The philosophy behind pseudoscience :

every intellectual endeavor, whether authentic or bogus, has an underlying philosophy. Science, for example, involves six kinds of philosophical ideas. These differ totally from those behind pseudoscience. Evaluating a field's underlying philosophy is a revealing way to make distinctions and judge worth.

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Jose Lopez-Rega was the evil gray eminence behind General Peron in his dotage, as well as that of Peron's successor, his wife, Isabelita. He had been a failed singer, a police officer, a bodyguard, and the author of best sellers on business and the stars, love and the stars, and the like. He was a firm believer in the occult and a practicing black magician. Lopez-Rega believed not only in astral influences and in the spirit world but also in his own ability to conjure up spirits and manipulate them. Once, he attempted to transfer the soul of the dead Juan Peron into his dim-witted successor, Isabelita. However, this task proved to be beyond his ability (see, e.g., Martinez 1989).

Lopez-Rega is not known to have dabbled in philosophy. However, like everyone else, he did hold definite philosophical views. Among these were the age-old myths of the immaterial soul, the possibility of paranormal cognition, and the existence of supernatural beings. These beliefs underlie his conviction that he was able to influence other people's behavior by sheer mental power, as well as to get in touch with higher powers. In turn, these beliefs and practices gave him the self-confidence, prestige, and authority he needed to perform his sinister political maneuvers. Among other things, he organized a death squad that carried out uncounted assassinations and torture sessions of political opponents during the 1973-76 period, when he was at the peak of his political power. Thus, El Brujo ("the Wizard"), as the Minister of Public Welfare was popularly known, had the backing of millennia of philosophical myths.

Every intellectual endeavor, whether authentic or bogus, has an underlying philosophy and, in particular, an ontology (a theory of being and becoming) and an epistemology (a theory of knowledge). For example, the philosophy behind evolutionary biology is naturalism (or materialism) together with epistemological realism, the view that the world exists on its own and can be investigated. By contrast, the philosophy behind creationism (whether traditional or "scientific") is supernaturalism (the oldest variety of idealism) together with epistemological idealism (which involves the disregard for empirical tests).

To be sure, most scientists, as well as most pseudoscientists, are unaware that they uphold any philosophical views. Moreover, they dislike being told that they do. And the most popular among the respectable philosophies of science of the day, namely the logical positivists and Popper's followers, teach that science and philosophy are mutually disjointed rather than intersecting. However, this view is false. Indeed, nobody can help but employ a great number of philosophical concepts, such as those of reality, time, causation, chance, knowledge, and truth. And once in a while, everyone ponders philosophical problems, such as those of the nature of life, mind, mathematical objects, science, society, and what is good. Moreover, the neutrality view is dangerous, because it masks the philosophical traps into which bona fide scientists may fall, and it dissuades them from explicitly using philosophical tools in their research.

Since there is no consensus about the nature of science, let alone pseudoscience, I will inquire into the

philosophies that lurk behind psychoanalysis and computationist psychology.

1. Science: Authentic and Bogus

We shall be concerned only with sciences and pseudosciences that claim to deal with facts, whether natural or social. Hence, we shall not deal with mathematics except as a tool for the exploration of the real world. Obviously, this world can be explored either scientifically or nonscientifically. In either case, such exploration, like any other deliberate human activity, involves a certain approach, that is, set of general assumptions, some background knowledge of the items to be explored, a goal, and a means or method of proceeding.

In a way, the general assumptions, the extant knowledge of the facts to be explored, and the goal dictate jointly the means or method to be employed. Thus, if what is to be explored is the mind, if the latter is conceived of as an immaterial entity and the goal is to understand mental processes in any old way, then the cheapest means is to engage in free speculation. Given such idealistic assumptions about the nature of the mind, it would be preposterous to try and catch it by exploring the brain. If, on the other hand, mental processes are assumed to be brain processes and if the aim is to understand the mechanisms underlying mental phenomena, then the scientific method, particularly in its experimental version, is mandatory. (This is the philosophical rationale of cognitive neuroscience.) That is, whether or not a scientist studies the brain in order to understand the mind depends critically upon her more or less tacit philosophy of mind.

In general, one starts research by picking a domain (D) of facts, then makes (or takes for granted) some general assumptions (G) about them, collects a body (B) of extant knowledge about the items in (D), decides on an aim (A), and in the light of the preceding, determines the proper method (M) to study (D). Hence, an arbitrary research project (p) may be sketched as the ordered quintuple p=(D, G, B, A, M). The function of this list is to keep track of the essentials in framing the following definitions.

A scientific investigation of a domain of facts (D) assumes that these are material, lawful, and scrutable, as opposed to immaterial (in particular supernatural), lawless, or inscrutable; and the investigation is based on a body of previous scientific findings (B), and it is done with the main aim of describing and explaining the facts in question (A) with the help of the scientific method (M). In turn, the latter may be described summarily as the sequence: choice of background knowledge; statement of problem(s); tentative solution (e.g., hypothesis or experimental technique); run of empirical tests (observations, measurements, or experiments); evaluation of test results; eventual correction of any of the preceding steps, and new problems posed by the finding.

Contrary to widespread belief, the scientific method does not exclude speculation: it only disciplines imagination. For example, it is not enough to produce an ingenious mathematical model of some domain of facts the way mathematical economists do. Consistency, sophistication, and beauty are never enough in scientific research, the end product of which is expected to match reality--i.e., to be true to some degree. Pseudoscientists are not to be blamed for exerting their imaginations but rather for letting them run loose. The place for unbridled speculation is art, not science.

The scientific method presupposes that everything can in principle be debated and that every scientific debate must be logically valid (even if no logical principles or rules are explicitly invoked). This method also involves two key semantic ideas: meaning and truth. Nonsense cannot be investigated, hence it cannot be pronounced false. (Think of calculating or measuring the time required to fly from one place to another using Heidegger's definition of time as "the maturation of temporality.") Furthermore, the scientific method cannot be practiced consistently in a moral vacuum. Indeed, it involves the ethos of

basic science, which Robert K. Merton (1973) characterized as universalism, disinterestedness, organized skepticism, and epistemic communism (the sharing of methods and findings).

Finally, there are four more distinguishing features of any authentic science: changeability, compatibility with the bulk of the antecedent knowledge, partial intersection with at least one other science, and control by the scientific community. The first condition flows from the fact that there is no "live" science without research, and research is likely to enrich or correct the fund of knowledge. In sum, science is eminently changeable. By contrast, the pseudosciences and their background ideologies are either stagnant (like parapsychology) or they change under pressure from power groups or as a result of disputes among factions (as has been the case with psychoanalysis).

The second condition can be restated thus: to be worthy of the attention of a scientific community, an idea must be neither obvious nor so outlandish that it clashes with the bulk (though not the totality) of the antecedent knowledge. Compatibility with the latter is necessary, not only to weed out groundless speculation but also to understand the new idea as well as to evaluate it. Indeed, the worth of a hypothesis or of an experimental design is gauged partly by the extent to which it fits in with reasonably well-established bits of knowledge. (For example, telekinesis is called into question by the fact that it violates the principle of conservation of energy.) Typically, the principles of a pseudoscience can be learned in a few days, whereas those of a genuine science may occupy an entire lifetime, if only because of the bulky body of background knowledge they are based upon.

The third condition, that of either using or feeding other research fields, follows from the fact that the classification of the factual sciences is somewhat artificial. For example, where does the study of memory fall: in psychology, neuroscience, or both? And which discipline investigates the distribution of wealth: sociology, economics, or both? Because of such partial overlaps and interactions, the set of all the sciences constitutes a system. By contrast, the pseudosciences are typically solitary.

The fourth condition, summarized as control by the scientific community, can be spelled out this way. Investigators do not work in a social vacuum but experience the stimuli and inhibitions of fellow workers (mostly personally unknown to them). They borrow problems and findings and ask for criticisms; and, if they have anything interesting to say, they get both solicited and unsolicited opinions. Such interplay of cooperation with competition is a mechanism for the generation of problems and the control and diffusion of results; it makes scientific research a self-doubting, self-correcting, and self-perpetuating enterprise. This makes the actual attainment of truth less peculiar to science than the ability and willingness to detect error and correct it. (After all, everyday knowledge is full of well-attested trivialities that have not resulted from scientific research.)

So much for the distinguishing features of genuine factual science, whether natural, social, or biosocial. (More can be found in Gardner 1983, Wolpert 1992, Bunge 1998a, and Kurtz 2001.) By contrast, a pseudoscientific treatment of a domain of facts violates at least one of the above conditions, while at the same time calling itself scientific. It may be inconsistent, or it may involve unclear ideas. It may assume the reality of imaginary facts, such as alien abduction or telekinesis, self-replicating and selfish genes, or innate ideas. It may postulate that the facts in question are immaterial, inscrutable, or both. It may fail to be based on previous scientific findings. It may perform deeply flawed empirical operations, such as ink-blot tests, or it may fail to include control groups. It may fake test results, or it may dispense with empirical tests altogether.

Besides, the pseudosciences do not evolve or, if they do, their changes do not result from research. They are isolated from other disciplines, although occasionally, they interbreed with sister bogus sciences, as witnessed by psychoanalytic astrology. And, far from welcoming criticism, they attempt to fix belief.

Their aim is not to search for truth but to persuade: they posit arrivals without departures and without journeys. Whereas science is full of problems, and every one of its findings poses further problems, pseudoscience is characterized by certainty. In other words, whereas science begets more science, pseudoscience is barren, because it generates no new problems. in sum, the main trouble with pseudoscience is that its research is either deeply flawed or nonexistent. This is why, contrary to scientific research, pseudoscientific speculation has not delivered a single law of nature or of society.

So much for a sketchy characterization of both authentic and bogus science. Let us now apply our analysis to a couple of interesting recent cases: physical chemistry and neuropsychology.

2. Two Cases: Self-organization and the Unconscious

Our first example is the treatment of self-organizing systems: complex wholes that get self-assembled in the absence of external forces. Self-organization, in particular, biological morphogenesis, is a wondrous but poorly understood process. No wonder that it has been the object of much pseudoscientific speculation peppered with high-sounding but empty expressions, such as "constructive force," "entelechy," "elan vital," "morphogenetic field," "autopoiesis," and the like. All such factors have often been regarded as being immaterial, hence beyond the reach of physics and chemistry. And they are neither described in any detail nor manipulated in the laboratory. Hence, talk of such factors is just hand waving, when not magic-wand waving.

By contrast, the scientific approach to self-organization is down-to-earth yet imaginative. Let us peek at a recent instance of this approach: the work of Adams, Dogic, Keller, and Fraden (1998). Colloids consisting of tiny rods and spheres were randomly suspended in a buffer sealed in glass capillaries, then left to their own devices and observed under a microscope. The rods were viruses, and the spheres plastic balls; the former were negatively charged, and the latter positively charged. After some time, the mixture separated spontaneously into two or more homogeneous phases. Depending on the experimental conditions, a phase may consist of layers of rods alternating with layers of spheres, or the spheres may assemble into columns.

Paradoxically, these various types of demixing are explained in terms of repulsions between the charged particles--which, intuitively; should preclude the crowding of particles with the same charge. And the equally paradoxical decrease in entropy (order increase) is explained by noting that the clumping of some of the colloids is accompanied by a raise in the translational entropy of the medium. In any event, the whole process is accounted for in strictly naturalistic terms. At the same time, the authors warn that their results are at variance with the pertinent theory--though of course not with any general physical systems. Such incompleteness is typical of factual science, by contrast to pseudoscience, where everything is cut and dried from the start.

Our second example is the study of the unconscious. Much has been written about it, most of it in a speculative vein, ever since Socrates claimed that, by clever questioning, he was able to ferret out tacit mathematical knowledge from an illiterate slave boy. Thanks to Eduard von Hartmann's best seller, Die Philosophie des Unbewussten (1870), the subject was already popular in 1900, when Freud first proposed his wild fantasies. Among other things, Freud reified the unconscious and attributed to it causal powers that allegedly accounted for a number of unexplained phenomena, such as slips of the tongue and the mythical Oedipus complex. But of course, it never occurred to him or to any of his followers to approach this subject in an experimental manner.

The scientific study of unconscious mental processes began a couple of decades ago with observations on split-brain and blindsight patients. Since then, the various brain-imaging techniques, such as PET

scanning and functional MRI, have made it possible to ascertain whether someone feels or knows something even though he or she does not know that he feels or knows it. Moreover, these techniques make it possible to localize such mental processes in a noninvasive way. An example is the paper by Morris, Ohman, and Dolan (1998)--which, unsurprisingly, does not cite any psychoanalytic studies. Let us look at it.

The amygdala is the tiny brain organ that feels such basic and ancient emotions as fear and anger. If damaged, a person's emotional and social life will be severely stunted. The activity of the amygdala can be monitored by a PET scanner; this device allows the experimenter to detect a subject's emotions, and even to locate them in either side of the amygdala. However, such neural activity may not reach the conscious level. In this case, only a brain scanner can help.

For example, if a normal human subject is briefly shown an angry face as a target stimulus, and immediately thereafter an expressionless mask, he will report seeing the latter but not the former. Yet, the scanner tells a different story. It tells us that, if the angry face has been associated with an aversive stimulus, such as a burst of high-intensity white noise, the amygdala is activated by the target, even though the subject does not recall having seen it. In short, the amygdala "knows" something that the organ of consciousness (whichever and wherever it is) does not. Psychoanalysts could use this very method to measure the intensity of a male's hatred for his father. But they don't, because they don't believe in the brain: their psychology is idealistic, hence brainless. More on this in section 4.

The number of examples of pseudoscience can be multiplied at will. Astrology, alchemy, parapsychology, characterology, graphology, creation "science," "intelligent design," Christian "Science," dowsing, homeopathy, and memetics are generally regarded as pseudoscientific (see, e.g., Kurtz 1985, Randi 1982, and THE SKEPTICAL INQUIRER). On the other hand, it is less widely accepted that psychoanalysis and computationist psychology are also bogus sciences. This is why we shall examine them in section 3. But first, we must take a brief explicit look at philosophy, for some of it is bogus.

3. Philosophy: Proscientific and Antiscientific

The above characterization of scientific research involves philosophical ideas of six kinds: logical, semantical, ontological, epistemological (in particular, methodological), ethical, and sociological. More specifically, it involves the notions of logical consequence and logical consistency; the semantic notions of meaning and truth; the ontological concepts of real fact and law (objective pattern); the epistemological concepts of knowledge and test; the principles of intellectual honesty; and the notion of a scientific community.

Why is this so? Because scientific research is, in a nutshell, the honest search for true knowledge about the real world, particularly its laws, with the help of both theoretical and empirical means--in particular the scientific method--and because every body of scientific knowledge is expected to be logically consistent and the subject of rational discussion in the bosom of a community of investigators. All the expressions in italics occur in (metascientific) discourses about any factual (empirical) science. And the discipline in charge of elucidating and systematizing the corresponding concepts is philosophy. Indeed, philosophy is the study of the most fundamental and transdisciplinary concepts and principles. Hence, philosophers are expected to be generalists rather than specialists. And some of us often assume the ungrateful task of passing judgment on the credentials of some pseudoscientific or ideological beliefs.

Now, different philosophical schools treat the above philosophical components of science differently or not at all. Recall briefly only four contemporary examples: existentialism, logical positivism,

Popperianism, and Marxism.

Existentialism rejects logic and, in general, rationality; it espouses an extremely sketchy, nearly unintelligible, and even ridiculous ontology; and it has no use for semantics, epistemology, or ethics. No wonder that it has had no impact on science--except indirectly, and negatively, through its debasement of reason and support of Nazism. No wonder, too, that it has not produced an intelligible philosophy of science, let alone a stimulating one.

By contrast, logical positivism defends logic and the scientific method; but it has no defensible semantics; it has no ontology beyond phenomenalism ("there are only appearances"); its epistemology overrates induction and misunderstands or underrates scientific theory, which it regards as a mere data abstract; and it has no ethics beyond Hume's emotivism. Unsurprisingly, logical positivism misinterprets relativistic and quantum physics in terms of laboratory operations instead of as representing objectively existing physical entities that exist in the absence of observers (see, e.g., Bunge 1973). Still, logical positivism is scientistic, and therefore far superior to the antiscience characteristic of postmodernism.

Popperianism praises logic but rejects the very attempt to do semantics; it possesses no ontology beyond individualism (or atomism, or nominalism); it values theory to the point of regarding experiment as only a way of testing hypotheses; it overrates criticism, underrates induction, and has no use for positive evidence; and it has no ethics beyond the Buddha's and Epicurus's and Hippocrates's injunction to do no harm. However, Popperianism has the merits of having defended a realist interpretation of physical theories and of having deflated inductivism. But Popper first underrated, and later accepted but misinterpreted, evolutionary biology as consisting exclusively of culling misfits; he opposed the psychoneural monism inherent in biological psychology; he rejected the materialist conception of history adopted by the most advanced historiographic school--that of the Annales; and he defended neoclassical microeconomics, which--as I will argue below--is pseudoscientific in being conceptually fuzzy and immune to empirical falsification.

As for Marxism, it has introduced some revolutionary ideas in social science, particularly the materialist conception of history and the centrality of social conflict. However, Marxian materialism is narrowly economicist: it underrates the roles of politics and culture (in particular, ideology). Moreover, Marxism, following Hegel, confuses logic with ontology. Hence, it is diffident of formal logic; its materialist ontology is marred by the romantic obscurities of dialectics, such as the principle of the unity of opposites; its epistemology is naive realism (the "reflection theory of knowledge"), which makes no room for the symbolic nature of pure mathematics and theoretical physics; it glorifies social wholes at the expense of individuals and their legitimate aspirations; it exaggerates the impact of society on cognition; and it adopts the ethics of utilitarianism, which has no use for disinterested inquiry, let alone altruism. No wonder that, when in power, dialectical materialist philosophers have opposed some of the most revolutionary scientific developments of their time: mathematical logic, relativity theory, quantum mechanics, genetics, the synthetic theory of evolution, and post-Pavlovian neuropsychology.

In short, none of these four schools matches the philosophy inherent in science. I submit that any philosophy capable of understanding and promoting scientific research has the following characteristics (Bunge 1974-1989):

Logical: Internal consistency and abidance by the rules of deductive inference; acceptance of analogy and induction as heuristic means, but no claim to a priori validations of analogical or inductive arguments.

Semantical: A realist theory of meaning as intended reference (denotation)--and as different from

extension--together with sense or connotation. And a realist view of factual truth as the matching of a proposition with the facts it refers to.

Ontological: Materialism (naturalism)--all real things are material (possess energy), and they all fit some laws (causal, probabilistic, or mixed). Mental processes are brain processes, and ideas in themselves, however true or useful, are fictions. Dynamicism--all material things are in flux. Systemism--every thing is either a system or a (potential or actual) component of a system. Emergentism--every system has (systemic or emergent) properties that its components lack.

Epistemological: Scientific realism--it is possible to get to know reality, at least partially and gradually, and scientific theories are expected to represent, however imperfectly, parts or features of the real world. Moderate skepticism--scientific knowledge is both fallible and perfectible. However, some findings--e.g., that there are atoms and fields, that there are no disembodied ideas, and that science pays--are firm acquisitions. Moderate empiricism--all factual hypotheses must be empirically testable, and both positive and negative evidence are valuable indicators of truth value. Moderate rationalism--knowledge advances through educated guessing and reasoning combined with experience. Scientism--whatever is knowable and worth knowing is best known scientifically.

Ethical'. Secular humanism--the supreme moral norm is "Pursue the welfare (biological, mental, and social) of oneself and others." This maxim directs that scientific research should satisfy either curiosity or need and abstain from doing unjustifiable harm.

Sociological: Epistemic socialism--scientific work, however artisanal, is social, in that it is now stimulated, now inhibited, by fellow workers and by the ruling social order, and the (provisional) umpire is not some institutional authority but the community of experts. Every such community prospers with the achievements of its members, and it facilitates the detection and correction of error. (Warning: this is a far cry from both the Marxist claim that ideas are exuded and killed by society and the constructivist-relativist view that "scientific facts" are local social constructions, that is, mere community-bound or tribal conventions.)

I submit that the above philosophical principles are tacitly met by the mature or "hard" sciences (physics, chemistry, and biology); that the immature or "soft" sciences (psychology and the social sciences) satisfy some of them; and that the pseudosciences violate most of them. In short, I submit that scientificity is coextensive with sound philosophy.

Moreover, the reason the pseudosciences are akin to religion, to the point that some of them serve as surrogates for it, is that they share a philosophy, namely philosophical idealism--not to be mistaken for moral idealism. Indeed, pseudoscience and religion postulate immaterial entities, paranormal cognitive abilities, and a heteronomous ethics. I will spell this out.

Every religion has a philosophical kernel, and the philosophies inherent in the various religions share the following idealist principles: Idealist ontology--there are autonomous spiritual entities, such as souls and deities, and they satisfy no scientific laws. Idealist epistemology--some people possess cognitive abilities that fall outside the purview of experimental psychology: divine inspiration, inborn insight, or the capacity to sense spiritual beings or prophesy events without the help of science. Heteronomous ethics--all people are subject to inscrutable and unbendable superhuman powers, and they are not obliged to justify their beliefs by means of scientific experiment.

All three philosophical components common to both religion and pseudoscience are at variance with the philosophy inherent in science. Hence, the theses that science is one more ideology and that science

cannot conflict with religion because they address different problems in different but mutually compatible ways are false. (More on religion in science in Mahner and Bunge 1996.)

4. The Cases of Psychoanalysis and Computationist Psychology

Do psychoanalysis and computationist psychology share the philosophical features that, according to section 3, characterize the mature sciences?

Psychoanalysis violates the ontology and the methodology of all genuine science. Indeed, it holds that the soul ("mind" in the standard English translation of Freud's works) is immaterial, yet can act upon the body, as shown by psychosomatic effects. However, psychoanalysis does not assume any mechanisms whereby an immaterial entity can alter the state of a material one: it just states that this is the case. Moreover, this statement is dogmatic, since psychoanalysts, unlike psychologists, do not perform any empirical tests. In particular, no laboratory has ever been set up by any psychoanalysts. Freud himself had emphatically dissociated psychoanalysis from both experimental psychology and neuroscience.

To mark the first centenary of the publication of Freud's Interpretation of Dreams, the International Journal of Psychoanalysis published a paper by six New York analysts (Vaughan et al. 2000) who purported to report on the first experimental test ever of psychoanalysis in the course of one century. Actually, this was no experiment at all, since it involved no control group. Hence, those authors had no right to conclude that the observed improvements were due to the treatment; they could just as well have been spontaneous. Thus, psychoanalysts make no use of the scientific method, because they do not know what this is. After all, they were not trained as scientists but only, at best, as medical practitioners.

The French psychoanalyst Jacques Lacan--a hero of postmodernism--admitted this and held that psychoanalysis, far from being a science, is a purely rhetorical practice: "l'art du bavardage." Finally, since psychoanalysts claim that their views are both true and effective without having submitted them to either experimental tests or rigorous clinical trials, they can hardly be said to proceed with the intellectual honesty that scientists are expected to abide by (even if they occasionally lapse). In sum, pychoanalysis does not qualify as a science. Contrary to widespread belief, it is not even a failed science, if only because it makes no use of the scientific method and ignores counterexamples. It is just quack psychology.

Computationist psychology claims that the mind is a set of computer programs that can in principle be implemented in either brains or machines--or perhaps even ghosts. That is, this popular school adopts the functionalist view that matter does not matter--that only function does. This view is encouraged by the idealist ontologies, whereas science investigates only concrete things on various levels: physical, chemical, living--thinking and nonthinking--or social. Moreover, the computationists beg the question whether certain mental processes are computations. They have no evidence that all mental processes are computational; they just assert this thesis.

But this thesis is false, since neither emotional nor creative processes are algorithmic, and only a fraction of cognitive processes are. For example, there can be no algorithms for acting spontaneously, asking original problems, formulating original hypotheses, forming fruitful analogies, or designing original artifacts, such as radically new algorithms, machines, or social organizations. Indeed, every algorithm is a procedure for performing operations of a specified kind, such as sorting, adding, and computing values of a mathematical function. By contrast, original scientific findings are not specifiable in advance--this being why research is necessary.

In sum, computationist psychology is nonscientific because it ignores negative evidence and it

disregards the matter of mind--the brain that does the minding. Consequently, it isolates itself from neuroscience and social science--and disciplinary isolation is a reliable indicator of non-scientificity. The secret of its popularity lies not in its findings but in the computer's popularity, in that it does not demand any knowledge of neuroscience, and in the illusion that sentences of the form "X computes Y" explain, while in fact they only conceal our ignorance of the neural mechanisms. (Remember that there is no genuine explanation without mechanism, and that all mechanisms are material; see Bunge 2006.)

So much for a sample of pseudoscience. The subject of its underlying philosophy is intriguing and vast, yet largely unexplored (see, however, Flew 1987). Just think of the many pockets of pseudoscience ensconced in the sciences, such as the anthropic principle, the attempt to craft a theory of everything, information talk in biochemistry, the "it's-all-in-the-genes" dogma in biology, human sociobiology, West Coast (purely speculative) evolutionary psychology, and game-theoretic models in economics and political science. Analyze an egregious error in science, and you are likely to find a philosophical bug.

5. Borderline Cases: Proto- and Semi-

Every attempt at classifying any collection of items outside mathematics is likely to meet borderline cases. The main reasons for such vagueness are either that the classification criteria themselves are imprecise or that the item in question possesses only some of the features necessary to place it in the box in question. Remember the case of the platypus, the egg-laying mammal.

Whatever the reason, in the case of science we find plenty of disciplines, theories, or procedures that, far from falling clearly either in the range of the scientific or outside it, may be characterized as proto-scientific, semi-scientific, or as failed science. Let us take a quick look at these cases.

A proto-science, or emerging science, is obviously a science in statu nascendi. If it survives at all, such a field may eventually develop either into a mature science, a semi-science, or a pseudoscience. In other words, when a discipline is said to be a proto-science, it is too early to pronounce it scientific or nonscientific. Examples: physics before Galileo and Huygens, chemistry before Lavoisier, and medicine before Virchov and Bernard. All of these disciplines matured quickly to become fully scientific. (Medicine and engineering can be called scientific even though they are technologies rather than sciences.)

A semi-science is a discipline that started out as a science, is usually called a science, yet does not fully qualify as such. I submit that cosmology, psychology, and economics are semi-sciences. Indeed, cosmology is still rife with speculations that contradict solid principles of physics. There are still psychologists who deny that the mind is what the brain does, or who write about neural systems "subserving" or "mediating" mental functions. And of course, many of the so-called Nobel Prizes in economics (which are actually prizes of the Bank of Sweden) are awarded to inventors of mathematical models that have no resemblance to economic reality--if only because they ignore production and politics--or to designers of economic policies that harm the poor. The game-theoretic models proposed by Thomas C. Schelling, which won a Nobel Prize in 2005, are a case in point. One of them designed the strategic bombing of the Vietnamese civilian population. The same game theorist also discovered that African Americans segregate themselves: they "feel more comfortable among their own color" (Schelling 1978, 138-139).

In some cases, it is hard to know whether something is scientific, semi-scientific, or pseudoscientific. For instance, the vast majority of nineteenth-century physicists regarded atomism as a pseudoscience, because it had produced only indirect evidence for the atomic hypothesis. Worse, since there was no detailed theory of individual atoms, atomism was only weakly testable, namely through the predictions

of statistical mechanics. But the theory became scientifically respectable almost overnight as a consequence of Einstein's theory of Brownian motion and Perrin's experimental confirmation of it. Only diehard positivists, like Ernst Mach, opposed atomism to the last.

Another example: quantum theory is undoubtedly a paradigm of successful high-level science. But the Copenhagen interpretation of this theory is pseudoscientific, because it places the observer at the center of the universe, since it assumes that every physical event results from a laboratory procedure. That this thesis is blatantly false is shown by the facts that the theory holds for stars, which are of course uninhabitable, and that it contains no postulates describing any observers. (More on this in Bunge 1973, Mahner 2001.)

String theory is a suspicious character. It looks scientific because it tackles an open problem that is both important and difficult, that of constructing a quantum theory of gravitation. For this reason, and because it has stimulated mathematics, it is attracting some of the brightest young brains. But the theory postulates that physical space has six or seven dimensions rather than three, just to secure mathematical consistency. Since these extra dimensions are unobservable, and since the theory has resisted experimental confirmation for more than three decades, it looks like science fiction, or at least, failed science.

The case of phrenology, the "science of skull bumps," is instructive. It proposed a testable, materialistic hypothesis, namely that all mental functions are precisely localizable brain functions. But instead of putting this exciting hypothesis to the experimental test, the phrenologists sold it successfully at fairs and other places of entertainment: They went around palpating people's skulls and claiming to locate alleged centers of altruism, philoprogenitivity, imagination, and so on. The emergence of modern neuroscience finished phrenology.

The discrediting of phrenology cast doubt not only on radical localizationism but also on the scientific attempts to map the mind onto the brain. In particular, the brain-imaging devices invented over the past three decades were first greeted with skepticism because the very attempt to localize mental processes sounded like phrenology. But these new tools have proved very fruitful and, far from confirming the phrenological hypothesis (one module per function), it has given rise to many new insights, among them, the view that all the subsystems of the brain are interconnected. If a tool or a theory leads to important findings, it cannot be pseudoscientific, because one of the marks of pseudoscience is that it is built around an old superstition.

Finally, a word of caution. Most of us are suspicious of radically new theories or tools, and this is the case for either of two reasons: because of intellectual inertia or because it is necessary to grill every newcomer to make sure that it is not an impostor. But one must try to avoid confusing the two reasons. Inquisitive types like novelty, but only as long as it does not threaten to dismantle the entire system of knowledge.

6. Pseudoscience and Politics

Pseudoscience is always dangerous, because it pollutes culture and, when it concerns health, the economy, or the polity, it puts life, liberty, or peace at risk. But of course, pseudoscience is supremely dangerous when it enjoys the support of a government, an organized religion, or large corporations. A handful of examples should suffice to make this point.

Eugenics, once promoted by many bona fide scientists and progressive public intellectuals, was invoked by American legislators to introduce and pass bills that restricted the immigration of people of "inferior

races" and led to the institutionalization of thousands of children regarded as mentally feeble. The racial policies of the Nazis were justified by the same "science" and led to the murder or enslavement of millions of Jews, Slavs, and Gypsies.

The replacement of genetics with the loopy ideas of the agronomist Trophim Lysenko, who enjoyed Stalin's protection, was responsible for the spectacular backwardness of Soviet agriculture, which in turn, led to severe food shortages. The same dictatorship replaced sociology with Marxism-Leninism, whose faithful rightly indicted the social flaws of the capitalist societies but neglected the study of equally acute social issues in the Soviet empire. The consequence was that these issues got worse, and no Soviet social analyst foresaw the sudden collapse of the empire.

More recent cases of the pseudoscience-politics connection are the issues of climate change, stem-cell research, "intelligent design," and wildlife protection on the part of the present U.S. government. Such interferences are bound to have negative impacts on science, medicine, and the environment. The latest case of government support of pseudoscience is the decision of the French health minister to remove from the official Web site a report that cognitive-behavioral therapy is more effective than psychoanalysis (French psychoflap 2005).

Conclusion

Pseudoscience is just as philosophically loaded as science. Only, the philosophy inherent in either is perpendicular to that ensconced in the other. In particular, the ontology of science is naturalistic (or materialist), whereas that of pseudoscience is idealistic. The epistemology of science is realist, whereas that of pseudoscience is not. And the ethics of science is so demanding that it does not tolerate the self-deceptions and frauds that plague pseudoscience. In sum, science is compatible with the proscience philosophy sketched in section 2, whereas pseudoscience is not.

"So what?" the reader may ask. What is the point of the above exercise in border patrolling? Answer: it may help as a warning that a research project inspired by a wrong philosophy is likely to fail. After all, this is all we can do when evaluating a research proposal before the data are in: to check whether the project is trivial or worse, namely, contrary to the "spirit" of science, so that it may deserve the infamous Ig Nobel Prize (Bunge 2004). Much the same holds, afortiori, for the evaluation of ongoing research. For example, present-day particle physics is brimming with mathematically sophisticated theories that postulate the existence of weird entities that do not interact appreciably, or at all, with ordinary matter, as a consequence of which they are safely undetectable. (Some of these theories even postulate that space-time has ten or eleven dimensions instead of the four real ones.) Since these theories are at variance with the bulk of physics, and violate the requirement of empirical testability, they may qualify as pseudoscientific even if they have been around for a quarter of a century and get published in the most reputable physics journals.

Second example: all economics and management students are required to study neoclassical microeconomics. However, they are unlikely to use this theory in tackling any real-life economic problems. The reason for such uselessness is that some of the theory's postulates are wildly unrealistic and others excessively fuzzy, hence hardly testable. Indeed, the theory assumes that all the actors in a market are free, mutually independent, perfectly well-informed, equally powerful, immune to politics, and fully "rational"--i.e., capable of choosing the options likely to maximize their expected utilities. But real markets are peopled by individuals and firms who have imperfect information and, far from being totally flee, belong to social networks or even monopolies. Moreover, the expected utility in question is ill-defined, being the product of two quantities that are estimated subjectively rather than on the strength of hard data, namely the probability of the event in question and the corresponding utility to the agent.

(Most of the time, the precise form of the utility function is not specified. And, when specified, the choice is not justified empirically.) Milton Friedman (1991) boasted that, in its present form, this theory is just "old wine in new bottles." In my view, the fact that the theory has remained essentially untouched for over a century despite significant progress in other branches of social science is a clear indicator that it is pseudoscientific. (More in Bunge 1998b.)

The moral: before jumping headlong into a research project, check it for unsound philosophical presuppositions, such as the beliefs that mathematical sophistication suffices in factual science, that playing with undefined symbols can make up for conceptual fuzziness or lack of empirical support, or that there can be smiles (or thoughts) without heads.

In short, tell me what philosophy you use (not just profess), and HI tell you what your science is worth. And tell me what science you use (not just pay lip service to), and I'll tell you what your philosophy is worth.

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