

tact, mingle and unite! Who am I to know? Perhaps they have not lost all feeling, all memory of their past state; perhaps they retain a remnant of warmth and life, which they enjoy in their own way at the bottom of the cold urn that holds them. . . . O dear Sophie, I thus cling to the hope that I may touch you, feel you, love you, seek you, unite with you, and meld into you when we no longer are . . . if the molecules of your erstwhile lover were destined to become inspired, aroused, and to seek yours scattered in nature! Allow me this reverie, so sweet to me; it would assure me eternity in you and with you (reference 1, page 151).

After this last quote, the late learned and humane quantum chemist Bernard Pullman added laconically: "After animate, sensitive, and intelligent atoms, here now are atoms in love. And why not, indeed?"

Reference

1. B. Pullman, *The Atom in the History of Human Thought*, A. Reisinger, trans., Oxford U. Press (1998).

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► **Hassani replies:** Mario Beauregard, Gary Schwartz, and Natalie Trent associate several notable physicists with the integration of consciousness in quantum theory. History is filled with great scientists who held unscientific, even anti-scientific beliefs. Lord Rayleigh believed in ghosts; J. J. Thomson believed in dowsing and psychics; William Shockley and James Watson sponsor racialism and eugenics. But these ideological mistakes, sometimes referred to as Nobel disease (see *PHYSICS TODAY*, September 1998, page 29), are not made right because of the science of their makers, and the science is not made wrong because of the ideological mistakes of its discoverers. It is the message that counts, not the messenger.

One person who can authoritatively judge the role of mind in quantum theory is John Bell, who proved its non-locality—a concept that pseudoscientists have deformed into their own commodity. Bell stated,

I think it is not right to tell the public that a central role for conscious

mind is integrated into modern atomic physics. . . . The only "observer" which is essential in orthodox practical quantum theory is the inanimate apparatus . . . once the apparatus is in place, and functioning untouched, it is a matter of complete indifference . . . whether the experimenters stay around to watch, or delegate such "observing" to computers.¹

Experiments that demonstrate our mental ability to influence physical objects would be as revolutionary as experiments that demonstrated the existence of the electron, the atomic nucleus, and gravitational waves. Why don't the authors submit their results to mainstream journals so that the larger community of experimenters could verify them? Yes, mainstream journals—that is where all the aforementioned experiments were published and where all science revolutionaries disseminate their ideas.

There are essentially three categories of scientists: mainstreamers; those mainstreamers who bend the mainstream; and those who leave the mainstream and become pseudoscientists.

All true scientists are in the first category. If they are exceptionally creative, they may end up in the second category. Pseudoscientists, being rejected by the mainstreamers, misinform the public with assertions that "science revolutionaries have also been rejected by mainstreamers, as we have." Nothing is further from the truth. Galileo Galilei, Isaac Newton, Albert Einstein, Erwin Schrödinger, and other great scientists were mainstreamers who made it to the second category.²

Larry Dossey calls consciousness "science's greatest mystery." For centuries, biology was "science's greatest mystery" because of the manifestation of life in living organisms. Many biologists believed in vitalism, the idea that a "vital force" regulated the activity of animate objects but could not "be derived from matter and reduced to anything more basic," as the "Manifesto for a post-materialist science" states about mind.³ However, with the discovery of DNA, "vital force" is no longer needed to explain the electrochemical reactions taking place at the subcellular level. Since the source of consciousness is the brain, the scientific answer to its nature will come only from the molecular investigation of neurons, not from near-death "experiments."

Mysteries always exist in science, and there are two ways to deal with them. One is to wait and give science a chance to resolve them. The other, the age-old strategy of pseudoscience, is to exploit the limitation of science and inject speculative and unproven conjectures as answers. While biologists have abandoned vitalism, the idea has not died out. It has been disguised and taken up by modern pseudoscientists: Consciousness is the new face of vitalism!

Tim LaFave raises a good point regarding debates between science and pseudoscience. Unfortunately, the outcome of such debates would be enormously in favor of pseudoscience, as the Nye–Ham debate demonstrated. When the listeners are scientifically illiterate, the snake oil vendor wins. That's why, in my Commentary, I proposed that pseudoscience be challenged in the classroom, where science is not drowned in the rhetorical charm of pseudoscience.

Philosophy, despite "its utter charm," as Hans Christian von Baeyer suggests, has been at odds with science ever since their separation. Democritus, the ancient scientist, said about philosophy: "Nothing exists except atoms and empty space; everything else is opinion." Modern physicist Richard Feynman was more blunt:

Here's this great Dutch philosopher [Spinoza], and we're [Feynman and his son] laughing at him. . . . You can take every one of Spinoza's propositions, and take the contrary propositions, and look at the world and you can't tell which is right. Sure, people were awed because he had the courage to take on these great questions, but it doesn't do any good to have the courage if you can't get anywhere with the question. . . . [Philosophers] seize on the possibility that there may not be any ultimate fundamental particle, and say that you should stop work . . . [because] "You haven't thought deeply enough, first let me define the world for you." Well, I'm going to investigate *without* defining it!⁴

References

1. J. Bell, *Speakable and Unspeakable in Quantum Mechanics: Collected Papers on Quantum Philosophy*, Cambridge U. Press (1987), p. 170.
2. S. Hassani, *Skeptical Inquirer* **39**(5), 38 (2015).
3. M. Beauregard et al., *Explore* **10**, 272 (2014).

4. R. P. Feynman, *The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*, Basic Books (2005), p. 195.

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Chernobyl nuclear-meltdown consequences

Thirty years after the Chernobyl accident, *PHYSICS TODAY* published an article, “What can Chernobyl teach us?” (April 2016, page 24), which unbelievably underplayed contemporary indications that no member of the public died as a result of the 1986 reactor meltdown. The four-page article was filled with bland reviews, images, and anecdotes of the type that for decades has dominated reporting, mostly unrelated to still-controversial consequences of the meltdown.

Although the accident resulted in destruction of the power plant, the medical consequences among the general population have been vastly and irresponsibly exaggerated. Long-term effects were not radiological but largely financial, institutional, and psychological.

Some early, never-validated estimates varied enormously, with total alleged fatalities from close to a million down to tens of thousands. For example, Frank von Hippel and Thomas Cochran, self-described public-interest physicists, estimated “2,000–40,000 thyroid tumor cases . . . of which a few percent might be fatal” and “3,500–70,000 cancer cases . . . of which approximately half might be fatal.”¹ Nothing like that grim forecast has ever come to pass.

Of 600 workers present, 134 received very high doses and suffered acute radiation sickness; 28 died in the first three months. Altogether, there were 31 fatalities from overwhelming radiation exposure, excessive heat burns, and direct mechanical trauma.² Also, a larger number of liquidators—personnel who dealt with the meltdown’s consequences—were subsequently subjected to above-normal radiation doses, possibly adding another dozen or so fatalities.

Media attention in the intervening decades has focused on the association

between radionuclide exposures and delayed medical effects. Initial thyroid radiation doses were particularly high in children and adolescents living in nearby regions; more than 6000 thyroid cancer cases have been diagnosed in that group. Although there’s been a tendency to attribute those incidences over time to the Chernobyl accident, cancer increases were also observed before the accident. Nevertheless, very few—perhaps a dozen or so—deaths from thyroid cancer can be clinically associated with radiation from Chernobyl.

An overall increase in mortality rates has since been reported in most areas of the former Soviet Union, and that must be taken into account when interpreting the accident studies. Apart from some thyroid cancer among those exposed at a young age, no increase in solid cancers or leukemia due to radiation has been clearly demonstrated. Nor has there been any proof of other nonmalignant disorders. However, widespread psychological reactions have been observed.

As for latent medical effects—including cancer—in adjacent nations, no casualties could be clinically confirmed: Contrary to estimates extrapolated from unproven theories about effects at low radiation doses, mortality among those exposed to the radioactive fallout cannot be distinguished statistically from normal morbidity. Nor have birth defects, radiation burns, or radiation sickness been verified.

When compared with other energy sources and industrial disasters, the Chernobyl reactor explosion resulted in far lower casualty rates. No postmortem data prove that any member of the public died of Chernobyl radiation. Decades after the accident, an international study team has continued to mention an unsubstantiated upper limit of 4000 induced public fatalities—a limit derived not from corroborative medical examinations but from doubtful extrapolations.² Yet, 30 years later the confirmed public death toll from Chernobyl remains near zero. The low rate of actual public fatalities is due in part to prompt post-accident national and international action.

Radiophobia, exacerbated by and after the accident, increased economic losses in the former Soviet Union and elsewhere in Europe. In Western nations, public apprehension about low-level radiation was stoked to encourage

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