from being a closed system like the religions and political ideologies, scientific research is a self-sustained process with new challenges and thus new discovery adventures. This is the only guarantee one should expect from adopting the scientific stance: that it will never cease to generate new jobs in the knowledge industry.

In this book I argue that the scientific stance can be profitably adopted in all the fields of inquiry and action, from physics to pharmacology to political science, policy design, and philosophy. This is of course the scientistic program (Bunge 2017a).

Consider the following five "hot" cases

1/ *Language*. The dictionary informs us that language "is the method of human communication." By contrast, the grammarian Noam Chomsky (2016) has always contended that language is primarily a window on the soul and an instrument of thought. Which of the two views is true or, rather, the truer? Whereas the dogmatist will accept one of them without further ado, the scientifically minded person is likely to ask for evidence in support of either thesis. Further, the skeptic may end up by suggesting a third hypothesis, namely, that (a) the primary function of language is communication, as suggested by personal experience as well as by sociolinguistics and primatological studies, and (b) its secondary function is to help thought processes, in particular the weighing of mutually inconsistent opinions and the refinement of intuitive or preanalytic ideas. See more on this subject in chapter 9.

2/ *Disease.* On feeling sick, I consult a friend who offers a diagnosis and even a treatment, as it worked for her as well as for a neighbor. But I am a tad more sophisticated, and consult the Mayo Clinic's big blue book. Sure enough, I find that my symptoms fit a certain disease; but a further search in the same volume suggests several other candidates. So, I ask for a hospital appointment, and get a diagnosis and a prescription. To make sure, I consult the medical literature to see whether the treatment I have been prescribed has passed randomized controlled trials. It has, but I am not feeling better. So, I continue to search the literature until hitting on John Ioannidis's (2005) pessimistic evaluation of the recent biomedical literature. Still, I do not give up, because I am confident that someone, somewhere, is studying my problem in a scientific manner – the only game in town according to the scientistic credo, which I happen to profess (Bunge 2017).

3/*Tropical forests: Carbon sinks or sources?* Until recently it was believed that forests are carbon sinks, whence the need to regulate logging. A recent study of satellite data about American, African and Asian tropical forests gathered over 12 years, has reversed that assessment: tropical forests are a net carbon source (Baccini and 5 coworkers, 2017).

Consequently the forest management policies, as well as the emisssion reduction targets, have to be revised. But it would be foolish to regard the new result as a license to keep deforesting, since trees serve us in many ways, in addition to participating in the carbon cycle; for example, they fix the soil and thus reduce landslides, and are homes to aboriginal populations.

4/ *Rich/poor gap*. Income inequalities have been rising everywhere since around 1960, to the point that the fabled American Dream, of going from rags to riches through hard work in the free market, is just that (Chetty et al. 2017). Two different strategies have been tried to cure this social ill – the mother of all social issues according to Rousseau. One is government intervention to either mediate or side with one of the two parties – managers and workers. The other strategy is to use union power, that is, collective bargaining, picketing, and strike. Both methods have worked in some cases though with decreasing frequency, either because of intransigence or because the unions have been betrayed by their leaders, rejected by management, or even outlawed. (Only 7% of the American workforce is unionized – exactly one-tenth of the corresponding figure in Sweden, Denmark, and Finland.)

A scientific approach to the inequality issue might conclude that the conflict itself should be avoided, by favoring the transformation of private firms into cooperatives, where workloads and compensations are discussed and determined democratically by the membership – unless the business in question is either a family concern or a public utility – in which case it behooves the state to manage it, and the public to fund it through fair taxes (see Bunge 2009).

In short, the scientific approach, once wrongly touted as the panacea for all cognitive issues, is currently under attack by postmodern writers and self-styled liberal policy makers. For example, in the midst of a severe epidemic of opioid prescription and dependency, some of the big pharmaceutical firms have discontinued research on nonaddictive analgesics just because the sales of opium-based pain-killers are profitable enough (see, e.g., Nemirowski 2011). Likewise, the denial of man-made global warming, and of the benefits of public education and health-care, ignore the scientific study of such issues, and favors the vote-gaining improvisations of populist politicians.

We are currently witnessing a quick return to the obscurantist attitudes that prevailed before the 1750-1950 period, when in the West the scientific stance prevailed over its antagonists. Scientism, once proud and ruling in Western culture (Schottler 2012), is now retreating in spite of its triumphs in all fields but politics, the one area where ignorance can pass for wisdom, selfishness for rationality, and brutality for strong leadership.

To sum up, the scientific stance has led to many a victory in the struggle for enlightenment and welfare. However, let us face it: public trust in that stance has weakened in recent years in several advanced nations, where regressive ideologies have replaced the researched ones.

5/ *Earliest Americans.* According to conventional wisdom, humans arrived in America, most likely from Siberia, about 13,000 years ago. The recent discovery of the Cerutti Mastodon site in Southern California (Holen, Deméré et al. 2017) may be evidence for the hypothesis that the earliest humans arrived in North America far earlier, namely 130,000 years ago. That site contains hammerstones and anvils from mastodon limbs for marrow extraction. These possible artifacts were found and studied by a team of eleven paleobiologists and earth scientists working at reputable universities and museums in the USA or Australia. They used some stringent criteria, from site dating to interdisciplinary means, to examine over 300 fossil mastodon bone fragments, some of which suggest percussion-fractures, as well as blows and abrasive smoothings suggestive of manual dexterity.

This finding shocked anthropologists. But enthusiasm should be tempered by the failure to find human-like remains, stone tools, and other artifacts, such as fireplaces. At all events, the ongoing debate is not about raw data but about how to ”interpret” them. It is thus an unsettled methodological issue. But at least we know what would solve it, namely finding distinctly human fossil bones along with indisputable artifacts such as scrapers and firepits. Thus, this philosophical debate would be won or lost by the scientists who made the bold jump from mastodon to man. And it would earn them prestige or regret but neither riches nor power. Hence the philistines, now on the rise worldwide, would at best remain indifferent.

6/ *Psychology and social studies: humanistic or scientific?* Ernst Weber (1851), Gustav Fechner (1860), and above all Wilhelm Wundt (1879) transferred psychology from its humanistic (or non-empirical) cradle to experimental and mathematical science. Nowadays only psychoanalysts, phenomenologists and followers of the Frankfurt “critical theory” school publish *a priori* speculations about mind and social behavior. Fortunately, these unscientific opinions are seldom taken seriously in the corresponding scientific communities.

7/ *Effectiveness of social programs.* How effective are the social programs aimed at palliating the stark inequalities in American society at the price of more than US$ 5 trillion a year? Nobody knows (Mosteller 1981). The same holds for gun-control laws: we still do not know whether they work (Cook & Donohue 2017). Why such ignorance? Because such programs and laws have been designed, fought over and assessed by vote-hungry politicians, not by experts in social technologies such as policy-making, law, management science, education science, and social work. In particular, the question of whether unemployment compensation discourages or helps the search for jobs was handled in ideological terms until Biegert (2017) subjected the relevant data for 20 European countries and the United States to a scientific analysis.

8/ *Free-trade vs. protectionism.* The free-trade policy is a key component of the traditional ideology abetted by the exporting countries like Great Britain. Only a handful of economists defended protectionism (high tariffs on manufactured goods) to allow industry to emerge and develop in the developing countries. In the USA, protectionism raised its head only in the 2016 presidential elections, when even Hillary Clinton expressed “reservations” about the free trade agreements signed earlier by her husband Bill, one of the most enthusiastic champions of free trade, which he praised as the universal key to prosperity. With very few exceptions, the economic professors were not available for comment. None of them explained the turnaround of the political guruship as a late realization that the main beneficiary of free trade had been China. The strategists of the most powerful empire in human history might have foreseen this momentous event if they had adopted a scientific stance when reviewing international trade.

9/ *Post facts and post truth?* The self-appointed sociologists of science Bruno Latour and Steve Woolgar gained instant celebrity in 1979 when they claimed that their study of "science in action" proved that facts are social constructions, whence truth is illusory. Their research consisted in observing the operations of some experimental workers whom they could not understand for lack of a scientific background. They only perceived that their subjects looked, made inscriptions, and engaged in gossip during coffee breaks. A fortiori, these self-appointed explorers of "science in action" could not understand the final products of such mysterious activities, namely papers in specialized journals. Being unable to understand anything beyond some fragments of overt behavior, they concluded that scientists made up the facts they claimed to study. For example, the ancient Egyptians could not have suffered from tuberculosis, because Robert Koch made up the corresponding bacillus only in 1882. This outrageous opinion, known as constructivism-relativism, was criticized by some scholars (e.g., Bunge 1999), but it took Latour (2017) nearly four decades to own that this dangerous nonsense had been among his *peccata juvenilia*, and that science should be accorded some authority after all.

10/ *Is scientific philosophy possible?* Philosophy and science were one until about 1700, when Berkeley, Hume and Kant divorced philosophy from science, and most universities were divided into two separate bodies: science, and arts or humanities. Science and philosophy merged again around 1850, when a handful of scientists and science enthusiasts introduced the so-called crass or vulgar materialism, which rejected both Kant's phenomenalism and Hegel's dialectics, but exaggerated the reach of Newtonian mechanics. Friedrich Engels (1878), Marx's coworker, criticized them for ignoring dialectics, and advertised his own materialist reworking of Hegel's system as scientific. Regrettably, Engels was not much interested in empirical corroboration, and wasted his considerable talents criticizing minor thinkers like Eugen Dühring. At about the same time, Charles S. Peirce – who, unlike Engels, had a solid scientific grounding – wrote about scientific metaphysics, but did not advance beyond a few programmatic observations. In the first half of the 19^{th} century Edmund Husserl (1995: 31) proposed his own phenomenology or egology as “the universal rigorous science” and also as “the most extreme opposite of the objective sciences.” Why should scientists pay any attention to this outspoken antiscientific stance?

The mathematicians, scientists and philosophers who gathered in the Ernst Mach Verein, or Vienna Circle (1929-1933), built logical empiricism, also called logical positivism, which claimed to be congruent with both contemporary science and the new logic. However, their influence was restricted to the theoretical physicists who mistook observers for reference frames – hence read ‘relative’ as ‘subjective’ and ‘existent’ as ‘observable.’ Their ambitious project failed because they preferred phenomenalism to realism, and claimed to have overcome the materialism/idealism chasm. Incidentally, let us remember that phenomenalists hold that everything *seems* but nothing *is*. By contrast, scientific realists believe that some things are; that appearances emerged only along with the earliest sentient beings; and that only scientific research can reveal the existents beneath phenomena, such as the water molecules released by the washing while drying under the sun. As for the nature of the mental, whereas idealists hold that it is immaterial, materialists maintain that mental processes, such as perceiving, computing, and awareness of self are brain processes – as revealed by cognitive neuroscience.

The scientific philosophy project was recovered a few decades later by the present author (Bunge 1974-1989). This program kept rationality and concern for corroboration, but replaced egocentric phenomenalism with hylorealism, a synthesis of realism with materialism. There will be more on this in the last chapter.

2. SHOULD SCIENTISTS LISTEN TO PHILOSOPHERS?

It is well known that most scientists have little patience with philosophical issues – unless they themselves do philosophy on the side, as Einstein (1934) and a few others did. Let us try to find out why.

1. The Hume cult

The vast majority of contemporary scientists claim that experience, from sensing to acting, and from observing to experimenting, is the alpha and omega of human knowledge. This epistemological principle is the center of empiricism, one of the grand philosophical traditions in both Indian and Western philosophy, along with idealism and materialism. It was introduced and discussed in 600 BCE by the Charvaka materialist and empiricist school (Dragonetti & Tola 2009). In the West, the most popular version of that principle is British empiricism, whose heroes were Francis Bacon, John Locke, and David Hume.

Bacon's influence during that period was such, that the Royal Society of London was founded in 1662 to put into practice his project of discovering and describing all the things in the world with the sole help of the senses. His prestige was such that even Newton, who owed him nothing – since his *Principia* was hypothetico-deductive rather than inductive – declared that his great work owed him everything. And Charles Darwin, who confided to his notebooks his contempt for Locke, in his autobiography declared his adherence to inductivism, apparently to protect his science from attacks by the upholders of the ruling philosophers.

Empiricism is still very popular. An opinion poll published in 2013 revealed that David Hume is nowadays the philosophers' favorite philosopher of all times, at least in the anglophone world. Hume himself might be surprised at this finding, since only one of his many books, namely his *Enquiry* (1748), was properly philosophical. Moreover, this work was neither successful nor very original, for it only elaborated in great detail the scholastic principle *Nihil est in intellectu quod prius non fuerit in sensu* – or "All concepts descend from percepts*.*" (See a detailed analysis in Bunge 1959a.)

Modern science, from physics to biology to historiography, has bypassed that principle, as may be gathered fom the ubiquity of “zero”, “atom”, “universe,” and “history.” Hume may have realized this, for he attacked Newtonian mechanics, the earliest successful scientific theory in history, despite ignoring the mathematics required to understand it. Hume disliked Newtonian mechanics for containing such nonempirical concepts as those of mass, inertia, and action at a distance, and for formalizing such counter-intuitive models as the heliocentric view of our solar system.

The scientific stance is currently being attacked as vehemently as ever. The German idealist Wilhelm Dilthey (1883) wrote the popular manifesto of the “humanistic” school, where he postulated – against the “spirit of the time” – that human beings are essentially spiritual, and as a consequence could only be understood by putting oneself in their shoes – a procedure he called *Verstehen*, variously translated as interpretation, empathy, and intuition. For instance, one may understand Napoleon’s attack on Russia as being fueled by his ambitions, which so far had been gratified. But this does not explain why he was able to recruit his Grande Armée, let alone why it suffered a crushing defeat. Cold weather, food scarcity and guerrilla attacks play no role in the hermeneutic or interpretive approach to large-scale social facts.

The sociologist Max Weber called himself a follower of Wilhelm Dilthey. When he commissioned a study of the Polish guest workers in Eastern Prussia, Weber had the choice between physicians and priests as primary data providers (Lazarsfeld & Oberschall 1965). Weber reckoned that the former would report on the state of health of the agricultural workers, whereas the priests would presumably report about their spiritual concerns – even though his informers were unlikely to share the religion or the language of their subjects. Obviously, in this case – one of the few projects Weber undertook that required empirical research – he adopted the unscientific stance inherent in German idealism (Bunge 2007).

A cynic noted long ago that philosophy is where science goes to die. Indeed, Hume’s empiricism, which played no role at all in the making of modern science, exerted an enormous influence on philosophy. Suffice it to recall Berkeley, Kant, and their two main offsprings: positivism from Comte and Mill to Mach, and the logical positivists – phenomenalists all of them and therefore allergic, at last initially, to the very idea of matter, in particular imperceptible matter, be it corpuscular or field-like.

Around 1800, positivism had become so ingrained in the scientific community, that even some eminent scientists parroted a scientific methodology that they did not practice, namely the one according to which scientists always start by making observations, and proceed to condensing them into inductive generalizations, which are subjected to tests in order to attain certainty. Even now, after the sensational success of highly sophisticated theories, such as quantum mechanics, most people think that scientific theorizing consists only in data fitting, or the compression of a bunch of empirical data into a polynomial – a task that may be assigned to a computer. This view is called *inductivism*.

True, Whewell, Peirce, Poincaré, Meyerson, and Popper criticized inductivism using historical counterexamples. But they did not disprove it, did not say where hypotheses come from, and did not analyze any experiments except for some imaginary ones. Moreover, they agreed with the empiricists in regarding experiment as the umpire, albeit not an infallible one.

So, which is a truer account of science? Let us peek at only a few points of interest to philosophy: the genesis of hypotheses, the role of the prevailing worldview, the indicators involved in every measurement, the battery of indicators of factual truth, and Popper's puzzling view that falsification trumps corroboration.

2. Genesis of scientific hypotheses

Nearly everyone agrees that we should distinguish several kinds of scientific hypotheses: ordinary empirical generalizations, scientific empirical generalizations, low-level theoretical statement, high-level ones, philosophical principles, and wild speculations. In this chapter we shall confine ourselves to exemplifying these kinds and making brief comments on them. Here are some examples:

Ordinary empirical generalization: "All adult dogs can bark."
Scientific empirical generalization: Galileo's law of free fall.
Low-level theoretical statement: Huygens's pendulum law.
High-level theoretical statement: Newton's laws of motion.
Philosophical principle: All material things are changeable.
Wild speculation: There are ideas outside human brains, and some of them – surely mine – will outlast humankind because they are incorporated into books, disks, pictures, and other inmates of the *Geistwelt*, or World Three, that are likely to survive a nuclear holocaust.

Theoretical physics contains extremely general statements, such as the Newton-Euler laws. However, even these proved to be limited, and were eventually generalized for generalized coordinates, which can be interpreted in non-mechanical terms, and are thus utilizable in electrodynamics and even in economic theory. The resulting equations are the Euler-Lagrange ones, which in turn are derivable from the variational principle about the system's lagrangian or action L, which states that the integral of L between any two instants is either a maximum or a minimum.

Hamilton's and similar variational principles are of particular philosophical interest for the following reasons. First, they are too far removed from measurements to be directly testable. Indeed, they are empirically *untestable*, yet at the same time the pinnacles of theoretical science, for they entail all the other general law statements. Incidentally, we keep the distinction, first drawn by the great physicist André-Marie Ampère (1834), between law or objective pattern, and the various law statements or formulas intended to conceptualize it.

Second, the earliest variational principle, namely the Maupertuis-Euler principle of least action (1744), seems to have been but the formalization of the metaphysico-theological principle that "nature is thrifty," as Maupertuis himself put it, or of the teleological assumption that every change is goal-directed, as Max Planck wrote. When William R. Hamilton rewrote it in 1834, the principle had lost all traces of its birth. The point is that some powerful scientific ideas are rooted in some of the rather obscure ideas born in some worldview or other.

Another, much more important, instance of the role of worldviews in the generation of scientific ideas and research projects, is the materialist principle that everything mental is cerebral. This ontological hypothesis, first stated by Alcmaeon (500-450 BCE), and adopted by Hippocrates and Galen, is no less than the spine of cognitive neuroscience, the contemporary phase of psychology.

An even more important case is that of Lucretius' principle of universal conservation: *Ex nihilo nihil fit* – nothing comes out of nothingness. Although Lucretius and the other ancient materialists were banned by all the theocracies since Justinian, that broad metaphysical principle resurfaced in the French Enlightenment of the 1700s.

Most historians of science seem to agree that Lucretius' materialist poem *On the nature of things* inspired the parents of the principle of conservation of energy, in particular the brewer James Prescott Joule (1843) and the medic Julius Robert Mayer (1845). This principle is not just one more hunch, but the first axiom of thermodynamics and a charter member of the modern *Weltanschauung.* One of its consequences, the impossibility of perpetual motion, is so important to technology, that the employees of patent offices spend much of their time examining the designs of the fake perpetual motion machines proposed by ingenious inventors who share Popper's belief that, since energy conservation is hypothetical, it may eventually be confuted.

3. External consistency

Everyone, except for the Hegelians and the posmodernists, admits that internal consistency is a must for any theory. How about *external* consistency, or compatibility with the bulk of antecedent knowledge, or even with the main postulates of the prevailing worldview? Let us recall three famous cases in 20th century physics: those of beta decay, steady-state cosmology, and multiverse cosmology.

Careful radioactivity measurements performed in 1911 seemed to show that beta radioactivity violated energy conservation: the energy of the products of radioactive decay involving the emission of an electron seemed to be smaller than the energy of the input. In 1933, Enrico Fermi suggested that an unknown particle carried away the missing energy. Because the hypothetical particle lacked electric charge, he called it a *neutrino*. But the neutrino defied all detection attempts until 1956. In 2015 beta decays with two neutrinos were discovered, and at the time of this writing neutrinoless decays are being sought – in defiance of the assumption that all scientific progress involves simplification.

Because collisions involving neutrinos are rare due to their small energy, until very recently most neutrino detectors were gigantic. So far, the largest is the IceCube, an array that occupies one cubic kilometer situated near the South Pole, and started to work in 2004. So much for a useless particle invented with the sole goal of saving energy conservation – one of science's sacred cows.

Second example: in 1948 the cosmologists Hermann Bondi, Thomas Gold and Fred Hoyle, parents of the steady-state cosmological theory, attempted to save its "perfect cosmological principle" from the standard interpretation of observed red-shifts, namely the expansion of the universe – or, more exactly, the increase in inter-galactic distances, since the predicate "expansion" makes sense only for finite things, and, so far as we know, the universe may be spatially infinite. The theory attracted the attention of those who disliked the Big Bang hypothesis, which suggested that the universe had a beginning – anathema for the prevailing secular and materialist worldview, according to which the universe has always existed (Bunge 1955).

The cosmologists in question attempted to save their theory by adding to it the hypothesis that matter was gushing out of nothing at the rate needed to balance the decrease in overall mass density accompanying the expansion. Of course, there is nothing wrong about ad-hocness as long as it is independently testable. But the said *ad hoc* conjecture contradicts all the conservation laws accepted in physics, starting with the conservation of energy (Bunge 1962). This exercise led me to add external consistency to the list of scientificity criteria (Bunge 2017). Since then, the continuous creation hypothesis has been quietly buried.

A third and last argument for the external consistency criterion is the battle over the mind, which has been going on for over three millennia. Though published in 1977, the Popper & Eccles volume *The Mind and its Brain* does not contain a single reference to papers in cognitive neuroscience. This was quite a feat, since the earliest victories of this discipline go back to Philippe Pinel, the founder of scientific psychiatry (1793), and Paul Broca's seminal paper of 1861 on the localization of speech production in the left cerebral cortex – Broca's area.

Philippe Pinel's philosophical idea that mental diseases are brain diseases, and consequently mental patients should be treated just as humanely as any other sick people, was put into practice nearly half a century before Broca's paper. Besides, Pinel's work inspired the 1838 French law, as well as the 1845 British Lunacy Act, enforcing the "moral" (humane) treatment of mental patients. In earlier times these had been chained, beaten, and sprayed with cold water. (This tradition remains in the name *loco*, Spanish for 'insane', given in Chile and Perú to certain prized marine molluscs that are softened by beating before being cooked.) So much for the view that philosophical materialism is immoral. Actually psychoneural dualism is immoral because it justifies torture and the death penalty, since the executioner cannot harm the immaterial and immortal soul.

In any event, the above-mentioned popular book by Popper and Eccles appeared more than a century too late, and only to support an unscientific view of the mind. Moral: Tell me which scientific advances your philosophy favor or hinder, and I will tell you its worth (see Bunge 2012).

Terminological excursus: the term 'materialism' calls for qualification, for it designates three very different ontological doctrines: (a) *physicalism* or vulgar materialism, according to which Material = Physical; (b) *dialectical*, according to which Material = Synthesis of opposites; (c) *systemic*, according to which *Material* = *Changeable* (Bunge, 1981, 2012.)

4. Indicators

An indicator, marker or sign of a property of a real thing is an observable, preferably a measurable one, of it. For example, the deviation of a magnetic needle is an indicator of the presence of an electric current, and an abnormally high concentration of glucose in blood is a diabetes indicator. Indicators mediate between unobservables and observables:

$$Phenomenon \rightarrow Dial\ reading \rightarrow Knowledge\ of\ fact$$

The main problem that astrobiologists are currently tackling is to identify which if any of the thousands of recently discovered exoplanets are homes to living beings. Given that those planets are trillions of kilometers away, that is a daunting task involving biosignatures, or life indicators, in otherwise unknown planetary atmospheres. Prima facie, water would be a good candidate, but it would be hard to find because sunlight can decompose water, thus freeing its hydrogen, which could easily escape into space. Therefore, only heavier gases would do as reliable biosignatures. Stay tuned.

Francis Bacon, usually presented as a crude empiricist, intuited that the oscillation period of a pendulum, or of a pendulum clock, depends on the gravitational pull, and that in turn the latter is weaker, the greater the height. To test this hypothesis, Bacon planned to compare the time shown by a pendulum clock raised to the highest church spire in town with that shown by a similar clock bound to the ground.

This experimental design was ingenious, but hard to implement with the coarse instruments available at the time. It was tried two centuries later, and its result confirmed Bacon's hunch: the gravitational pull decreases with the distance from the planet, a fact that settled the age-long controversy over whether weight is an intrinsic or a relational property of bodies.

Bacon's ingenious albeit failed experiment was only an episode in the centuries-long saga of indicators – also called signs, markers, or proxies. This story started with the search for reliable indicators of time intervals, mass, specific gravity, time, viscosity, acidity, and many other properties. We now have precision anemometers, chronometers, scales, galvanometers, spectrographs, pH meters, Geiger counters, and other physical and chemical contraptions, far more precise than the ancient sand-clock, aqua regia, and litmus paper. All science students become familiar with indicators in their lab practices.

Physiologists and psychologists too have invented a number of quantitative indicators. For example, Pavlov used the amount of saliva secreted by his dogs at the sight of a meat morsel as an indicator of their hunger. The pupil's contractions and dilations have been used routinely as hate and love indicators; and a commercially available eye tracker is routinely used to find out the point of gaze, and thus the subject's movement intentions.

Archaeologists and anthropologists have been using indicators, such as tools, earthworks, and drawings, ever since our species was baptized *Homo faber* (working man). The alternatives *H. sapiens* (knowing), *adorans* (worshiping), *ludens* (playing), and *loquens* (speaking) have also been proposed, possibly under the influence of idealist philosophies. But all the indicators of craftmanship, learning, worship, play and speech are material: fossil bones and artifacts such as flint quarries, scrapers, harpoons, totem poles, fireplaces, and sheep nucklebones used as dice in games of chance.

Even believers in speech as what makes us unique should grant that the only evidence for this conjecture is what is also evidence for interaction and cooperation, such as remains of defense earthworks, communal buildings, whaling, and big-game hunting, that involve social organization, discussion, and planning, all of which in turn require something more sophisticated than grunting or gesturing. But the glossocentrists dismiss sociolinguistics: they focus on syntax, forgetting that sentences indicate or represent ideas or feelings, and that the main function of speech is communication. (See further discussion in Chapter 9.)

Since about 1960, a number of new social indicators have been devised for studying or managing formal social groups or entire societies. The best known of them is the UN human development indicator (1990), far more reliable than the GDP introduced in the 1930s. Since 1974 there has been a whole journal called *Social Indicators Research*. Yet, the very notion of an indicator or marker does not occur in the most popular philosophies of science, or even in theoretical physics textbooks.

Take, for instance, Dirac's *Principles of Quantum Mechanics* (1930), which in my student days was regarded as the bible of quantum mechanics, though it was seldom used for teaching because it reflects its author's proverbial laconism. This work postulates that the eigenvalues of "observables" (dynamical variables) are the values their measurement may yield. This assertion comes from the operationist philosophy tacitly accepted uncritically by the faithful of the Copenhagen school, but is at variance with experimental physics.

Consider, for instance, the Hamiltonian or energy operator H of a quantum-mechanical object such as an atom. H and the state function Ψ occur jointly in the basic formula (axiom) of quantum mechanics, namely $ih\partial\Psi/\partial t = H\Psi$, where i is the imaginary unit and h the Planck constant divided by 2π. Of the three variables, only t, interpreted as time, is