DISTINGUISHING SCIENCE FROM PSEUDOSCIENCE

Barry L. Beyerstein

Department of Psychology
Simon Fraser University

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Knowledge consists in understanding the evidence that establishes the fact, not in the belief that it is a fact.

Charles T. Spraling

INTRODUCTION

The prestige and influence of science in this century is so great that very few fields outside of religion or the arts wish to be seen as overtly unscientific. As a result, many endeavors that lack the essential characteristics of a science have begun to masquerade as one in order to enhance their economic, social, and political status. While these pseudosciences are at pains to resemble genuine sciences on the surface, closer examination of their contents, methods, and attitudes reveals them to be mere parodies. The roots of most pseudosciences are traceable to ancient magical beliefs, but their devotees typically play this down as they adopt the outward appearance of scientific rigor. Analysis of the perspectives and practices of these scientific poseurs is likely to expose a mystical worldview that has merely been restated in scientific-sounding jargon. Pseudosciences are characterized by non-reproducible findings that are allegedly mediated by forces unmeasurable by conventional scientific methods. Critics' failures to validate these claims are frequently dismissed with the self-serving assertion that the results are obtainable only by those who share the pseudoscientist's beliefs and arcane skills. Before considering some examples and criteria for distinguishing pseudosciences from real sciences, a few definitions are in order.

SCIENCE:

Science is systematized knowledge derived from observation, study, and experimentation. Thus, it deals only with phenomena that can be examined empirically. Contrary to popular opinion, it is not a grab-bag of immutable facts, but rather a way of asking questions and evaluating various possible answers. The objective is to describe the makeup of the physical universe and the underlying principles that govern activities therein. In the process, scientists attempt to agree upon a limited number of constituents that combine to produce the complexity the natural domain and to derive a set of laws that describe the interactions among those components.

Scientific observations are carried out under controlled conditions in order to minimize the impact of researchers' biases and expectations as well as random influences from the environment. Public accessibility of methods and findings, and skeptical evaluation of results, are paramount requirements in the scientific community. Single experiments practically never settle an important scientific debate—it is the preponderance of evidence among researchers in

the field (who must be able to replicate each others' findings) that determines the currently accepted explanation for any given phenomenon.

In carrying out this disciplined examination of the natural world, scientists attempt to generalize from particular observations to formulate general laws. Having established those lawful relationships and a body of reliable data, they organize them into *testable* theories to explain the facts at hand and, if possible, predict new phenomena that would not otherwise have been apparent. By broadening the generality of their theories, scientists hope to extend their explanatory power to cover other phenomena in the subject domain.

The paleontologist Stephen Jay Gould defined a scientific or "natural" law as: "a generalization so overwhelmingly confirmed by empirical observation that it would be perverse to withhold provisional assent." Note Gould's insertion of the word "provisional." By this he meant to emphasize that while currently accepted laws are the best-supported conjectures we have at the moment, they are subject to revision if improved tools or methods should generate novel findings. The same honing and revision is also applicable to scientific theories. It is this self-correcting aspect that perhaps most distinguishes sciences from religious doctrines and pseudosciences. The latter are prone to enshrine their explanations in stagnant dogmas that are immune to revision by new discoveries. Active sciences are constantly in flux.

PSEUDOSCIENCE:

Pseudosciences are fields that try to appropriate the prestige of genuine sciences, and copy their outward trappings and protocols, but fall far short of accepted standards of practice and verification in the legitimate fields they seek to emulate. Pseudosciences do not value debate and criticism and rarely show intellectual ferment or genuine progress. Their explanations are usually contradicted by well-established scientific knowledge and their own findings rarely, if ever, withstand scrutiny by competent critics. Box 1 contains some examples of the kinds of laws, principles, and research data that pseudosciences contradict.

TECHNOLOGY:

Technologies are processes that utilize the knowledge derived from basic research in applied, usually commercial, settings. E.g., medicine is applied biological science; mechanical engineering employs the principles of physical mechanics to create useful machines, structures, etc.; DNA "fingerprinting" identifies individuals by using the principles of genetic diversity discovered in molecular biology; and behaviour modification psychotherapies utilize insights into the mechanisms of learning and reinforcement discovered in experimental psychology.

BOX 1. KINDS OF SCIENTIFIC LAWS, EMPIRICAL DATA, AND WELL-ESTABLISHED PRINCIPLES VIOLATED BY PARANORMAL OR PSEUDOSCIENTIFIC CLAIMS:

1. The Inverse Square Law
2. Laws of Thermodynamics (e.g., the Law of Entropy)[1]
3. Laws of Conservation of Energy, Momentum, etc.
4. Injunctions against reverse causality ("Time's Arrow")
5. One or more of C. D. Broad's "Basic Limiting Principles" (see Box. 3)
6. Data of modern neuroscience, psychology, and psychophysiology
7. Many pseudosciences claim extraordinary precision, power, or yields— well beyond those achievable by conventional scientists (and often by means of secret proprietary processes, formulas, or equipment).

Many detractors who claim to dislike science turn out, upon closer examination, to be opposed instead (and often quite reasonably) to uses of particular technologies that are harmful to people or the environment. While scientists cannot always foresee or control the potential applications of the knowledge they produce, neither have they always been as vigilant or vocal as they ought to have been in opposing certain harmful or exploitative applications of their fundamental insights.

Quite a few pseudosciences are really pseudotechnologies; i.e., commercial ventures promoted by hucksters who mislead consumers into thinking that their products are sound applications of scientific knowledge. Often the research these promoters cite is valid in itself,

[1]These three laws, which, among other things, rule out perpetual motion machines and reverse causality (which would have the case if precognition were true, for instance), were once humorously summarized by an anonymous wag as:

1. You can't get something for nothing.
2. You can't break even.
3. You can't get out of the game.

but its relevance to the hawker's wares is misrepresented in order to overcome buyer resistance. Generally speaking, any supporting "research" done by these distributors or their associates will be found to be seriously flawed. Mountebanks are especially fond of claiming that their products are derived from whatever ranks as the most prestigious scientific field of the day. The hope, of course, is that this unearned affiliation will allay the customer's skepticism. This kind of soothing is often necessary because the sales patter is likely to contain extravagant promises which no ethical expert would make—claims that one would hope would arouse suspicion in any reasonably well-educated person. Even if the promised results are well beyond the state of the art in the legitimate fields whose data these pitchmen misappropriate, the prospect is so enticing that wishful thinking can easily overpower common sense.

Pseudoscientists commonly use a number of rhetorical ploys to advance their cause. These sales gambits are well-known to social psychologists who specialize in persuasion techniques. The manipulative ways in which pseudoscientists apply them were recently dissected in an informative article by Anthony Pratkanis ("How to sell a pseudoscience," *The Skeptical Inquirer*, Vol. 19[4], 1995; pp. 19-25).

Bogus science prospers in the market place by selling false hope, usually by pandering to the naive belief that someone, somewhere has figured out how to get something for nothing (see Box 4). Artful manipulators thrive on the comforting but doubtful assertion that all physical constraints and limitations on human achievement are mere conventions, applicable only to those so unimaginative as to believe in them. Wild claims of this sort are likely to surface wherever proven empirical techniques offer no quick and easy route to a highly desirable end. Potential consumers are well advised to keep in mind that if something sounds too good to be true, it probably is.

EXAMPLES OF PSEUDOSCIENCES:

This section introduces a representative sample of pseudoscience. Included are examples of state-sponsored, ideologically-driven pseudoscience as well as cases where competent, conventional scientists have strayed temporarily into pseudoscientific pursuits without recognizing, initially anyway, the error of their ways. And then there are the more common varieties of pseudoscience epitomized by self-styled "researchers" with minimal qualifications working on the periphery of established fields. These practitioners are easily recognized by their penchant for making brash claims about how their pending "discoveries" will revolutionize the fields they expect to enlighten.

As the reader will see, there are some pursuits that are pseudoscientific by any reasonable definition and others that, although they may be wrong-headed or overblown in some of their claims, are clearly not pseudoscientific in their entirety. In other words, there is a large gray area. In some instances in this disputed region, the practices, data, and theories in question may be unorthodox and overly speculative, but not demonstrably absurd. Claims of this sort should merely be considered "unproven at present." The history of fringe science leads one to expect

that most of these outlandish conjectures will eventually be rejected, but as long as their proponents abide by the accepted rules of verification and open discourse, it is only fair that they be afforded a reasonableopportunity to demonstrate the worth of their ideas. Those who keep returning with the same threadbare idea, after repeated failures, however, are another matter.

Though most solitary visionaries ultimately turn out to be cranks, every so often one proves to be the pioneer in a new and important branch of science. It is well to remember, though, that the heroes of these rare success stories brought the initially doubting fields around *by force of evidence, not mere conjecture and special pleading.* Although there are several well-known cases where the scientific community was unduly slow in accepting an unconventional but correct theory, it is also worth emphasizing that, most of the time, such reluctance is quite reasonable. It is up to the claimant to support his or her own case and the scientific community is generally well-served by its institutional skepticism. Pseudoscientists are fond of the *non sequitur* that, because orthodox scientists opposed a few innovators who were later proved correct, this somehow implies the validity of their own far-fetched ideas.[2] The illogical nature of this argument was wittily exposed by Carl Sagan who quipped that, yes, they laughed at Copernicus and they laughed at Einstein, but they also laughed at Bozo the Clown.

Fringe thinkers whose ideas have been spurned often charge that they were rejected merely because the "Scientific Establishment" is unreasonably resistant to new ideas, especially when they come from "outsiders." An Australian researcher, William K. Honig, took this charge to heart. Although he was a reputable conventional scientist himself, Honig felt this large corpus of unorthodox musings might contain some useful ideas that *were* being overlooked by main-stream scientists. So, in 1978, Honig founded a unique journal called *Speculations in Science and Technology.* He intended it to be a forum for unconventional arguments and theories that would not get past the editors of the existing peer-reviewed journals because they were overly speculative, lacked sufficient supporting data, contradicted presently accepted theories, etc.

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[2] In many accounts by supporters of fringe science, the ultimately-vindicated pioneer was not only rejected, but also ridiculed by the closed-minded, irrational Establishment. In fact, in most of these oft-repeated cases (e.g., Alfred Wegener's proposal of continental drift), there was no means available at the time to test the unconventional ideas, so they were merely put on the shelf, pending the presentation of suitable data. Wegener himself, though his ideas about continental drift remained in scientific limbo because they could not be tested at the time, was not ridiculed for proposing them, as some anti-science critics claim. He continued to enjoy the justly deserved prestige his other contributions had earned and once the technology became available to find empirical support for his theories, they were accepted remarkably quickly by the field of geophysics (see Nils Edelman: "Wegener and pseudoscience," *The Skeptical Inquirer*, 12[4], 1988, pp. 398-402. See also the commentary by the editor, Kendrick Frazier, in the same issue).

Despite their exotic sources, seeming implausibility, or errors in the way they were presented, Honig hoped a few submissions would prove to be diamonds in the rough. After five years of offering the world's scientific oddballs the fair hearing they had supposedly been denied, Honig was disappointed to have to conclude that there had been valid reasons for ignoring these self-styled visionaries. In an article titled "Science's Miss Lonelyhearts" (*The Sciences*, May-June, 1984, pp. 24-27), Honig described why he finally abandoned his optimistic new venture. Despite diligent searching, and monumental patience, he had found none of the proverbial "back-yard geniuses" who had been suppressed by an envious, hidebound in-group. Instead, he found only a steady stream of cranks, near-paranoids, and malcontents, sprinkled with the occasional individual with a possibly interesting idea but who was incapable of developing it or communicating it to others. Honig concluded that the truly innovative thinker, though he or she might have a harder time than those who stay closer to the received wisdom of the time, will eventually receive a hearing through the normal scientific channels. More recently, the advent of the Internet has been a boon to all who wish to swim against the tide of orthodoxy. The good news is that never before have outsiders had as much opportunity to disseminate their thoughts. The bad news is that the sheer volume of speculation has made it harder than ever to discover the pearls among the dung. With this in mind, let us now turn to some concrete examples of pseudosciences.

PSEUDOSCIENCE IN BIOLOGY:

Political and religious beliefs periodically lead to distortions of objective scientific data and sometimes spawn full-blown pseudosciences. Two illustrative examples of such corruptions of biological science in this century are "Lysenkoism" and "Scientific Creationism."

In Stalin's USSR, the demonstrably false ideas of Trofim Lysenko were declared true principles of genetics by the state. Lysenko was favoured because his bogus support for the Lamarckian notion that acquired characteristics could be inherited fit well with the Marxist ideology of the political hierarchy. The result was to stifle legitimate genetic research in the Soviet Union for decades. Serious practical consequences followed, such as lost agricultural productivity, environmental degradation, and shortages of trained personnel ready to help the country prosper in the dawning era of biotechnology. Sad to say, many of Soviet science's best and brightest were sent to the Gulag for daring to question Lysenko's folly (see Valery N. Soyfer: *Lysenko and the Tragedy of Soviet Science*, Rutgers University Press, 1994).

More recently, and closer to home, so-called "Scientific Creationists" have begun to assert that a literal interpretation of the story of divine creation in the Biblical Book of Genesis is a reasonable alternative to the theory of evolution by natural selection. Proponents argue that creationism is a legitimate science that should be taught in the standard biology curriculum. There are, of course, no biologists, paleontologists, or geologists of any standing who support this crude attempt to disguise religion as science. Indeed, most thoughtful Christians find the idea of a 6000-year-old universe ludicrous as well. There are also some biologists, it should be

noted, who are practicing Christians but see no need for conflict between religion and science in this arena. They accept evolution as the mechanism by which the Creator chose to have life on earth unfold. Indeed, Pope John Paul II recently promulgated this position as the official doctrine of the Catholic Church. Although most biologists probably see no need to postulate a personal agent who willed the laws of nature into existence, there is no logical contradiction in this view, because science deals only with proximal mechanisms. It cannot deal with questions of ultimate causation which are the realm of metaphysics and religion.

Lysenkoism and Creationism both provide sad but fascinating examples of how some people with advanced degrees and accomplishments in relevant scientific fields can distort and ignore what they have learned in service of their religious or political convictions. The racial pseudoscience of the Nazi regime is a more repugnant example of how state sponsorship of biological nonsense can lead to tragedies of immense proportions. Fortunately, such extreme cases are rare but they stand as a sobering reminder of what can happen when the public is willing to make skepticism and the demand for solid evidence subservient to ideology.

PSEUDOSCIENCE IN CHEMISTRY:

Polywater: In the 1960's, reports emerged from the laboratories of two respected Russian scientists, Fedyakin and Deryagin, that seemed to reveal a fourth state of water, i.e., in addition to its liquid, gaseous, and frozen forms. In the rush to confirm and possibly harness this new phenomenon, a number of scientists with good reputations let their hopes and beliefs cloud their objectivity. In so doing, several of them behaved in this particular instance much like pseudoscientists do as a matter of course (see Felix Franks, *Polywater*, MIT Press, 1982). They managed to confirm the existence and report various novel properties of this "new" substance. The system of peer review and replication eventually corrected these false starts, however. More careful analyses revealed that the "new" material was in fact a very subtle form of contamination introduced by parts of the laboratory apparatus. The initial "breakthrough" was an honest mistake, not crackpot science, but as egos and reputations became threatened in the ensuing debate, a few members of the scientific community initially failed to live up to the accepted canons of their profession. The polywater story is both a case of pathological science and a good example of how the system can work to correct such errors. Every generation seems to produce its own debacle of this sort. The story of "cold fusion," to be discussed later, ranks as the current generation's contribution to this literature.

Crackpot Additives and Nostrums: While the polywater fiasco shows that even respected scientists can occasionally behave like pseudoscientists, the majority of pseudoscience comes from outsiders who believe they have achieved striking discoveries that are being overlooked, if not outright suppressed, by the hidebound, self-serving "Establishment." For instance, hardly a year goes by without another announcement of a unique additive that will double or quadruple thefuel efficiency of an internal combustion engine. The story is usually accompanied by allegations that the big oil companies are persecuting the discoverer in desperate attempts to

protect their bloated profits.[3] As consumers have become accustomed to ethical consumer industries touting examples of "better living through chemistry" through reasonably accurate publicity campaigns, many people have been lulled by this truly remarkable progress into a willingness to accept even the most outrageous puffery at face value. Thus they eagerly enrich unscrupulous or self-deluded operators who cater to these seductive but unobtainable dreams. For instance, in our slimness-obsessed society, there is always a ready market for "revolutionary, new" pills, salves, or creams that will "melt fat away" (without the need for exercise or self-denial, of course). Likewise, grooming products with "secret European formulas" that supposedly dispel wrinkles continue to come and go like clockwork. There is no credible evidence that these products work, but this has hardly dented their sales. Garage sales across the continent are littered with the discarded leftovers of disappointed customers.

PSEUDOSCIENCE IN PHYSICS:

N-Rays. One of the best-known examples of esteemed scientists acting like pseudoscientists is found in the career of the French physicist, René Blondlot, around the turn of the 20th century. On the heels of the discovery of X-rays by the German, Roentgen, French scientists felt pressured to catch up by scoring a breakthrough of their own. Blondlot, who already had several important discoveries to his name, believed he had observed yet another form of radiation which he named "N-rays" in honour of his institution, the University of *N*ancy. Blondlot's "observations" were eventually shown by the American physicist, Robert Wood to have been the joint result of wishful thinking and some subtle distortions that normally occur in visual perception. These visual aberrations tend to be ignored under ordinary viewing conditions but they stood out against the backgrounds of Blondlot's viewing apparatus. The discoverers of N-Rays had allowed their hopes and expectations to colour their observations. Unfortunately, they had failed to include a simple experimental control that would have saved them much embarrassment. Wood made his point by surreptitiously inserting this control condition into a demonstration provided for him during a visit to Blondlot's laboratory. It is interesting to note that there had been a number of independent "replications" of N-rays by respected laboratories; the fact that some others had failed to find the new radiation had piqued Wood's interest. His exposé highlights the need for mechanized recording of data, wherever possible, to minimize the all too human tendency to "see" what we are predisposed to see. It is this tendency to find what we expect that makes tight experimental controls, independent replication, and careful statistical analyses an absolute necessity in all research. If honest, well-trained scientists occasionally fall prey to such foibles, it is not hard to understand why pseudoscientists are such frequent victims.

As mentioned earlier, outside of mainstream physics, there continues to be a determined cadre of home inventors and tinkerers who remain convinced that they have found ways around

[3] A particularly distressing instance, one that resulted in a fatal explosion, was recounted by Richard Feynman who was being favoured with a demonstration of such a "revolutionary, new" engine (see his "Mr. Papf's perpetual motion machine," *The Skeptical Inquirer*, 14[1], 1989, pp. 46-48).

one or more of the nagging limitations imposed by the conventional laws of science. The infamous Newman Energy Machine is only the latest in a long line of "perpetual motion devices" which purportedly generate more energy than what is fed into them. Newman continues rail in the media about his mistreatment by physicists who maintain that such devices are precluded by the laws of thermodynamics and to fight the U.S. Patent Office for their refusal to grant him a patent on his device (see Marjorie Sun, *Science*, 11 July 1986, p. 154). In the same vein, every
so often we see another claim to have developed an anti-gravity device that, if true, would violate several well-established laws of science.

Fantastic Energies. Also in the sphere that calls itself "paraphysics," there are those who postulate heretofore unsuspected kinds of energy[4] to explain the supposed ability of "vortices" such as the Bermuda Triangle to swallow up disproportionate numbers of vessels without a trace. In fact, there is no good evidence that a higher proportion of ships or planes disappear in this region than on any other equally well-traveled route that is subject to comparable weather and tidal conditions (see Lawrence Kusche, *The Bermuda Triangle Mystery-Solved*, Warner Books, 1975). In the absence of a phenomenon in need of an explanation, it seems quite superfluous to be hypothesizing brand new energy forms that are neither required by nor predicted by the established branches of physics .

Mysticism and Quantum Mechanics. The New Age has spawned another popular cottage industry, this one devoted to showing that various ancient writers of Eastern philosophy were really cognizant of the underlying structure of the universe that has only recently been revealed by modern particle physics. The best-known of this genre is *The Tao of Physics* (Fontana, 1975). Its author, Fritjof Capra, claims to have discovered striking parallels in the two traditions, such as the notions that emptiness is form, reality is everything you can think of, and all existence is an unbroken wholeness. In his book *Physics and Psychics* (Prometheus, 1990) the physicist Victor Stenger, describes Capra's attempts to marry mysticism and modern science as "random meanderings through Eastern literature to find a catchy quotation here and there that vaguely sounds like the new physics." Another excellent reply to those who would mix mysticism and subatomic physics can be found in *The God Particle* by the Nobel Laureate, Leon Lederman.

Once again, we see that if one is allowed to interpret poetic metaphors freely, a match can easily be forced between "what the author obviously meant" in this or that allegorical passage and virtually any modern referent. This has been demonstrated time and again with the predictions of the 16th century astrologer and soothsayer, Nostradamus. Modern disciples of Nostradamus point out remarkable similarities between the descriptions contained in his flowery

[4] Conventional science recognizes only electromagnetism, gravity, and the strong and weak nuclear forces as legitimate forms of energy.

images and events in their own lifetime. Unfortunately for these seekers, the same passages they see as obviously having foretold events in their own time have been just as convincingly attributed by people in earlier eras to monumental happenings in their own lifetimes (see James Randi's *The Mask of Nostradamus*, Prometheus Books, 1992). To make matters worse, many of those allegedly stunning "hits" are mistranslations or outright fabrications inserted into the original writings after the events they were supposed to have predicted. For the modern romantics who see threads of quantum mechanics in ancient tomes of oriental mysticism, the resemblances are equally superficial and in the eye of the beholder. For a fascinating explanation of how our minds read personally-relevant specifics into the pronouncements of fortune-tellers and others, where there are really only vague generalities awaiting interpretation, see Ray Hyman's 1977 article on "cold reading" listed in the bibliography.

Crop circularity. Another quaint example of pseudoscience is "cereology," the study of supposedly mysterious circles (and, later, increasingly complex patterns, including Mandelbrot sets!) that show up unexpectedly from time to time in grain fields. Explanations from the cereologists have included fanciful new physical theories, akin to those favoured in Bermuda Triangle lore (though the trend of late has been to invoke extraterrestrial machinations). Why visitors from foreign worlds, who have mastered the daunting technological problems of space travel, would content themselves with making graffiti in grainfields, rather than, say, carving a new Mount Rushmore-type tableau in the Rockies to inform us of their obscure intentions, remains a mystery. And that such allegedly advanced beings should need the cover of darkness and choose only unobserved fields in which to play should strike the cereologists as a bit suspicious. Although numerous pranksters have come forward to claim credit for the nighttime appearance of these "signs," most cereologists remain unconvinced. British skeptics in conjunction with the BBC have created patterns in fields which the top figures in the cereology movement subsequently declared impossible to create by human means. Self-debunking by the very humans who made the patterns merely engendered a bit of back-pedaling and the assertion that there are too many of these mysterious happenings for them *all* to be hoaxes. One of the strongest indications that they are indeed all hoaxes was supplied by Joe Nickell and John Fischer in their 1992 investigative report which appeared in *The Skeptical Inquirer* (Vol.16, No. 2, pp. 136-149). The authors showed that the geographical and chronological distributions of the circles, as well as their increasing complexity over time (a mere circle no longer attracts the network news cameras), followed a predictable pattern reminiscent of those of many hoaxing fads from the past. It has also been noted that the extra-terrestrials initially seemed to have had a distinct anti-Chinese bias. It was not until the earlier European reports began to be translated into Chinese and broadcast by the liberalized Chinese media that crop circles started to miraculously appear in the People's Republic. True to form, the cereology movement has amassed its share of mystery mongers with no formal qualifications, but it has also attracted the usual smattering of maverick engineers, climatologists, and physicists, as well.

Free energy for all. We should not leave this section without a brief mention of the recent "Cold Fusion" controversy. Like the polywater story discussed above, it is a good example of the grey areas between science and pseudoscience. In 1989, two chemists at respected universities in the US and England, Stanley Pons and Martin Fleishman, stunned the physics community with an

announcement which, if true, would have heralded the end of energy shortages forever. They reported (in the popular press initially, rather than via a peer-reviewed journal, although refereed papers did eventually appear) that they had achieved nuclear fusion with inexpensive apparatus in a conventional chemistry lab. This was all the more remarkable given that decades of concerted effort with multi-million-dollar reactors had made only limited progress toward achieving sustained nuclear fusion.

In an example of how vetting of claims in the scientific community ought to proceed, experts around the world immediately attempted to replicate Pons and Fleishman's findings—but ultimately without success. The emerging consensus was that they had misinterpreted certain ambiguous results in their initial experiments. Some critics contended that this had been abetted by lapses in objectivity arising from strong emotional commitment to the idea of cold fusion and prospects of the immense fame and fortune that might have followed. That the scientific community took these improbable findings seriously and quickly set out to see if they could be repeated is to the system's great credit.

Honest errors and misinterpretations bred of hope and expectancy happen frequently in science, especially at the messy frontiers of active fields—that is why *independent* replication is the gold standard in any legitimate discipline. Although Pons and Fleishman's purported breakthrough stemmed from unconventional methods and it represented an intrusion by chemists into a field requiring considerable sophistication in nuclear physics, their initial work would not have qualified as pseudoscience. However, their response to criticisms and their dogged refusal to accept failures by many others to reproduce their work are more worrisome. Today, practically no reputable physicist anywhere still believes in cold fusion, but Pons and Fleishman continue to soldier on. They have left academia and are continuing their search in a private institute in the south of France. It is funded by a large Japanese industrial corporation.

PSEUDOSCIENCE IN MEDICINE:

The health professions have attracted more than their share of pseudoscientists offering eagerly-awaited cures for various diseases. Conditions for which medical science can, at present, offer the least hope are particularly likely to attract bogus therapists. The uncertainty and sense of helplessness that follow diagnosis of a serous illness are often more than a match for the critical thinking skills that, in happier times, might have led the patient to question such overblown promises. The body's normal healing processes and the ubiquitous placebo effect can easily make any sham treatment seem effective. For that reason, all putative therapies must be tested in carefully designed and controlled clinical trials. They must involve a large number of patients with the same complaint. Any new treatment must be compared in a "double blind" evaluation where neither the patient nor the therapist knows who was randomly assigned to receive either the "active" therapy or an inert placebo. Unless the active treatment group shows a significantly greater recovery rate than the placebo control group and a no-treatment group, it has no claim to legitimacy. Most so-called "alternative medicine" has either not been properly tested in this way, or has been tested and failed.

If there truly is nothing more scientific medicine can do for a patient, the comfort pseudoscientific practitioners can provide is not necessarily a bad thing (unless of course the widows and orphans are left destitute by the unconscionably high price of the treatment). But when quacks divert patients from genuinely curative treatments, the results can be tragic. A recent case of this sort occurred in the province of British Columbia where belief in quackery led to the unnecessary death of a 16-year-old girl. She was considered a good candidate for a life-saving liver transplant, but at the urging of her parents who were devotees of "alternative medicine," she chose instead to fly to a clinic in Mexico whose main treatment was a bizarre vegetable diet coupled with frequent coffee enemas.

Homeopathy. A few quacks manage to come up with novel nonsense, but most merely present recycled versions of old, long since discredited nostrums. For instance, homeopathy was a serious contender among the competing philosophies of disease and treatment during the pre-scientific era of medicine. Although its remedies were pushed aside when scientific research showed its theory of pathology to be untenable, homeopathy has remained alive despite the inanity of its underlying rationale.

Homeopathy recommends treating diseases with agents that will actually *exacerbate* the symptoms, but which are administered in solutions so dilute that it is almost certain that none of the active ingredient survives in the watered-down concoction. The claim that such a vanishingly weak potion could still affect bodily processes is akin to saying that if I spit in Vancouver harbor, I will pollute Tokyo Bay. Homeopathy requires the dubious assumption that pure water can "remember" something that it once contained and thereby continue to produce the absent substance's effect. To instill this "memory," homeopaths engage in quaint preparation rituals that demand a huge but *exact* number of dilutions and a precise number and type of shakes of the vial between each dilution. These comical ceremonies, coupled with their far-fetched "explanations" for why their elixirs could possibly work (when, admittedly, no active ingredients remain), are just the kind of warning signals that should raise a discerning consumer's suspicions that a pseudoscience is lurking in the wings.

The resurgent popularity of homeopathy in recent years is due to a combination of aggressive marketing by New Age entrepreneurs, the support of a small number of maverick scientists and physicians, and the patronage of a few high status clients such as some members of the British royal family. This revival was fueled by some apparently supportive research from the lab of the Paris immunologist, Jacques Benveniste. Largely on the strength of Benveniste's reputation (justly achieved early in his career by successfully toppling an entrenched orthodoxy in his specialty), the counterintuitive results were published in the prestigious journal, *Nature.* A subsequent investigation by a team sent by the editor of *Nature* revealed several irregularities in the procedures followed by some of the collaborators who actually carried out the experiments in Benveniste's lab. Incidentally, the original studies were funded by a large manufacturer of homeopathic remedies. A full chronicle of this episode can be found in the Spring 1988 issue of *The Skeptical Inquirer.*

Although these homeopathic effects could not be replicated by independent researchers, this has not dampened the enthusiasm of the healing cult's devoted followers. My standing challenge to them is simple. My lawn is a biological system that is presumably immune to placebo effects (I am not currently aware of any claims for "grass consciousness," but I might welcome the idea if it became an accepted reason to avoid mowing). It should be possible to produce a homeopathic fertilizer in the time-honoured way. We could then have a double-blind comparison of its efficacy vis-a-vis the product from my local garden shop. It would then be apparent to all if the grass is indeed greener on the other side of the metaphysical fence.

The foregoing account, and others in the following sections, demonstrate that intelligence, proper training, and high achievement in a scientific field are not automatic proof against being drawn into pseudoscientific blind alleys.

Quack Cancer and Arthritis Cures and Vitamin Fads. The field that refers to itself as "alternative medicine" is awash with doubtful cancer and arthritis remedies and fad "dietary aids" that cannot withstand expert scrutiny. What passes for research in these areas provides numerous case studies of how pseudoscientists think and work. Laetrile, for instance, the most infamous of the "alternative" cancer remedies, has failed all reliable double-blind clinical trials, and is not approved for use in Canada or the US. Nonetheless, this has not stemmed the flow of desperate patients who flock to Laetrile clinics in other countries. Likewise, sales of copper bracelets and exotic elixirs that supposedly alleviate arthritis continue, despite the lack of empirical support and the revelation that many of the anti-arthritis potions contain toxic ingredients. Overblown claims for the therapeutic efficacy of Vitamin C provide additional instructive examples, as do those for "orthomolecular" or "megavitamin" cures for psychoses. The alleged anti-cancer properties of vitamin C are equally unsubstantiated.

Gray Areas. In most fields of medicine there are also controversial treatments that are neither generally accepted practice nor total quackery. The practice of chelation therapy is a case in point. It is the conventional treatment of choice for patients suffering from heavy metal poisoning, but recently it has been claimed to be effective in treating atherosclerosis ("hardening of the arteries"). Despite its poor showing in numerous research studies, its supporters (a small band of duly licensed physicians, many of whom are allied with fringe health food faddists) continue to advocate chelation therapy for cardiovascular problems. In this, they run counter to the advice of the vast majority of the research community and their respective medical associations.

Chiropractic. Likewise, chiropractic falls into a gray area. Its ministrations can be beneficial in certain cases, but its underlying rationale is pure pseudoscience. Joint manipulation has a long history and seems to be therapeutic for a limited number of musculoskeletal disorders. Chiro-

practors who limit their efforts to such ailments undoubtedly do some good. The dangers lie in those who espouse chiropractic as a complete health care system applicable to all maladies, including infections, malignancies, diabetes, immune disorders, etc. Chiropractors who believe this often overstep their sphere of competence and divert people from proven medical therapies that could actually help them. There are also many cases on record where chiropractors have caused serious harm by manipulating vertebrae that were diseased for reasons other than what their training would lead them to believe. The penchant of many chiropractors for dubious diagnostic devices and dietary supplements are also causes for concern. Likewise, the profession's irrational stand against childhood immunization and the appropriate use of antibiotics (based on its rejection of the germ theory of disease) has been actively harmful.

When chiropractic treatments do help, they almost certainly do so for reasons other than what passes for theory in this field that suffers from very shaky scientific underpinnings. Chiropractic's explanatory system was devised in the last century by an self-taught grocer, Daniel David Palmer, and has remained largely unchanged since then. Its principal tenets are (a) that *all* disease stems from blockage of so-called "vital energies" which supposedly flow through the nerves that exit from the spinal column, and (b) that this vital flow (and health) can be restored by realigning the vertebrae to alleviate the bottleneck. This theory is no more tenable today than the archaic notion that diseases are caused by demons. That is not to say, however, that chiropractic manipulation mightn't alleviate some cases of low back pain, for instance, but for reasons quite unrelated to the pseudoscientific theory used by chiropractors to justify the treatment.

Acupuncture. Other areas that are plagued by a mix of pseudoscience with reliable research are acupuncture and traditional herbal medicine. Acupuncture undoubtedly works in some people as an analgesic. However, as in the case of chiropractic, its traditional explanation must be placed firmly in the category of pseudoscience. The traditionalists believe that acupuncture works by balancing the flow of "vital energies" through "meridians" in the body. Both of these conjectural entities have remained undetectable by modern scientific methods. This is not surprising because acupuncture's traditional explanatory rationale dates back thousands of years, before human anatomy and physiology were scientific fields, indeed to a time when it was forbidden in China to dissect cadavers to explore their inner structure.

Making sense of the large and conflicting literature on Traditional Chinese Medicine (TCM) is made all the more difficult by the fact that TCM, until recently, was heavily promoted by the Chinese Communist regime for political purposes. Although Mao Tsedong and the party hierarchy preferred their own private physicians trained in Western scientific medicine, they touted the superiority of TCM to the masses. This was partly for purposes of building national pride and partly because the impoverished country could not afford to provide scientific medicine for all.[5] One of the consequences of this policy was that research papers from Chinese

[5] For a revealing look at the low esteem in which the Chinese Communist Party hierarchy held traditional Chinese medicine, when amongst themselves, see Li Zhisui's *The Private Life of Chairman Mao* (NY: Random House, 1994). Dr. Li, a doctor trained in Western scientific medicine, was Chairman Mao's private physician from

hospitals of that era had to be vetted by political commissars (who usually had no biomedical training) before publication. Predictably, the results usually favoured the party line that TCM was superior. These tainted papers linger on in the literature, making it doubly hard to assess the true worth of TCM, which is not to say that there are no traditional practices that are scientifically defensible.

How much of acupuncture's demonstrable clinical effect is due to a combination of placebo effect, distraction, or self-hypnosis and how much to its ability to cause the release of the body's own natural pain-killers (the endorphins), remains an active subject of research and debate. One of the doubters, the Stanford oncologist Wallace Sampson, has pointed to an interesting relationship in the acupuncture literature, one often seen in fringe areas of science. When the entire corpus of research is surveyed, and the individual papers ranked for the adequacy of their methodology and experimental controls, there is a strong *inverse* relationship between the quality of the research procedures and the amount of therapeutic relief reported. The quality of research in the area is improving, however. The better researchers are making much more modest claims and have tightened their experimental procedures considerably. Several reputable laboratories are now attempting to document acupuncture's mechanisms of action at the cellular and biochemical level. This group includes such well-known neurophysiologists as Professor Han Ji Sheng of Beijing Medical University, whose laboratory I have visited. These researchers restrict their study to acupuncture's effects on pain, inflammatory processes, etc., where there are scientifically plausible mechanisms that might mediate its clinical effects. They reject, as did I when I was a visiting professor in China, the wilder claims some acupuncturists make, such as that acupuncture can cure maladies like cholera, deafness, and mandibular overbite. Unfortunately, many not-so-competent researchers continue to muddy the waters with poorly controlled clinical studies of acupuncture that make it difficult to sift the wheat from the chaff. Those interested in a comprehensive and hard-nosed critique of the acupuncture literature will find one in the chapter by Petr Skrabanek in the edited volume by Stalker and Glymour, listed in the readings at the end of this essay. Another good source is George Ulett's *Beyond Yin and Yang: How Acupuncture Really Works* (Warren H. Green Inc., 1992). A more general overview of the philosophy, origins, and practices of Traditional Chinese Medicine (TCM) is contained in a two-part article by Barry Beyerstein and Wallace Samson that appeared in the July/August and the September/October issues of *The Skeptical Inquirer.*

Herbalism. Many mainstays of modern pharmacology have their origins in traditional folk

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1954 until Mao's death. For Mao and his closest associates, Li had the latest in scientific treatments available at all times. At the same time, party officials extolled traditional medicine treatments for the masses. On a recent scientific exchange visit to China, I was able to ascertain from the traditional practitioners themselves that only about 15% of the medical care administered in China today is of the traditional variety.

remedies: e.g., aspirin (from the willow tree), digitalis (from foxglove), morphine (opium poppy), quinine (chinchona bark), curare (*Strychnos toxifera*), and vinblastine and vincristine (anti-tumour drugs derived from the Madagascar periwinkle), to name just a few. Traditional Chinese herbalism has already provided western physicians with valuable medications such as ephedrine (from the plant Chinese herbalists call *Ma Huang).* Undoubtedly, many other useful medicines remain to be isolated from the huge traditional pharmacopeia and a number of drug companies are actively supporting expeditions by ethnopharmacologists to places such as the Amazon rain forest in search of effective traditional remedies.

Unfortunately, as it stands, most traditional herbs have not yet been properly tested for safety or efficacy. Thus herbalism remains an inseparable mixture of some safe and effective remedies, some inert placebos, and some dangerous substances. It is difficult, if not impossible, in most instances, to tell which concoction belongs in which of these categories. The good news is that, particularly in China, attempts have begun to try to apply modern scientific methods to separate the effective herbal medications from the placebos and to isolate the active ingredients from those that actually work. Those traditional practitioners around the world who oppose such efforts and cling to their frankly magical explanations for the effects of their preparations can hardly be surprised if the scientifically-inclined continue to regard their practices as pseudo-scientific at best.

Also in the pseudoscience camp must be placed all traditional remedies made from rhinoceros horns, tiger penises, bear gall bladders and parts of other magnificent, endangered species. Lucrative poaching to harvest these animal parts is seriously threatening these species with extinction. And all this for useless treatments based solely on principles of sympathetic magic, the ancient belief that "like begets like"—these are symbolically potent parts of powerful beasts, so it is believed that the organs must therefore magically transfer to the people who take them the vitality and fortitude of their donors.

Psychological effects on disease. Finally, in the gray areas of health care, there is the much-debated idea that psychological factors make a large contribution to the onset and remission of diseases. Obviously, some of these claims are more controversial than others. People's attitudes can certainly make them act in ways that are beneficial or detrimental to their health. It is also well-established that various kinds of stress can impede immune system functioning, for instance. This can raise susceptibility to infections and lower vigilance against certain cancerous cells. Similarly, via prolonged over-activation of the autonomic nervous system, psychological states can contribute to various stress-related problems such as stomach ulcers[6] and some cardiovascular illnesses.

Nonetheless, the percentage of variance in disease statistics that can be attributed to psychological factors alone is not nearly as large as many New Age healers and pseudoscientists

[6]Even here the role of stress has been downplayed following the recent discovery by the Australian physician, Barry Marshall, that the primary cause of ulceration is actually a bacterium, *Helicobacter pylori*. The contribution of stress is now seen as impeding immune responses, making it easier for the bacterium to proliferate.

contend. Much research in this area suffers from methodological flaws and the most reliable estimates seem to agree that psychological variables account for, at most, 2-3% of the variance in incidence of most diseases.

The downside of these worthwhile attempts to encourage people to improve their lifestyle and take more responsibility for their own health care is that it has also led to a resurgence of the superstitious belief that people become ill because they *deserve* to. In keeping with the New Age agenda, this is part of a strong wish to reinstate a moral dimension in the workings of the natural world. An unintended consequence of the suggestions of "alternative" therapists that diseases can be cured by laughing, praying, thinking good thoughts, or practicing mental imagery, is that when they fail, as they usually do, to halt the course of a serious ailments, these patients are likely, quite unfairly, to blame themselves. In keeping with the New Age notion of moral forces settling scores in the natural world, they assume their own moral shortcomings must have been responsible not only for their becoming sick initially, but also for not getting better—this is truly adding insult to injury.

PSEUDOSCIENCE IN PSYCHOLOGY:

Astrology. Most people today would think it ludicrous to explain astrophysical phenomena with cosmological speculations that were accepted 3000 years ago, but a surprising number of otherwise well-educated individuals see no inconsistency in using the magical theories of behaviour that comprised the psychology of the ancient world to explain human conduct in the here and now. Astrology, an immensely popular pseudoscience with great pretensions, has been subjected to rigorous empirical tests and found to be worthless. Nonetheless, in the minds of many educated people it remains an acceptable way of explaining our personalities and inclinations. For documentation of the futility of astrology, graphology, palmistry, and other pseudoscientific "character reading" schemes, the reader should consult the relevant sections of the reference list at the end of this essay.

Graphology. Astrology's close relative, graphology, which claims that personality, ability, and moral stature can be discerned from the configuration of one's handwriting, has also been thoroughly discredited, but this has not deterred the many businesses and some government agencies that still hire handwriting analysts to assist them in making personnel decisions. A few police departments and courts have also fallen prey to this pseudoscientific character reading system. Not content to suggest that sloppy people might have sloppy handwriting and artistic people may write with a certain originality or flair (which is not always the case, anyway), these consultants claim to detect hidden dishonesty, sexual perversion, drug addiction, philandering, etc., all from looking at a person's style of writing.[7] With no more scientific credibility than

[7] Like the concoctions of animal-parts discussed above, graphology is founded on a belief in sympathetic magic (i.e., "like begets like"). So, for instance, according to handwriting analysts, someone who doesn't close the loops on his letters can't close his mouth either, and is judged, therefore, to be a gossip. Likewise, someone who has variable slopes on her letters is assumed to be subject to "changing inclinations." The scientific evidence that this primitive character reading system actually works in overwhelmingly negative. For evidence of graphology's impotence and harmfulness, see *The Write Stuff*, edited by Barry and Dale Beyerstein, listed in the bibliography.

palm readers, they offer their services in areas where people's reputations, professional advancement, and livelihoods can be affected. One handwriting analysis firm actually has the audacity to offer courses for therapists on how to reveal repressed memories of childhood sexual abuse from nuances in the writing of the supposed victims. To cast aspersions on the competence or ethical standing of unsuspecting people (many people slandered in this fashion never even know their writing was shown to a graphologist) by means of this kind of pseudoscience is really no different from passing judgement on someone's diligence, honesty, or suitability for a job by reference to his or her skin colour or presumed percentage of "Jewish genes."

Subliminal self-help tapes. These days, we are constantly assailed by flamboyant sales pitches from promoters of the subliminal self-help industry. They are hoping to sell audiotapes that contain therapeutic suggestions too faint to be heard amidst the background of music, forest sounds, etc. Although the self-help messages are not audible, they allegedly go directly to the subconscious where they have an irresistible effect. According to the ads, such messages can produce everything from relaxation, a super memory, and enhanced social competence to cancer remission and breast enlargement. My personal favorite is a subliminal tape that offers to cure deafness! Of course, these products have been carefully tested and found to be worthless. Although respected psychologists such as Begg, Greenwald, Merikle, Moore, and Pratkanis have independently confirmed the inability of these products to deliver the promised benefits, the reader should no longer be surprised to hear that the subliminal self-help industry continues to thrive. The British Psychological Association has taken a strong stand against subliminal pseudoscience, but despite concerted efforts by Professor Timothy Moore of Toronto, the Canadian and American Psychological Associations have declined to do the same. It is perhaps significant that many dues-paying members of these associations continue to profit from the sale of these scientifically debunked self-help products.

Pop-Psychology. The human potential movement and the fringe areas of psychotherapy also harbor a number of other scientifically questionable panaceas. Among these are Scientology, Neurolinguistic Programming, Re-birthing, and Primal Scream Therapy which have never provided a scientifically acceptable rationale or evidence to support their therapeutic claims (see the accompanying bibliography for further readings on these topics).

These days, many pop-psychology products seek sorely needed credibility by claiming unearned affiliation with legitimate areas of brain research. Thus a spate of "brain-tuners" have hit the market, offering all manner of benefits by supposedly re-training brain waves. Again, evidence is lacking (see Barry Beyerstein, "Brainscams: Neuromythologies of the New Age," *International Journal of Mental Health*, Vol. 19(3), 1990). The health food industry and New Age marketers have cashed in on equally dubious "smart cocktails" that allegedly improve brain functioning by pre-loading the body with the amino acids used by the brain to manufacture various neurotransmitters. It should come as no surprise that the sales programs preceded the validation research which, as usual, disputes the claims.

Another current fad among gullible counselors is "eye-movement desensitization" therapy which claims that serious mental symptoms can be cured simply by asking clients to

track the therapist's fingers as they waggle in the periphery of the client's visual field. Like the brain tuners, this too is alleged to break up dysfunctional patterns of neural activity, scoring miraculous recoveries where conventional therapies have failed. Testimonials rather than hard data from placebo-controlled studies keep all such pop-psychology enterprises afloat.

False memory creation. A more pernicious example where parts of the therapeutic community have refused to heed the cautions of scientific researchers is the use of so-called "memory-enhancement" techniques. In their zeal to combat the real and all too prevalent problem of childhood sexual abuse, many therapists have espoused risky methods that supposedly revive in the adult long-repressed memories of childhood abuse. In fact, memory researchers have shown that these probing techniques are just as likely to create vividly believable pseudomemories of abuse as they are to trigger accurate recollections of real trauma (see E. Loftus and K. Ketcham: *The Myth of Repressed Memory: False Memories and Allegations of Sexual Abuse*, St. Martin's Press, 1994). In addition to producing many tragically false allegations, it is sad that the growing public realization that *some* of the "memories" these patients fervently believe to be true are actually illusory has begun to engender a backlash which could potentially hamper the efforts of some bona fide victims to achieve the justice and the therapeutic relief they deserve.

The same risky methods of memory probing in distressed and suggestible people are also popular among therapists who encourage their patients' delusional beliefs that they were abducted by the crews of UFOs for nefarious purposes. In these cases, similar "memory enhancement" techniques elicit highly emotional "recollections" of supposed kidnappings, and sexual or other types of maltreatment at the hands of space aliens. Having talked to many "abductees," I am convinced that most are sincere in their convictions. That they can honestly feel they are recalling (as opposed to fantasizing) events that most people consider utterly improbable, strengthens the case of those researchers who argue that compelling pseudomemories of many kinds can be created without anyone's intent to do so.

Parapsychology. Some critics dismiss psychical research, or parapsychology as it is now known, as unalloyed pseudoscience. Despite the long history of self-delusion, non-replicable findings, and fraud that has plagued the field, it must be conceded that there is, today, a core of honest and competent researchers who employ the conventional methods of psychological research in their quest for paranormal phenomena. As long as these investigators apply the appropriate experimental controls and statistical procedures, and allow critics to scrutinize their labs and their findings, they do not deserve to be associated with the psychic charlatans that titillate the tabloid journalists. Nonetheless, the vast majority of psychologists still believe that the tiny deviations from chance expectancy that parapsychologists find in their experiments are due to subtle, undetected artifacts, rather than truly supernatural phenomena. Until psychical researchers can meet the skeptics' demands for a routinely replicable effect, one that doubters as well as believers can obtain, the field will continue to be regarded with suspicion by most mainstream scientists. In the meanwhile, parapsychologists who attempt to live up to the accepted rules of scientific research should not be branded as pseudoscientists. That should be reserved for those in their ranks who are demonstrably guilty of the kinds of misconduct outlined below. The bibliography at the end of this treatise contains extensive commentaries on the

longstanding debate between the parapsychologists and their critics.

The foregoing discussion has provided a sample of the variety of pseudoscientific claims and practices that are currently fashionable. For a more accurate picture of the extent to which such beliefs permeate modern technological societies, Box 2 provides a representative, but far from complete, list of phenomena considered doubtful, if not outright fanciful, by scientists in relevant fields of study. Although we cannot begin to deal with them all in a short overview such as this, readers are encouraged to select others of their favorites for more detailed examination via the reading list provided. Note that within the various sections in Box 2, the entries run the gamut from merely unproven at this time to extensively tested and debunked at the other extreme. Note also that, in certain instances, the phenomenon or experience may be valid in itself, but the most widely accepted explanation is occult or pseudoscientific nonsense. In such cases, the public often assumes the phenomenon is supernaturally caused because it is unaware that there are scientifically credible, non-occult explanations available to anyone willing to pick up a library card and do a bit of homework. Near-death experiences and out-of-body experiences are two examples where scientists accept the honesty and accuracy of people's subjective reports but reject the notion that there is anything supernatural about such experiences. Similarly, firewalking, which is widely beleived to require supernatural intervention to avoid serious injury, can be explained by well-known principles of physics. The reading list at the end of this document will aid those who wish to examine the evidence presented by skeptical investigators of these and other occult or pseudoscientific claims.

BOX 2. KINDS OF CLAIMS CONSIDERED DOUBTFUL BY THE MAJORITY OF THE SCIENTIFIC COMMUNITY:
Extra-Sensory Perception:
telepathy, clairvoyance, precognition, retrocognition (seeing the past), psychokinesis ("mind over matter"), fetal memories, angel sightings
Alleged Evidence of Survival After Death:[8]
Spiritualism, mediums, past-life regression, ghosts, poltergeists, spirit (or demonic) possession, near-death experiences, out-of-body experiences., Ouija boards, past-life memories, exorcism
Alleged Extraterrestrial Influences on Human Behaviour:[9]

[8] With regard to so-called "near-death experiences," the descriptions of the *experience* are not at issue—it is the *interpretation* that creates differences of opinion. Most researchers, the present author included, accept that these experiences seem compellingly real. However, scientific investigators recognize them as complex hallucinations that are not unique to the interval preceding death.

[9] The proposition that there might be life elsewhere in the universe is clearly not pseudoscientific, although there is at present no credible evidence to support this conjecture. Reputable scientists arrive at different estimates of the probability of extraterrestrial intelligence and await possible confirmations with interest. This is quite different from the claims of "UFOlogists" that we are regularly contacted, visited and even abducted and impregnated by these denizens of foreign worlds. The UFO community is also well-supplied with people with

UFO's, Alien Abductions, Astrology, Lunar effects on human behaviour, Ancient Astronauts (e.g., Eric von Daniken), crop circles ("Cereology"), Cattle mutilations by extraterrestrials
Divination and Fortune Telling:
"Psychic Readings": mediums, Tarot cards, I Ching, palmistry, numerology, tea leaves, crystal ball "skrying," astrology, graphology, entrail reading, dream prophesy, Nostradamus, Jeane Dixon *et al.*
Box 2. Cont'd. **"Spell Casting" / Supernatural Powers**
Witchcraft, Satanism, Sorcery, Voodoo, "The Evil Eye", Carlos Castaneda's Don Juan
Monsters:
Sasquatch (Bigfoot), Yeti (Abominable Snowman), Loch Ness Monster, Ogopogo, "Caddy" (Cadborosaurus) .
Physical Anomalies:
Bermuda Triangle, Great Lakes Triangle, The Devil's Sea (Japan), Corrupt versions of Quantum Mechanics, Pyramid Power, Kirilian Photography, Psychokinesis, Teleportation, Moon Effects on behaviour, Velikovsky's Cosmological Theories, Spontaneous Human Combustion, perpetual motion machines
Unproven Medical Procedures and Psychic Healing:
Faith healers, Psychic Surgeons, Bogus cancer drugs (e.g., Laetrile), Bogus arthritis cures (e.g., copper bracelets), The Bates Method ("sight-without-glasses" exercises), High Colonics, Naturopathy, Homeopathy, Crystal healing, Therapeutic Touch, Reflexology, Iridology, Qi Gong, many, though not all, "herbal cures" (Matol® and Blue Green Algae are among the many highly doubtful ones that are currently popular), Bee venom therapy, Environmental sensitivity syndrome, Fad diets including many so-called "food supplements" and "health foods"
Unproven Psychological Theories and Treatments:
Scientology, EST, Re-birthing, Neurolinguistic Programming, Past Life Therapy, Aroma Therapy, pop-biorhythm calculators, Astrology, Handwriting Analysis (Graphology), Primal Scream Therapy, Jungian Archetypes, Rolfing, Reichian Orgone therapy, Plant Consciousness, Untested New Age self-improvement schemes, sleep learning, Transcendental Meditation (most claims other than simple relaxation), subliminal perception (for self-help therapy and learning)

scientific training who are willing to bend it in service of their unshakable beliefs.

"Applied" Psychic Powers:	
	Psychic detectives, psychic archaeologists, exorcists, psychic dentists, psychic historians, psychic military battalions, psychic meteorologists, dowsers and diviners, psychic mineral deposit detectors

WHAT DO THESE QUESTIONABLE PHENOMENA HAVE IN COMMON?

The items in Box 2 exemplify various characteristics of a broader worldview that is prevalent among proponents of such beliefs. Perhaps most importantly, these people tend to share a particular attitude concerning the role of evidence—not only what would constitute reasonable evidence for particular beliefs, but more fundamentally, whether objective evidence is even necessary to substantiate one's beliefs. Those who are enamoured of the contents of Box 2 are also liable to conduct themselves in recognizable ways in their work and in debate. It is to these attributes that we now turn. In the following sections, I am greatly indebted to Professor Mario Bunge of McGill University. An eminent physicist and philosopher of science, Professor Bunge has done more than any other scholar to elucidate the boundaries between science and pseudoscience.

In a 1981 *Skeptical Inquirer* article, Bunge argued that, more than their subject matter *per se,* it is where fields stand on the issue of evidence that distinguishes scientific pursuits from pseudosciences. Thus, rather than dividing cognitive domains into sciences versus non-sciences, Bunge proposed dividing them into what he called "belief fields" and "research fields." In the belief fields he included religions, political ideologies, pseudosciences and pseudotechnologies, as well as any mystical system that believes that enlightenment can be gained through revealed truth rather than painstaking examination. Research fields, on the other hand, can include disciplines not typically thought of as scientific, as long as their practitioners are committed to gathering objective data to support their positions. Using this criterion, much work in the humanities would qualify, for inclusion in the research fields, for instance. Of course, the basic sciences, the formal sciences (mathematics, logic, semantics, etc.), the social and behavioural sciences, and the applied sciences are obviously research fields by this definition.

The primary attribute of belief fields is that, for their devotees, evidence is personal and subjective. I.e., they advocate using emotional criteria to distinguish truth from falsehood. Belief fields hold private feelings and hunches to be reasonable grounds for certainty—or, as New Age writers put it, "You create your own reality." It is popular, in such company, to deny the existence of a common external reality and to denigrate even the possibility of engaging in dispassionate, objective study of anything. For the myriad of deconstructionists and post-modernists who travel these paths, there are supposedly no non-personal standards of verification. Thus any individual's "gut feelings" about reality are as valid as anyone else's and science has no special claim to believability. "Truth" for such extreme relativists is merely a reflection of the power relationships extant in society at any given moment. Such a perspective inevitably invites one to ask how it would ever be possible for an adherent of this position to conclude that any of Hitler's deeds was morally wrong. After all, he may have only been a forerunner of the Age of Aquarius, simply "following his bliss."[10]

[10] The extent of such rampant subjectivisim and obscurantism was recently revealed in a humourous but telling hoax perpetrated by the physicist, Alan Sokal. Wondering how far the post-modernists would go, he submitted a deliberately nonsensical article to their premier journal, *Social Text.* It purported to link principles of quantum mechanics with favorite shibboleths of deconstructionist thought, such as the idea that science is merely another conventional belief system established by powerful elites and which has no special claim to describe the

physical universe accurately (Sokal even went so far as to question the objective existence of the physical universe!). Not only did major post-modernist thinkers not recognize that Sokal was putting them on, but they dug themselves in deeper with their attempts to exonerate themselves after Sokal debunked himself.

By contrast, evidence in research fields is *interpersonal*. That is, it can be compared by disputants, according to open and objective criteria. It is sometimes said that objectivity is merely inter-subjectivity. I.e., an "objective" consensus is reached by comparing various individuals' perceptions with each other and against agreed-upon external standards. In research fields, hypotheses are accepted or rejected on the basis of evidence that any competent observer can double-check by repeating the same publicly-stated procedures that were followed to generate it in the first place. Posited effects must be repeatable under controlled conditions if they are to be believed. In this arena, any hypothesis is acceptable, *as long as it is testable and there is evidence to back it up.* Current orthodoxies are open to question and revision, if there are new and better data to support the amendments.

Those who vilify science are fond of pointing to embarrassments where, admittedly, the "old guard" clung to outmoded theories longer than they should have, given the new evidence that was then available. Of course, these detractors aren't as eager to mention the many other instances where whole fields came around remarkably quickly when presented with revolutionary new findings—take physicists' acceptance of quantum mechanics, for example (or the rapid revision of medical thinking on ulcers described in Footnote , above). It is well to remember that we have been discussing the *ideals* of scientific behaviour, those that distinguish it from most other realms of human discourse. These rules of conduct are not always lived up to in every case because science is practiced by human beings who are prone to the same foibles, blindspots, and inflated egos as anyone else. Jumping to congenial conclusions and overlooking uncomfortable facts are common traits of *Homo sapiens,* scientists included. Scientists simply differ in that their commitment to open scrutiny of methods and findings can reduce the impact of the shortcomings they share with the rest of humanity. Just as not all doctors, lawyers, teachers, or journalists live up to the highest ideals of their professions all of the time, scientists are also susceptible to the same blunders to which non-scientists fall prey from time to time. Occasional hubris notwithstanding, it is just that scientists are more likely than toilers in most other areas to acknowledge these human frailties and to institute checks and balances to minimize, however imperfectly, their effects. The norms of scientific behaviour, including the peer-review system, double-blind controls, etc., evolved to prevent, as much as is humanly possible, being led astray by the self-serving ways in which our minds and social systems are prone to work.

That said, it should also be emphasized that when the prevailing scientific opinion turns out to have been wrong, this is much more likely to have been the result of honest mistakes in interpretation, or limitations of the current apparatus or methods, rather than venality or fraud. Often it is the case that newer work reveals that data which seemed to be pointing unequivocally to a certain conclusion were actually due instead to some subtle, undetected artifact. This can be an important discovery in itself, and whole new fields are sometimes opened by such events. To some workers' disappointment, but to no one's discredit, these false starts are revised in the future curricula. This is what is meant by the statement that science is ultimately self-correcting. More than any other calling, science reserves its highest honours for those who prove their predecessors wrong. Warts and all, science comes nearer to the democratic ideal of an open marketplace of ideas than any other realm of social activity. Is it perfect? No, it is run by human

beings.

THE NORMS AND CHARACTERISTICS OF PSEUDOSCIENCE.

To be called pseudoscientific, a field or one of its practitioners need not be guilty of all of the "sins" of omission or commission described below, only a reasonable number of them. Just how many blots we can tolerate in someone's copybook before deeming it fair to saddle him or her with this unflattering label can become a point of contention when individual cases are discussed. Each valid ascription of one of the incriminating traits described below adds weight to the suspicion that the field or individual is practicing bogus science. There is no automatic cut-off, however—some suspects must remain suspicious but not convicted. It is also true that some fields begin as pseudosciences but gradually gain respectability by improving their standards and procedures. E.g., alchemy evolved into modern chemistry and osteopathy slowly upgraded itself until it was assimilated into scientific medicine.

As shown in some of the examples discussed earlier, legitimate fields, or certain individuals who work in them, may occasionally fail on some of the criteria presented here. But, although it is fair to expose these lapses, as long as they represent aberrations in otherwise rigorous disciplines or careers, it would be overly harsh to assume everything associated with the person or area is equally tainted. As long as the field is institutionally dedicated to empirical verification of its procedures, aware of the possibility of unscientific pitfalls, and advocates rectifying lapses of this kind by better training of personnel, improving research methods, etc., it remains apart from the pseudosciences where such transgressions are the norm. In the following "pseudoscience checklist," I have once again built upon the seminal work of Professor Mario Bunge.

PSEUDOSCIENCES—CHARACTERISTICS OF THE FIELDS:

Isolation. A major strength of science is that its various branches are interrelated and mutually supportive. If all the different sub-disciplines do not actively cross-fertilize one another on a day-to-day basis, at least they are not mutually contradictory. Not so with pseudosciences. Pseudosciences are typically isolated from mainstream research organizations and from workers in relevant academic fields. Their proponents do not value or promote close links with data and theory from other applicable areas of inquiry. Because of this lack of dialogue, pseudosciences tend to sport a great number of idiosyncratic terms and definitions. Neologisms and non-standard techniques and equipment abound (take Scientology's "E-meter," for example). Pseudoscientists rarely participate in the learned societies devoted to subject matters of mutual interest. In fact, many of them are openly antagonistic to the history of previous research in areas that impinge upon their own. Rather than standing on the shoulders of giants as Newton claimed to have done, many pseudoscientists prefer to stand in their faces.

As a result of their insularity, when pseudoscientists debate their critics, they seem surprisingly ignorant of basic concepts in academic fields that ought to inform their work. They rarely make appropriate use of well-established knowledge from legitimate scientific disciplines, but when they do appeal to these data or techniques, they are often inappropriately selective and/or out of date.

Rarely do pseudoscientists submit their findings and theoretical work to the appropriate refereed academic journals. Instead, their work is likely to appear in the popular press or in proprietary journals belonging to their own organizations. It is also frequently found in self-published tracts or monographs or in the "vanity press" which accepts virtually all submissions and charges the authors for publication. Another sign of a pseudoscience is that the "textbooks" used by professionals in the field and the popular books on the topic, written for public consumption, are often one and the same. Graphology is a field where this is particularly prevalent.

Some pseudosciences merely contradict strongly supported data in some area of conventional science. Their assertions are not entailed by established theories and observations or by logic. Others run afoul of more fundamental principles that underlie the basic scientific worldview. Many pseudosciences require assumptions that defy common sense and everyday experience. I.e., they are contrary to one or more of what the philosopher C.D. Broad called the "Basic Limiting Principles" (BLPs—see Box 3, below).

BOX 3. C. D. BROAD'S "BASIC LIMITING PRINCIPLES":

C. D. Broad was a Cambridge philosopher who was inclined to believe in the reality of psychic phenomena which, if true, would, by definition, defy not only generalizations from our everyday experience, but also many well-established laws of science (for relevant examples, see Box 1, above). Broad was greatly impressed by the parapsychology experiments published in the 1940's the by the British mathematician, S. G. Soal. Soal's experiments purportedly demonstrated psychic abilities under controlled laboratory conditions. Initially a skeptic, Soal went on to publish what, in his day, was taken to be the best evidence for extrasensory perception (ESP). Broad considered Soal's results incontrovertible because he found it inconceivable that someone with Soal's academic standing and reputation for integrity could be duped, mistaken, or dishonest. Unfortunately, as the statistician Betty Markwick later showed, Soal had tampered with his data to produce his spurious evidence for clairvoyance.

Broad, of course, was unaware of Soal's perfidy, and in his defence of psychic powers, he produced one of the most useful summaries of the principles that are generally accepted to govern interactions in the physical world-i.e., the ones that must be breached if psychic powers are indeed real. Ironically, Broad enumerated these "Basic Limiting Principles" (BLPs) in order to state clearly what he thought it was that researchers such as Soal were showing (with their well-confirmed demonstrations of psychic phenomena) to be violable after all. Although the data Broad relied upon are no longer believed, skeptics still find his statement of principles useful, precisely because they, unlike Broad, believe these principles *have* stood the test of time. Like Thomas Paine, skeptics continue to ask, "Is it more

probable that nature should go out of her course or that a man should tell a lie?"

Today's doubters would add to Paine's classic admonition their belief that the probability of human error is also much higher than the likelihood that any of Broad's Basic Limiting Principles is subject to repeal. Subtle mistakes and unintentional cognitive distortions undoubtedly account for a far greater proportion of apparently supernatural occurrences, as well as more pseudoscientific pronouncements, than deliberate deception.

Broad's BLPs are considered the fundamentals of reasoned thought, antecedent to any "named" laws of science such as Newton's Laws, Boyle's Law, etc. Rather than laws of nature, Broad saw them, like the principles of logical reasoning, as rules tacitly accepted by almost everybody in modern technological societies. I.e., they are almost universally agreed to describe how nature works, at least as far as everyday events are concerned. Insofar as these BLPs would be considered "basic common sense" by most people in our culture, including the scientifically untutored, the sociologist Marcello Truzzi once referred to them as our society's "cultural storehouse of 'truths.'" Because they are overwhelmingly confirmed by experiment as well as mundane experience, any alleged violation of these BLPs would necessarily rank as an extraordinary claim, calling for very strong reasons if one were to conclude that the apparent violation was not due to some sort of error or fluke occurrence. The following section paraphrases and summarizes Broad's original list which appeared in his 1953 book, *Religion, philosophy and psychical research* (NY: Harcourt Brace).

Broad's Basic Limiting Principles.

1. An event should not have any effects before it has happened ("time's arrow" or the injunction against reverse causality).

2. It is impossible that an event which ends at a certain date should contribute to cause an event that begins at a later date unless the period between the two dates is occupied in the following way: the earlier event must initiate a process or structural change (mechanism) that continues throughout the interim and contributes to initiation of the later event.

3. It is impossible that an event at a certain time and place should produce an effect at a remote place unless a finite period elapses between the two events and unless that period is occupied by a causal chain of events occurring successively and continuously between the two times and two places.

4. It is impossible for a mental event to produce directly any change in the material world except certain changes in the individual's own brain; i.e., without the mediation of muscular effort.

5. Dependence of mind on brain—i.e., a necessary condition for any mental event is an intact, functioning brain.

6. It is impossible for a person to perceive a physical event or object except by means of sensations that event or thing produces in his/her mind. There must be a physical, causal chain of events linking the event/object to the sense organs, sensory pathway, brain receiving area

7. It is impossible for person A to know what experiences person B is having or has had except by: a) hearing or reading B's descriptions; b) hearing or seeing, and interpreting, B's cries, gestures, expressions, etc.; or c) drawing inferences from material evidence left by B.

8. It is impossible for a person to forecast, except by chance, extrapolation from past regularities, or the like, or from such information supplied by others.

9. It is impossible for a person to know of past events unless he or she: a) experienced it during the present lifetime in the present body and this has left a persistent physical trace (i.e., memory) in his/her brain; b) was told about the event or read an account by someone who experienced it; or c) draws inferences or accepts inferences of trusted sources, based on personal experience, records, and prior knowledge of regularities of nature.

As we have seen, many pseudosciences are based on dogmas that would violate one or more of the foregoing principles. The same is true of most alleged psychic, occult, or paranormal events. Given the overwhelming evidence from personal experience and experimentation favouring these principles, it is reasonable to demand that assertions that they have been violated be backed up with unusually strong evidence before dismissing the alternative explanation that the apparent violation was due to fraud or error.

Non-falsifiability. As the philosopher Karl Popper pointed out, any explanation for which there is no set of data that could possibly refute it is really no explanation at all. A growing accumulation of instances supporting a theoretical explanation can only strengthen our subjective probability that the theory is correct, but a single disconfirming instance is sufficient to topple the entire enterprise. In his examination of a variety of pseudoscientific theories, Mario Bunge has shown that most are irrefutable in this sense. Many of them are non-falsifiable, in principle, because they are not stated in a testable way, or they are so vague that there is no evidence which could not be accommodated by *ad hoc* tinkering with the theory's postulates. For instance, Freudian psychology posits that all males suffer from an Oedipus Complex. When no evidence of such malice toward one's father can be found, the theory explains this by asserting that the young man must have repressed this urge because it is consciously unacceptable. How do we know repression is at work? Because there's no evidence of an Oedipus Complex . . . . Thus, lack of evidence counts as support for the theory. This kind of inability to be proven wrong is, by itself, sufficient grounds to declare a theory unscientific.

In addition to being non-falsifiable, most pseudosciences purport to be all-encompassing. Something that claims to explain everything usually explains nothing.

Misuse of Data. Pseudoscientists frequently distort or misuse reliable scientific data (e.g., phrenologists carried the quite defensible notion of cerebral localization of function to absurd lengths, and "scientific creationists" are fond of mangling the second law of thermodynamics for their own polemical purposes). In this way, pseudoscientists are often able to piggy-back nonsense upon reliable knowledge. It is common among advocates of bogus science to start with a position that oppon-ents will readily concede. They then proceed, almost imperceptibly, to add increasingly contentious and unsupported arguments until the shred of truth with which they began can no longer support the edifice that has been constructed upon it.

Sciences are cumulative and self-correcting, pseudosciences aren't. Pseudo-sciences are stagnant; they show little evidence of progress. Their core concepts, methods, and explanations

rarely, if ever, change because of new empirical findings or the application of new technological or theoretical advances. As a group, pseudosciences exhibit little of the intellectual excitement, controversy, or ferment that characterize legitimate research fields. Instead of breaking new ground, pseudosciences tend to rely on the exegesis of "sacred texts" which devotees soon learn not to question or modify. Likewise, oldness is venerated for its own sake, the assumption being that if it has survived so long, the field must be sound. E.g., astrologers proudly assert that astrology has been around for thousands of years. They rarely stop to think that racism and sexism, not to mention belief in a flat earth and a geocentric universe, are even older.

Special pleading. Wanting to be both new and old at the same time, pseudoscientists often venerate their long heritage and still plead for special treatment because they are engaged in new explorations that should entitle them to more time in which to "iron out the bugs." They want both the prestige of an established field and release from the strict rules of evidence by which the older, legitimate fields must abide. Just as there is very little that is new in the New Age, most pseudosciences have been around long enough to have outlived the period of grace that should be granted to proto-sciences in their formative, "pre-paradigmatic" stages. In other words, as Mario Bunge has repeatedly argued, it's time for them to "put up or shut up."

Pseudosciences invariably purvey uplifting, congenial beliefs. A few examples that demonstrate the comforting nature of the fields we have been discussing are contained in Box 4. Doubtful as they are, even the worst curmudgeon would have to admit that it would be nice if many of these assertions were true.

BOX 4. PSEUDOSCIENCES' COMFORTING BELIEFS:

a) Healing can be effected painlessly, instantaneously, and without effort. (E.g., faith healers, therapeutic touch, Xi Gong, fad diets, quack cancer cures, homeopathy, crystal healing....)

b) Talent, knowledge, and wisdom can be acquired instantaneously in secret ways that require little or no sacrifice or effort. (E.g., "brain tuners," "smart drugs," subliminal tapes, most self-help seminars....)

c) Nostalgia for the absolute. The old, comforting verities of the past can be *scientifically* supported; they need not merely be accepted as articles of faith. (E.g., "Creation Science," purportedly scientific evidence for an afterlife....)

d) We can have perfect prediction of the future allowing us to enhance the safety and economic well-being of ourselves and our loved ones. (E.g., pop-biorhythms, graphology, astrology, precognitive dreams....)

e) There are foolproof ways of telling what people are *really* like and predicting what they will do. (E.g., graphology, astrology, and pop-psychology's other pseudoscientific character reading and aptitude tests)

f) There are no limitations on human ability and achievement (E.g., pop-psychology's self-improvement seminars, such as Neurolinguistic Programming, EST, etc.; subliminal self-help tapes, ...)

g) The energy crisis can be banished forever. (paraphysics, perpetual motion machines, gasoline stretchers, pyramid power, cold fusion....)

h) Even though we have despoiled our planet and seem to be perpetually disposed to engage in war, there are other worlds or dimensions that have solved these problems and are willing to take us under their wing. (E.g., channelers, UFOlogists....)

i) Death hath no sting. Our personalities will live on. (E.g., Near-death studies, channelling, spiritualism....)

To summarize, pseudosciences invite us to buy into the desirable but unobtainable dream of abundance, health, and happiness for all. They add to their appeal when they assert that all this can be had in return for minimal effort or sacrifice. Enticing as this scenario obviously is, it is still fitting to be reminded once again of the old adage, *Caveat emptor*. It was this human will to believe that the philosopher Demosthenes had in mind over 2000 years ago when he said, "Nothing is easier than self-deceit. For what each man wishes, that he also believes to be true."

THE PRACTITIONERS:

Some tell-tale attributes of the typical pseudoscientist have already emerged in the preceding discussions of their products. There are other signs to watch for as well, and, just as was the case with the traits that demarcate pseudoscientific disciplines, not all of the defining characteristics will be found in every one of their adherents. Some of these worrisome features, in tolerable amounts, could well be present in some legitimate scientists. It is only when a boastful pretender exhibits too many of them, and to an excessive degree, that it is fair to assume we are dealing with a pseudoscientist.

Impenetrability. One common indicator of a pseudoscientist is an unshakable commitment to some questionable finding or hypothesis. Following the writer Eric Hoffer, this is sometimes known as the "true believer" syndrome. A certain amount of this singlemindedness and imperviousness to criticism is probably necessary in order to keep most researchers going in the face of the long hours and tedium that most scientific work entails. A thick skin, a strong sense of self-worth, and not a little willingness to engage in self-promotion are attributes found in the careers of many successful scientists. It is only when extremes of these tendencies lead researchers to champion outrageous causes or to be impervious to evident signs of futility that it becomes problematic. When the disputed work is a direct extension of the researcher's ideology or core belief system, biases are especially likely to interfere with objectivity. Pseudosciences are often an outgrowth of the practitioner's core convictions and in such cases there is practically no evidence or argument that could possibly change the true believer's mind.

Magical thinking. Pseudoscientists as a group are also attracted to magical thinking, i.e., the expectation that imagination and will power, by themselves, will make desirable things come to pass. Their cosmologies tend to be animistic, human centered, and permeated by immaterial causes and influences. They also have a fondness for explanations involving etherial "vibrations," "planes," "fields," "sympathies," etc., that cannot be tied to empirical (i.e., *measurable*) referents. Truth for people of this persuasion is determined by what one *feels* about a matter, not what evidence can be adduced in its favour. This, as mentioned earlier, is often found alongside a desire to re-insert a moral dimension into the prevailing mechanistic view of the natural universe (which they find too cold and restrictive for their liking). These seekers want a cosmos in which the universal forces, whatever they may be, recognize and justly reward the moral worth of individuals. They want human beings to be special rather than mere pawns of an impersonal, naturalistic universe. Instead of accepting that we are a product of natural forces and subject to the same universal laws as inanimate objects, they prefer to believe that people can override this tyranny by good deeds and thoughts. In this, they are at variance with the scientific view that human beings evolved from the same constituents and processes as the rest of the cosmos—which, unfortunately, affords them no unique status or protection.

The essence of the aforementioned belief system was described by the philosopher Charles Frankel in a 1973 essay entitled "The Nature and Sources of Irrationalism," which appeared in the journal *Science.* According to Frankel, for the mystically-inclined,

> [t]he universe man inhabits is divided into two realms—one of appearance, the other of reality. The former is marked by accident, doubt, uncertainty, coldness, and alienation. In the second, doubt is dispelled, time and death have no sting. One is embraced by a world congruent with one's deepest desires, and discord and trouble are dissolved in an encompassing sense of harmony and coherence.

This worldview is founded on the belief that insight, intuition, and direct, subjective revelation are the sources of infallible knowledge. In conflicts between "instinct" (intuition, "gut feelings") and reason, instinct is the more reliable guide to the truth. ("If it feels good, do it.") For adherents to this view, enlightenment (wisdom) is sudden and complete and the preparation necessary in order to receive it is moral, not intellectual. Accordingly, not only is intellectual effort not the surest way to proceed, it may actually impede enlightenment. Of course, this is opposed to the empiricist (scientific) view which holds that observation, discourse, analysis, argumentation, and testing are the soundest sources of knowledge (i.e., that learning is slow, effortful, and requires attention—in other words, it is cumulative and achieved by trial-and-error). Empiricists assume that false starts and errors will occur and these are to be corrected by more hard work.

Ulterior motives. Proponents of pseudoscience often have a financial stake in the claims they promote. This further tends to compromise their objectivity. It is true that, these days, conventional scientists are increasingly apt to have commercial interests in their work as well. If so,

their pronouncements should be equally scrutinized for intentional or inadvertent biases, but it should also be noted that in legitimate fields there are at least some built-in safeguards in this regard. The oversight policies of the scientific granting agencies, research institutions, and journals make disclosure of orthodox researchers' conflicts of interest more likely. Most pseudoscientists, on the other hand, work outside this system and thus are under no obligation to reveal any entanglements of this sort.

Lack of formal training. If practitioners of pseudoscience are not self-taught, they often have credentials that are irrelevant to the areas in which they offer their questionable pronouncements. Exemplary qualifications in one area do not necessarily translate into equal competence in unrelated fields. A case in point is that of William Shockley who received a Nobel Prize for being the co-inventor of the transistor and later went on to pontificate on the genetic basis of racial differences in intelligence.

Observers of pseudoscience frequently encounter self-professed "outsiders" who flaunt their lack of formal education, claiming that it allows them to bring a fresh, unbiased outlook to their work. Ignorance of previous accomplishments in the field supposedly permits them to see truths that were missed by those who were brainwashed by the standard modes of training. It is true that breakthroughs have sometimes been made by outsiders who brought with them novel approaches, but these days most areas of science are so complex, conceptually and technically, that the likelihood of someone who has not served something like the normal apprenticeship making a revolutionary contribution is quite small. The insights of science are not readily available to those on the run. As Pasteur wisely observed, "Nature favors the prepared mind."

The "bunker mentality." In addition to being proud of their insularity, which they take as a sign of rugged independence, pseudoscientists are also prone to see their lack of recognition as the result of persecution or suppression by a hostile "Establishment." As a result, another frequent sign of a pseudoscientist is the willingness to engage in wild conspiracy theories. How else to explain the lack of acceptance of someone given to considering himself the new Galileo, Einstein, or Pasteur? Not only are pseudoscientists fond of making grandiose claims, but they also frequently show an excessive reluctance to admit ignorance. A humorous but telling checklist for spotting such operators was recently uploaded to the Internet by John Baez (see Box 5).

BOX 5. THE CRACKPOT INDEX.

By John Baez:

A simple method for rating potentially revolutionary contributions to physics.

1) A 5-point starting credit.
2) 1 point for every statement that is widely agreed to be false.
3) 2 points for every statement that is clearly vacuous.

4) 3 points for every statement that is logically inconsistent.
5) 5 points for each such statement that is adhered to despite careful correction.
6) 5 points for using a thought experiment that contradicts the results of a widely accepted real experiment.
7) 5 points for each word in all capital letters (except for those with defective keyboards).

8) 10 points for each claim that quantum mechanics is fundamentally misguided (without good evidence).
9) 10 points for each favourable comparison of oneself to Einstein, or claim that special or general relativity are fundamentally misguided (without good evidence).

10) 10 points for pointing out that one has gone to school, as if this were evidence of sanity.
11) 20 points for suggesting that you deserve a Nobel prize.
12) 20 points for each favourable comparison of oneself to Newton or claim that classical mechanics is fundamentally misguided (without evidence).

13) 20 points for every use of science fiction works or myths as if they were fact.
14) 20 points for defending yourself by bringing up (real or imagined) ridicule accorded to one's past theories.
15) 30 points for each favourable comparison of oneself to Galileo, claims that the Inquisition is hard at work on one's case, etc..
16) 30 points for claiming that the "scientific establishment" is engaged in a "conspiracy" to prevent one's work from gaining its well-deserved fame, or suchlike.
17) 40 points for claiming one has a revolutionary theory but giving no concrete testable predictions.

THE CONTENTS OF PSEUDOSCIENCES:

Lack of replicability by the uninitiated. In pseudosciences many effects are postulated that run counter to natural laws or easily replicable data in legitimate fields. Typically, these dubious phenomena are neither producible on demand nor accurately predictable. Not surprisingly, pseudosciences contain many "results" that can not be reproduced by competent critics. This would normally be considered a shortcoming, but it is sometimes elevated instead to the status of a finding in itself, and given a glorified title such as "The Shyness Effect." Parapsychologists are particularly apt to believe that their pet phenomena will disappear when examined by

skeptics under controlled conditions (Would you accept your bank manager's reassurance that your account tallies when she checks it but not when the auditor does?). Pseudoscientists often claim when others can't replicate their results that special talents of the experimenter are necessary to achieve the putative effect. However, when their data gathering methods are observed, they are usually found to have been content with subjective estimates by the experimenter, rather than demanding objective, preferably automated, measurements. This, as we saw in the case of N-rays, is often responsible for spurious findings.

Size of claimed effects is inversely related to stringency of experimental controls. Institution of double-blind procedures, adequate control groups, automated data gathering techniques, and the like, tends to eliminate or greatly reduce the effect sizes claimed by pseudoscientists. Wallace Sampson noted such a relationship in his appraisal of the acupuncture literature, and numerous observers such as James Alcock, C. E. M. Hansel, and Ray Hyman have noted this for decades in their critiques of the field of parapsychology.

Large effects are attributed to causes which are of barely detectable magnitude. Often the magnitude of effects claimed by pseudoscientists is largely unrelated to the magnitude of the putative causal agent. For instance, among those who believe in telepathic communication, it is commonly held that the infinitesmally small amount of energy involved in the neural processes that constitute mental events can be heard around the world. It was this lack of congruence between the magnitude of cause and effect that most bothered Albert Einstein when he explained to the parapsychologist J. B. Rhine his doubts about the reality of psychic phenomena.

Unusually high precision, sensitivity of detection, or accuracy of measurement is claimed. Avowed effects are of a magnitude close to the theoretical or practical limits of detection–i.e., close to the noise level in the system employed in the experiment. The current parapsychological work with random number generators suffers from a need for astronomical numbers of trails to pull out above-chance effects which are very small and perilously close to the noise levels of the apparatus. This does not prove that results such those reported by the Princeton engineer, Robert Jahn are spurious, but it raises the suspicion that they could be due to some kind of artifact. Parenthetically, these studies have also failed to be replicated in experiments conducted in other laboratories (such as that of Professor Stanley Jeffers of York University's Physics Department). In Jeffers' case, the studies were conducted with the original researchers' assistance, and in some cases, funding.

NORMS OF BEHAVIOUR IN PSEUDOSCIENCES:

Observers of fringe science have spent a great deal of time watching pseudoscientists at work. From their observations can be derived some generalizations about habitual methods of operation among pseudoscientists. Mario Bunge, for one, has emphasized that, unlike mainstream scientists, pseudoscientists are rarely interested in discovering natural laws–their observations tend to be a hodge-podge of unconnected, often contradictory, alleged facts. Their work is neither synthetic nor systematic, tending instead to flit from one isolated demonstration to another. As a rule, neither mathematical analyses nor mathematical modelling are prevalent, nor are they particularly valued. Similarly, the importance of logic in deriving hypotheses, integrating data with theory, and weighing conclusions is not stressed. There is frequent appeal to the authority of the unquestionable, and often quite old, tomes that defined the field.

Skepticism from within or without is not welcomed, as evidenced by the fact that little effort is expended in searching for counter-examples, alternative explanations, or data that would refute pet hypotheses. Critiques and disconfirming data are likely to be "explained away" in an *ad hoc* manner. Critics are often subjected to *ad hominem* attacks rather than having the substance of their objections dealt with.

The Nobel Laureate chemist, Irving Langmuir, had a longstanding interest in what he called "pathological science." After examining many cases of self-delusion among researchers of various sorts, he attempted to summarize some of the tell-tale signs of the type. The symptoms of pathological science Langmuir identified are reprinted in Box 6.

Box 6. Irving Langmuir's Symptoms of "Pathological Science".
1. The maximum effect that is observed is produced by a causative agent of barely detectable intensity, and the magnitude of the effect is substantially independent of the intensity of the cause.
2. The effect is of a magnitude that remains close to the limit of detectability or, many measurements are necessary because of the very low statistical significance of the results.
3. There are claims of exceptional accuracy.
4. Fantastic theories contrary to experience are suggested.
5. The ratio of supporters to critics rises up to somewhere near 50 percent and then falls gradually to oblivion.
Irving Langmuir (1953), quoted in V. Stenger, *Physics and Psychics*, (Prometheus Books, 1990, p. 69).

Human Judgmental Errors and Biases. Many of the most egregious errors made by pseudo-scientists stem from the fact that, as a group, they are insufficiently aware of the need for tight experimental controls to help reduce the kinds of errors in data gathering and decision making that frequently intrude when we rely on casual observations and reasoning. Cognitive psychologists have studied the myriad ways in which humans can fool themselves (see, e.g., the books by Gilovich and by Nisbett and Ross in the suggested readings at the end of this essay). These researchers underscore the need for systematic, mechanized, quantitative observations to help compensate for the fallibilities of human decision making. Work in this area suggests that our cognitive abilities evolved under conditions where it was usually more advantageous to arrive at a "quick and dirty" answer that was close enough to the mark than to get the exact answer by means of slower, more precisely logical reasoning processes. Because they are economical of mental effort and lead us tolerably close to the right answer often enough, we all rely frequently on a number of these shortcuts in reckoning that have come to be known as "cognitive heuristics." Useful as they are in the long run, these habits of thought can still lead us to major errors if the right conditions should prevail. In addition to studying errors attributable to the fallibility of inference (the research domain known as "cognitive and heuristic biases"), psychologists have also studied the contributors to incorrect conclusions that stem from the fallibility of perception and the corruptability of memory.

Because of these uncertainties in the ability of human cognition to handle large, complex bodies of information, unaided human judgement simply cannot be trusted to draw the right conclusions when many variables are interacting at once. Much research has shown that failure

to compensate for these cognitive limitations can result in large and systematic errors in the inferences we draw about events in the world around us. That is why we need the scientific approach–it is a way of trying to stack the deck against our human propensity for jumping to expected or congenial conclusions.

Public scrutiny. A prime requisite of science is public availability of methods and data. Pseudoscientists are often evasive when responsible critics ask to examine their apparatus or raw data. An example is that of "therapeutic touch," the modern descendent of the magical healing technique that used to be known as "laying on of hands." When practiced by the kings of old, whose Divine Right supposedly included the power to cure their subjects of illnesses, it was known as "the Royal Touch." This ancient form of faith healing has adopted a pseudoscientific veneer and has become quite popular in some schools of nursing and more than a few otherwise reputable hospitals. As one might expect, the experimental evidence for the practice is pitifully inadequate. However, there is one research paper that is always cited by proponents of therapeutic touch because it, unlike the rest, seems to have incorporated the kinds of controls demanded by conventional biomedical researchers. On the surface, this article—by a parapsychologist named Daniel Wirth—seems to have met the most obvious objections levelled in the past at fringe healt claims, but if so, one wonders why a paper of such potential import would have to be relegated to a New Age journal called *Subtle Energies* (Vol. 1, No. 1), rather than, say, *Science* or *The New England Journal of Medicine.*

In wishing to pursue several doubts suggested by some omissions and vague allusions in Wirth's article, Dale Beyerstein and Béla Scheiber have been stymied in their quest for more information and access to his raw data. These two critics wasted dozens of hours checking telephone directories, contacting professional associations, sending telegrams, and the like, trying to get in touch with Wirth. They left numerous messages with people who know him and, as of the time of writing, he has not responded to several letters mailed to the address he listed in his publication. When Dale Beyerstein contacted Wirth's thesis supervisor in the department where he received his master''s degree in parapsychology, the former advisor was curiously reluctant even to admit whether or not he knew Wirth's present whereabouts. Trying to flush out this reluctant researcher, Beyerstein has posted requests for information to relevant interest groups via the Internet, so far to no avail. Given the extraordinary lengths the critics to which have gone in trying to contact Wirth, and the number of separate routes they have taken to let him know they would like to learn more about what he actually did in his study, one must wonder if he has some reason for not wishing to be queried.

Secrecy and suspicion. Pseudoscientists often come up with gizmos and gadgets for which they make fantastic claims. While they will sometimes conduct demonstrations, these are often carried out in ways that prevent doubters from observing the underlying mechanisms or techniques. The operative principles are frequently guarded suspiciously for fear that the priceless idea will be stolen. Such was the case with Dr. Albert Abrams, one of the most infamous quacks America has ever produced. Abrams amassed millions early in this century by selling a tightly-sealed treatment device he called an "oscilloclast." Purchasers were required to sign a sworn statement that they would never look inside the sealed instrument box. After Abrams' death, one of his devices was cracked open and found to contain a meaningless jumble of wires and non-functional components. In the meantime, in a manner that should give pause to

those who claim that satisfied customers count as proof of therapeutic efficacy, Abrams' peculiar contrivance had accumulated a devoted following, totally convinced that it had dramatic curative powers.

THE NEED FOR SKEPTICISM

The physicist Victor Stenger once said that a phenomenon is not accepted as a scientific fact until its observation becomes almost commonplace. One of the main strengths of science is this institutionalized skepticism—things are not conceded to be true until sufficient evidence has been amassed. Unfortunately, the term "skepticism" has acquired pejorative connotations in the vernacular of the the New Age movement wherein positive-thinking gurus have convinced so many that requests for evidence are unnecessarily restricting. "After all," they say, "anything is possible if you believe hard enough." Despite this widespread misconstrual of its actual meaning, the word "skepticism" merely refers to a method of inquiry. A skeptic is one who demands reasonable evidence and logical justification before granting provisional assent to truth claims. Equally important, a skeptic is also one who will *modify his or her beliefs if presented with more definitive evidence*.

When I give public lectures on this topic, I am frequently assailed by someone in the audience who thinks he or she is being cleverly original with the line, "I'm skeptical about skepticism. Heh. Heh. Heh." On cue, I reach for my dictionary and say, "Fine. And what is the alternative that you prefer?" Skepticism, according to *Webster's Collegiate Dictionary,* is "the method of suspending judgement pending investigation; it includes inquiry, questioning, criticism, doubt." As a point of view, it is the opposite of *dogmatism*. *Roget's International Thesaurus* lists among the antonyms of skepticism: gullibility, credulousness, dupability, exploitableness, humbugability, simpleness, and naivety. How many of us would be eager to have these descriptors applied to ourselves?

George Bernard Shaw once remarked that "the power of accurate observation is commonly called cynicism by those who don't have it." Skepticism is often confused with cynicism which, as Shaw was obviously aware, is something quite different. The correct meaning of "cynic" is one who constantly attributes base motives to other people's actions, especially if these deeds appear to be generous or altruistic. Although it is sometimes difficult not to become cynical when one sees pseudoscientists preying on gullible members of the public, it is still possible to be a civil and charitable skeptic. The kind of skeptic I like to encourage will answer politely, "That's nice, but this doesn't make sense to me. Would you please show me why you believe that." This kind of skeptic would never assume *a priori* that he or she was dealing with a fool or a charlatan in a situation of this sort. Independent reasons would always be necessary to back up such an assumption.

PRINCIPLES OF SKEPTICISM

In this age of the sound bite, it is often useful to have a succinct statement of what it means to be a skeptic. There are different brands of skepticism, only the first of which I wish to advocate. I am indebted to the philosopher, Paul Kurtz, for making the following distinctions. A

methodological skeptic is one who, in approaching disputes, weighs the evidence fairly and accepts, provisionally, whichever position is best supported by logic and evidence. This pragmatic approach is different from that of the *philosophical skeptic* who denies the possibility of ever being certain about anything (In an absolute sense, he or she may have a point, but it makes it very difficult to get about the job of living one's life). The position of the methodological skeptic is also different from that of the *pathological skeptic* whose mind is so firmly made up that he or she refuses to examine contrary information. Such a closed-minded individual is no better than the gullible fool who will accept anything without asking if it makes sense or can be supported. Open-mindedness is indeed a virtue if it means that one is disposed to give one's opponents a fair hearing. But just because someone declines to change his or her mind after being presented with an inadequate case does not imply, as fringe supporters often assert, that he or she is closed-minded. In response to such a slur, William Orton once replied, "If you keep your mind sufficiently open, people will throw a lot of trash in it."

Believers in various areas of fringe science often accuse methodological skeptics of being pathological skeptics (and, to be sure, it is often an effective rhetorical device). Undoubtedly, some pathological skeptics exist among the critics of fringe science but, in my experience, most who withhold their assent on these controversial issues would be quite willing to change their minds if presented with sufficient reason for doing so. For instance, Phillip J. Klass, the most prominent doubter on the subject of the extraterrestrial origins of UFOs, is an agnostic on the question of the possibility of life elsewhere in the universe and is not averse to the idea that *someday* it might be demonstrated that such beings exist and have even tried to contact us. Klass has said many times that nothing would give him greater pleasure than to be able write in *Aviation Week and Space Technology*, the magazine where he has served as an editor for over 30 years, that there was *finally* acceptable evidence that alien beings had visited our planet. In my own case, I have often said that the fame and fortune that would accrue to me (not to mention the place in history) if I were to be the first to provide scientifically acceptable evidence that someone possessed ESP would more than compensate me for eating a bit of crow.

To wrap up this essay, here, then, is the essence of the skeptical position as it has been advocated in the foregoing discussion:

1. Extraordinary claims demand extraordinary evidence. The more conterintuitive a claim, or the more it seems to contradict existing, easily demonstrable knowledge, the more one needs to be convinced that the new report is not due to error or fraud on the part of the claimant. It is just as important to look at what else we must *reject* if we accept a cotroversial claim as it is to examine the evidence in its favour.

2. The burden of proof lies with the claimant. The claim stands or falls on the quality of the evidence the proponent can provide. It is not the skeptic's job to prove him or her wrong. It is also quite alright for the skeptic to say, "I don't know." He or she needn't feel obliged to offer a counter-explanation unless there is a plausible and well-supported one at hand. It is sometimes the best strategy, when confronted with a dubious claim, simply to point out its logical improbability and the paucity of evidence in its favour, and then adopt a "wait-and-see" attitude.

3. To be taken seriously, claims must be testable, at least in principle. Above all,

claims must be falsifiable. In addition, they must be stated clearly and in a logically rigourous manner. It must be explicitly stated what will count as evidence, for and against the claim, and what will constitute an adequate amount of evidence.

4. The evidence must be public and accessible to all competent critics. Science is a public activity based on trust. With very few exceptions, any researcher who cannot or will not allow serious competitors to observe his or her methods or apparatus, or to have access to the raw data from an experiment, must surrender the presumption to be believed merely on his or her own say so. Over and above the possibility of fraud, there is the more likely probability that egregious results could be due to subtle, uncontrolled variables that the experimenter may not have noticed.

Application of these simple rules of thumb, and comparisons of dubious cases with the sample beliefs and practices described in this essay, would do much to help expose pseudo-science as well as a number of garden variety scams in everyday life. It is hoped that arming citizens with this information will help them to avoid being taken in by hucksters of various stripes. The principles outlined above are just as applicable to pronouncements of politicians or the stories in the morning newspaper as they are to scientific crackpots. Further information on these and other examples can be obtained from the references in the list of suggested readings at the end of this paper. Before concluding, it would be well to mention some of the reasons why this sometimes thankless task is worth the effort. There are practical consequences; it is not merely an interesting intellectual exercise.

WHAT'S THE HARM?

Those who attempt to expose pseudosciences can expect to be roundly disliked by those who have a stake in the questionable enterprise and for obvious reasons. But critics are often chastised by others as well, including many who have no particular belief in or benefit from the dubious claim. This criticism sometimes arises from a commendable but misplaced desire to come to the aid of someone who is perceived as an underdog. More often, perhaps, it is because pseudosciences tend to be seen as a harmless form of silliness that don't rate such a disproportionate reaction from the scientific community. "Lighten up!" their defenders will say to the earnest skeptic, "What's the harm?" Indeed, the costs in any individual case are sometimes quite modest but overall, the consequences of widespread growth of pseudoscience are much greater than many tend to think. In the case of medical quacks who cause needless suffering or death, handwriting analysts who besmirch people's reputations, and poorly-trained psychotherapists who unintentionally implant false memories of sexual abuse, the negative impact is plain for all to see, but there are also other costs of scientific illiteracy that can be more subtle. The following is a list of some other kinds of harm that belief in pseudosciences can cause.

1. **Deception of the public.** Most people generally would rather have correct information than false data upon which to base their beliefs and decisions. People should not prosper by spreading false information, whether they intend to mislead or not.

2. **Monetary harm**—the "truth in advertising" criterion. Pseudosciences deliver little value for the money they extract.

3. **Diversion from tested products that really do live up to their claims.** Pseudosciences result in a waste of time and money that could have been spent more productively. *E.g.,* cases where patients forego proven medical therapies, enriching dangerous quacks while their conditions progress to the point where conventional treatments can no longer help them, the employment of dowsers to choose well sites, or graphologists to select personnel..

4. **Promotion of magical thinking** (the "something for nothing" mentality). The occult worldview that spawns pseudosciences promotes the belief that thinking good thoughts can substitute for concerted effort. It fosters the false hope that there is some magical shortcut just waiting to be revealed. This diverts careful thought and hard work from the much needed search for real solutions to the daunting problems we face in today's world.

   In certain special cases, such as in Nazi Germany, official promotion of occult and pseudoscientific beliefs and the denigration of critical thinking has helped pave the way for truly monstrous events. It was a fear of this dark potential of unreason that Sarvepalli Radha Krishnan was expressing when he uttered the warning, "If we believe absurdities, we shall commit atrocities."

5. **Pseudosciences encourage false hopes and unreasonable expectations.** E.g., beliefs such as those of the "Post Modernists" and New Age promoters of the human potential movement who assert that physical and personal limitations are just arbitrary conventions"—i.e., they apply only to those who are unimaginative enough to acknowledge them. Unfortunately, there are very real limitations to human abilities in confronting nature and our selves. It is the intransegence of these barriers that makes the ever-optimisitc pseudoscientist's advertisements so appealing in the first place.

6. **Failure to surmount these obstacles can lead to self-recrimination, deterioration in self-image, and depression.** When the vaunted technique doesn't work, or the desired changes don't last the disappointed customer is more likely to turn on himself that on the purveyor of false hope ("I'm a hopeless case. I didn't try hard enough.")

7. The climate in which pseudosciences thrive contributes to a **decline in scientific literacy and critical thinking skills**. The spread of pseudoscience discourages the reasonable right of potential customers to demand acceptable evidence from impartial, controlled trials, rather than unsubstantiated testimonials from satisfied customers.
8. Declining scientific literacy **detracts from the ability of citizens to make informed choices on many pressing policy issues.** There is an increasing number of

choices that confront voters in industrialized democracies which cannot be properly understood without at least a passing familiarity with the basic principles of science. Yet, survey after survey finds the majority of North Americans to be scientifically illiterate (and often proud of it). Similarly, our economic well-being in an era of global competition will depend more and more on the availability of a scientifically knowledgable workforce. It is ironic that many of the Far-Eastern nations that are threatening to overtake us in technologically sophisticated markets have been adopting Western scientific approaches while New Age believers in the West have been advocating a shift toward ancient Eastern doctrines with supposedly superior "other ways of knowing." Our Eastern competitors have been reaping the economic benefits of their concerted efforts to improve math and science performance in their schools while we have let our standards slide—science courses have become increasingly optional in our school systems, and pseudosciences have even gained access to the curriculum in some localities. Sad to say, promotion of extreme relativism and anti-scientific attitudes is even prevalent in many of our finest universities as the Sokal hoax, mentioned in Footnote 10, will attest. Further evidence of this disturbing trend trend will be found in *Higher Superstition: The Academic Left and its Quarrels with Science* by Paul Gross and Norman Leavitt (Johns Hopkins University Press, 1994).

SUMMARY AND CONCLUSION

The late Nobel Laureate, Richard Feynman was not only one of the greatest scientific geniuses America has produced, he also had a life-long interest in exposing bogus research, which he liked to call "cargo-cult science."[11] Feynman described cargo-cult sciences as sham enterprises that present the outward appearance of doing science but have none of its real substance. As Anthony Pratkanis put it in an article in the Spring 1992 issue of *The Skeptical Inquirer* (p. 264), cargo-cult science has

[11] The term "cargo cult" refers to pre-technological Melanesian societies that, during World War II, were the recipients of various cargoes that missed their intended destinations in military supply operations. When anthropologists later came into contact with these isolated tribes, they found that they had formed hypothetical explanations for why they had been so favoured with these deliveries from the air. They had incorporated their speculations into elaborate rituals, designed to re-attract the superhumans who had supplied them with this bounty. In the process, the conjectures that were offered evolved into full-blown religious dogmas. Not knowing what some of the items they scavenged were for, the recipients often built complex icons and ceremonies around them as well. Feynman drew parallels between the rituals of pseudoscientists and these pre-literate tribes.

> the illusion of objectivity, the appearance of careful study, and the motions of an experiment—but lacks one important ingredient: skepticism, or a leaning over backward to see if one might be mistaken. The essence of science is to doubt your own interpretations and theories so that you may improve upon them.

It is this lack of doubt, hard-nosed self-examination, and a willingness to look for alternatives to one's preferred explanations, along with the comforting nature of their conclusions, that primarily accounts for the longevity of pseudosciences. They practically never disappear. One need only look at the resurgence in popularity of astrology, graphology, homeopathy, therapeutic touch, phrenology, spiritualism, ...

It strikes manyobservers as odd that pseudosciences should be so popular in societies that are so utterly dependent on valid science for their health, safety, entertainment, nutrition, and mobility, not to mention their productivity and economic well-being. The blame for the widespread appeal of pseudoscience is often laid at the feet of a school system that does an inadequate job of instilling basic scientific literacy in the population. This is undoubtedly true to some extent, but I have tried to show in this essay that there are also a number of psychological factors that make pseudosciences particularly alluring. Individual pseudosciences may wax and wane in popularity but the hopeful messages they convey are so enticing that a thorough debunking in one era is far from a guarantee that they will not rise from the ashes to nourish a new group of true believers once the forewarned generation has died off (see Carl Sagan, *A Demon Haunted World: Science as a Candle in the Dark*, Random House, 1996).

It was the intent of this essay to provide readers who have (or wish to develop) a keen ear for nonsense with some tools for separating scientifically supportable endeavours from those that merely look like the real thing. The readings that follow, as well as the ones that appeared in the body of the text, above, should help in that quest. They all serve to remind us of that time-honoured warning to potential consumers of widgets or ideologies: Caveat emptor!

SUGGESTED READINGS ON PSEUDOSCIENCE AND SKEPTICISM

General:

The Skeptical Inquirer. Published bi-monthly by the Committee for the Scientific Investigation of Claims of the Paranormal. Box 703, Amherst, NY 14226-0703 USA; (716) 636-1425. —contains scientific critiques of all areas of the occult and pseudoscience.

The Rational Enquirer. Published quarterly by the British Columbia Skeptics. Box 48844 Bentall Centre, Vancouver, B.C. V5A 1S6. (Check the back pages of *The Skeptical Inquirer* for the addresses of similar groups in your own province or state,)

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Dean, G. (1987) Does Astrology Need to be True? The Answer is No. *The Skeptical Inquirer.* v. 11: 257-273.

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The Bermuda Triangle:

Kusche, L. (1975) *The Bermuda Triangle Mystery--Solved.* NY: Warner Books.

Creation Science ("Creationism")

Kitcher, P. (1982) *Abusing Science: The Case Against Creationism.* Cambridge, Mass.: MIT Press.

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Ruse, M. (1982) *Darwinism Defended: A Guide to the Evolution Controversies.* Reading, Mass.: Addison-Wesley.

Dowsing (Water Witching):

Vogt, E. & Hyman, R. (1979) *Water Witching U.S.A.*, Chicago: University of Chicago Press.

Carlos Castaneda, Teachings of Don Juan:

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Miracles:

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