
Special Report

Water With Memory? The Dilution Affair

Martin Gardner

“**E**XPERIMENTER EFFECT” has two meanings. Outside psychic research circles it refers to the way a strongly held mind-set can unconsciously bias an experimenter’s work. Among parapsychologists it also refers to the supposed unconscious influence of an experimenter’s PK (psychokinetic) powers on the research.

Putting aside the second meaning (if such an effect is real it would throw doubt on all empirical findings since Galileo), a bizarre instance of the experimenter effect came to light last July. It involves a group of scientists at INSERM U200, a medical-research institute in a Paris suburb. Their findings were widely publicized (*Newsweek*, July 25; *Time*, August 8), not merely because they were so astounding but because for the first time they seemed to provide strong empirical support for the fringe medicine of homeopathy.

The century’s most notorious instance of an experimenter effect that sparked a vigorous scientific controversy also occurred in France. In 1903 René Prosper Blondlot, a respected French physicist, claimed to have discovered a new kind of radiation, which he called N-rays after the University of Nancy, where he worked. Scores of papers confirming the reality of N-rays had appeared in French journals before a skeptical American physicist, Robert Wood, visited Blondlot’s laboratory and played a dirty trick on him. Wood secretly removed from Blondlot’s apparatus a prism that was claimed to be essential to the observation of N-ray spectra. Blondlot went right on describing the lines he fancied he was seeing. After Wood reported this in the British science journal *Nature* (vol. 70, 1904, p. 530), N-rays vanished from physics, but poor old Blondlot never acknowledged his self-deception.

Last June, physicists and chemists around the world were incredulous over a paper in *Nature* (vol. 333, June 30, p. 816) titled “Human basophil degranulation triggered by very dilute antiserum against IgE.” The report was

SCIENTIFIC PAPER

Human basophil degranulation triggered by very dilute antiserum against IgE

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When human polymorphonuclear basophils, a type of white blood cell, are exposed to anti-IgE antibodies, they release histamine. The latter can be demonstrated at dilutions of anti-IgE that range from 10 to 100% of the basophils, despite the fact that dilutions need to be accompanied by vigorous shaking for the effect to be related to the molecular organization of water.

The antibodies responsible for human immediate hypersensitivity belong to the IgE isotype. The most salient feature of IgE is its capacity to bind to mast cell and polymorphonuclear basophil membranes through their human basophilic receptors.

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NATURE VOL. 332 30 JUNE 1988

When to believe the unbelievable

An article in this week's issue describes observations for which there is no present physical basis. These are good and particular reasons why prudent people should, for the time being, suspend judgement. Unreplicable observations are not always dismissed by the scientific community. The rationalization of physical phenomena, when, for example, it is proved correct? The principle is that, when an observation is made, it should be taken as a fact.

The French group's original report and Nature's editorial calling it unbelievable.

signed by 13 biologists—two from Israel, one from Italy, one from Toronto, and the others part of a team at INSERM headed by biochemist Jacques Benveniste. The phrase “very dilute” in the title is a whopping understatement. As the editors of *Nature* pointed out in an unusual disclaimer accompanying the article, the dilution of the French group was so extreme that not a molecule of the antiserum was left in its solvent. The editors considered the results unbelievable, but said they were publishing the paper for two reasons: It purported to give an accurate account of work that had been widely trumpeted in France by popular articles, and it provided other scientists with an opportunity to confirm or falsify the extraordinary claims.

What were these claims? In essence the French researchers were convinced that, after all the molecules of a certain antibody were removed from distilled water, the water somehow “remembered” the antibody’s chemical properties. Although such a claim violates fundamental laws of physics, it lies at the very heart of homeopathy, a medical pseudoscience that flourished in the United States in the nineteenth century and is now enjoying a modest revival. Homeopaths maintain that, if a drug produces symptoms of a disease in a healthy person, inconceivably small quantities of that same drug will cure the disease. Moreover the smaller the amount of the drug—including its total absence—the more potent its curative power.

Thousands of homeopathic drugs are listed in the cult’s *materia medicas*—handbooks that vary widely from time to time and from country to country. If a drug is soluble—bee venom, for example—it is mixed with water or alcohol in repeated dilutions. The mixture must be shaken violently for about ten seconds after each dilution, otherwise the medicine won’t work. If a drug is not soluble, it is ground into a fine powder and diluted by repeated mixing with powdered lactose (milk sugar). A moderate homeopathic dose, called “30c,” is arrived at by first diluting the drug to a hundredth part and then repeating the process 30 times. As someone pointed out, it is like taking a grain of a substance and dissolving it in billions of spheres of water, each with the diameter of the solar system.



Jacques Benveniste

Sygnia

Benveniste claims that the antibody he used is still potent when dilutions are even more extreme—one part to 10^{120} parts of water! As science writer Malcolm Browne remarked in his *New York Times* account of the French claims (June 30), astronomers estimate the number of stars in the universe as a mere 10^{20} . Benveniste said the potency of his dilutions is comparable to swirling your car key in the Seine, going some hundred miles downstream, taking a few drops of water out of the river, and then using them to start your car. It is easy to show mathematically that

when such extreme dilutions are made of homeopathic drugs, as they are constantly, the chance of a single molecule remaining in the solvent or powder is vanishingly small.

Certain white blood cells, called “basophils,” have granules that stain a reddish color when treated with a blue dye. Incubating these cells with a strong solution of an antibody causes them to lose those granules, a process known as “degranulation.” When a solution of the antibody has been diluted to the point at which no molecules of the antibody remain in the distilled water, one would expect the cells to retain their red-staining granules. Not so. According to Benveniste, about half the basophils continued to degranulate when so treated.

How do homeopaths explain this supposed potency of infinitesimal doses, even when the dilution removes all molecules of a drug? They invoke mysterious vibrations, resonances, force fields, or radiations totally unknown to science. Benveniste suggests in his paper that antiserum molecules may somehow cause water molecules to rearrange their hydrogen atoms in some inexplicable fashion that mimics the action of the antibody even when it is no longer there. In other words, water can remember the properties of a missing substance.

This magic memory water is even weirder than polywater, a conjectured new type of water that caused an enormous flap among chemists in the 1960s. Boris Derjaguin, a Soviet chemist, announced that when water collects in hairlike capillary tubes it acquires all sorts of strange properties. John D. Bernal, a noted British physicist and historian of science (he was also a dedicated communist and a great admirer of Soviet science), hailed it as the “most important physical-chemical discovery of this century.”

Because polywater, as it was called, could have great military uses, the

Army, Navy, and other U.S. agencies began tossing out generous grants. A flood of papers about polywater popped up everywhere. Derjaguin even wrote a nontechnical article about the water for *Scientific American* (November 1970). *Nature* (224, 1969, p. 198) published a warning from an American scientist that research on polywater should proceed with extreme caution because it might polymerize the earth's oceans, destroy all life, and change the earth into a planet like Venus.

It turned out that the miraculous water was just ordinary water contaminated by dirty test tubes. Derjaguin himself threw in the towel by announcing that for ten years he had wasted his time studying nothing more than dirty water. Meanwhile millions of dollars had been squandered on polywater research. You can read all about this remarkable farce in *Polywater* (MIT Press, 1981), a fine book by Felix Franks. He faults government agencies for premature funding, technical journals for overpermissiveness, experimenters for repeated self-deception, and the mass media for irresponsible hype.

It is too early to know if Benveniste's homeopathic water will survive as long as polywater did, or if the French biochemist will eventually withdraw his paper. *Nature*, highly suspicious of so outrageous a claim, asked a team of unpaid volunteers to fly to Paris to devise and observe a replication of Benveniste's experiments in his own laboratory. (The visit and investigation were preconditions for publication of the original article.) Benveniste readily agreed, and even planned a celebration with champagne when the replication was over and his results were vindicated. The team consisted of John Maddox, editor of *Nature*, who has a background in physics; Walter Stewart, an organic chemist and a specialist in scientific fraud from the National Institutes of Health in Bethesda, Maryland; and the indomitable magician and psi detective, James Randi.

NATURE VOL 304 20 JULY 1988

NEWS AND VIEWS

"High-dilution" experiments a delusion

The now celebrated report by Dr J. Benveniste and colleagues elsewhere is found, by a visiting Nature team, to be an insubstantial basis for the claims made for them.

The remarkable claim, made in *Nature* (333, 816, 1988) by Dr Jacques Benveniste and his associates are based chiefly on an extensive series of experiments which are statistically ill-constructed, from which no substantial effect has been made to exclude systematic errors, including such as when interpretation

tical physics experiments. (INSERM 211) We ask: how have we found with the best of them that

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NATURE VOL 324 4 AUGUST 1988

When to publish pseudo-science

The opinion that this journal should not have published a famous article on solute-free solutions overlooks the multivalent function of a general journal of science.

NATURALLY, but mistakenly, a handful of readers (and some others) are perplexed that *Nature* should have published the article by Dr Jacques Benveniste and his associates (333, 816; 1988) reporting the unbelievable circumstance that solutions of a biological reagent retain their activity even when diluted beyond the point at which most copies of the active ingredient can be detected with degradation. (INSERM 211) Each article with degradation factors in it has all or 30 per cent degradation at regular liquid concentrations and not for the same at high dilution? Similar double-blind experiments (Dr J. Benveniste) were under the control of a statistical analysis, using a better method.

Strictly academic journals have simple rules to follow when deciding what to publish. General journals such as this, whose function is not only to publish excellent original research but to keep a general readership well-informed, necessarily have other tasks to try to do well. Merely reporting events with no always science is the whole of science?

NATURE VOL 304 20 JULY 1988

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Dr Jacques Benveniste replies:

AMAZONIAN J. Maddox, with all his experience, fell with us into the trap set by a spool of self-appointed keepers of the scientific conscience, with no substantial scientific published record" (J. Maddox, *Nature* 333, 795, 1988). Their accusation, the climate they created in the five days of our ordeal, their inability to get in touch with our biological system and their judgement based on our dilution series changes this inquiry altogether. Who, with even the slightest research background, would dare on five years of our work and that of five other laboratories

and knew both codes (double-blind). There is another heart-to-heart incident: Stewart imposed a death sentence in the counting room, yet loud laughter was heard where he was filling chambers. There, during this critical process, was Randi playing tricks, distracting the technician in charge of his supervision! It will now be clear what a mockery of scientific inquiry this was. Only the complete implications

Nature's subsequent investigative team called the results a delusion. Benveniste replied angrily, and a subsequent editorial defended *Nature's* actions.

Their blistering report in *Nature* (334, July 28) opens: "The remarkable claims made . . . by Dr. Jacques Benveniste and his associates are based chiefly on an extensive series of experiments which are statistically ill-controlled, from which no substantial effort has been made to exclude systematic error, including observer bias, and whose interpretation has been clouded by the exclusion of measurements in conflict with the [claims]. . . . The phenomenon described is not reproducible in the ordinary meaning of that word. We conclude that there is no substantial basis for the claim. . . . The hypothesis that water can be imprinted with the memory of past solutes is as unnecessary as it is fanciful."

The popular French magazine *Science et Vie* (Science and Life) in its August issue was disturbed by the fact that Benveniste had announced as early as May, at a national conference on homeopathy, that his paper would be appearing in *Nature*. On July 1, journalists in France received a thick press release about the forthcoming paper, and in July the French stock exchange did a brisk business in Boiron shares. *Science et Vie* wondered if French newspapers and television stations would give as much publicity to the debunking of Benveniste's work as they did to its promotion. If not, "water memory will remain an established fact for believers in homeopathy."

The key person in all the French experiments, as well as in their "confirmation" by a laboratory in Israel, was Dr. Elizabeth Davenas, a young woman in her twenties and a good friend of Bernard Poitevin, one of the two homeopathic doctors in the French group. She is the observer who looks through the microscope to count the red-staining granules that remain. Randi listed 15 different pretexts on which she accepted "good" cases and rejected "bad" ones; Stewart's list contained 19 such items. It is not clear whether she



Photo by James Randi

Elizabeth Davenas, lead experimenter of the French group, in her lab.



Photo by James Randi

Walter Stewart and John Maddox during a break from their observations.

is deceiving herself in a manner similar to Percival Lowell's famous self-deception when he peered through telescopes and drew pictures of intricate canals on Mars, or whether some cells actually lose color occasionally because of contaminants. On this point the *Nature* investigators write:

In circumstances in which the avoidance of contamination would seem crucial, no thought seemed to have been given to the possibility of contamination by misplaced test-tube stoppers, the contamination of untended wells during the pipetting process and general laboratory contamination (the experiments we witnessed were carried out at an open bench). We have no idea what would be the effect on basophil degranulation of the organic solvents and adhesives backing the scotch tape used to seal the polystyrene wells overnight, but neither does the laboratory.

The original *Nature* report was understandably greeted with loud hosannas by homeopaths around the world. Readers interested in the wild history of this once most popular of all alternative medicines can consult Chapter 16 of my *Fads and Fallacies* (Dover, 1952), or "Homeopathy: Is It Medicine?" by Stephen Barrett in the *SKEPTICAL INQUIRER* (12, Fall 1987; see also comments in the letters section of the 1988 Spring and Summer issues). Dr. Barrett is also the author of a hard-hitting paper in *Consumer Reports* (January 1987) about a yearlong investigation of homeopathy. His report concludes:

Unless the laws of chemistry have gone awry, most homeopathic remedies are too diluted to have any physiological effect. . . . CU's [Consumers Union] medical consultants believe that any system of medicine embracing the use of such remedies involves a potential danger to patients whether the prescribers are M.D.'s, other licensed practitioners, or outright quacks. Ineffective drugs are dangerous drugs when used to treat serious or life-threatening disease. Moreover, even though homeopathic drugs are essentially nontoxic, self-medication can still be hazardous. Using them for a serious illness or undiagnosed pain instead of obtaining proper medical attention could prove harmful or even fatal.

I find in my files a sad clipping from the *New York Post* (July 25, 1954) about Jerold Winston, a Long Island boy, age 4, who died of leukemia. For 16 months he had been treated only with a homeopathic remedy by his mother, the daughter of a homeopathic doctor. The parents were facing a possible manslaughter charge for child neglect. Who knows how many tragedies like this occur when gullible people rely solely on worthless medicines?

Homeopathy had almost died in the United States by 1960, though it continued to be popular in France, Germany, Russia, India, England, Mexico, Argentina, Brazil, and other countries. But in the New Age climate of the seventies and eighties it experienced a surprising upsurge among those who are attracted to holistic medicine, natural foods, herbal remedies, acupuncture, reincarnation, and the paranormal. There are now several hundred homeopathic doctors in the United States, about half with orthodox medical degrees. The others are mostly chiropractors, naturopaths, dentists, veterinarians, and nurses. This is a small number compared to some 14,000 such physicians in 1900, when more than 20 schools in the United States taught the art and there were more than 100 homeopathic hospitals.

New books on homeopathy are appearing on general trade lists. Jeremy Tarcher, a publisher of New Age literature (including books on Spiritualism) has two homeopathic volumes in his current catalog: *Everybody's Guide to Homeopathic Medicines*, by Stephen Cummings and Dana Ullman, and *Homeopathic Medicine at Home*, by Dr. Maesimund Panos and Jane Heimlich. Heimlich is the wife of Dr. Henry Heimlich, originator of the famous "Heimlich maneuver," used to aid persons choking on food. In 1980 she was quoted in the *New York Times* (November 19) as saying she took great pride in converting her father, the dancing teacher Arthur Murray, to homeopathy.

The Complete Book of Homeopathy, by Michael Weiner and Kathleen Goss, was issued by Bantam Books in 1981. With all the media publicity about Benveniste, and the continuing growth of New Age nonsense, more such books are surely on the way. Nothing stimulates a fringe medical cult more than attacks by skeptics, or by "allopaths," the homeopathic term for orthodox doctors.

Cummings and Ullman, in their book on homeopathy, claim there are more than 6,000 homeopathic doctors in France today, and 18,000 pharmacies that sell their medicines. In India, they tell us, more than 70,000 doctors practice the art. (In an article in the January 1984 issue of *Fate* magazine, the

nation's sleaziest occult periodical, Ullman upped this number to 200,000.) England's royal family, according to the Queen's physician, has been under homeopathic care for more than 150 years. Dozens of famous nineteenth-century American writers, political leaders, and businessmen patronized homeopathic physicians, including Washington Irving, who died under the care of a homeopathic family doctor. Ullman, who holds a master's degree in public health from the University of California, Berkeley, is the nation's top homeopathic journalist. He was arrested in California in 1976 for practicing medicine without a license.

How will homeopathic doctors and true believers react to *Nature's* debunking? There is not the slightest doubt they will take their cues from Benveniste's angry reply, which ran in the same issue of *Nature* as the critique. His invective is unprecedented in a science journal. Members of the *Nature* team are branded "amateurs" who created "hysteria" in the French laboratory. Their investigation is called a "mockery of scientific inquiry." Benveniste likens it to the Salem witch-hunts and the McCarthy persecutions. He told the *Wall Street Journal* by phone (July 17) that the *Nature* report was a sinister plot to discredit him. In Paris he told *Le Monde* (July 27) that Walter



In this cartoon, which appeared in *Science et Vie*, Jacques Benveniste is saying, "A frog passed through this water in 1789." The frog wears a stocking cap associated with the time of the French Revolution.

Stewart was incompetent and the investigation was a “scientific comedy . . . conducted by a magician and a scientific district attorney who worked in the purest . . . Soviet ideology style” to install a “scientific gulag.”

“During the whole week I was tempted to kick them out,” he said to the French newspaper *Le Figaro* (July 27). “We never could imagine the extent to which these ‘experts’ were going to shuffle the cards.” He attacked *Science et Vie* for calling him a “new Lysenko,” adding “you should know that I am the most important researcher in the world and the one most in demand at colloquia.”

It is obvious from Benveniste’s fury that he learned absolutely nothing from *Nature*’s investigation. Its lessons had the same effect on his mind as a vanishing substance has on distilled water.

Consider the egotism and folly of this man. He rushes into print with a claim so staggering that if true it would revolutionize physics and medicine, and guarantee him a Nobel prize. Yet he did this without troubling to learn the most elementary techniques for conducting truly double-blind tests or for supervising self-deceiving observers. When Randi mentioned N-rays to him, he said he had never heard of them! Does he remember, one wonders, the story of polywater?

A few scientists and science journalists criticized *Nature* for publishing the original article. Daniel Koshland, Jr., editor of *Science*, agreed that a responsible journal should “encourage heresy” but added that it also should “discourage fantasy.” It is one thing, he told science writer Walter Sullivan (*New York Times*, July 17), to publish unorthodox work that may turn out to be wrong, but the French claim about water with a memory was too far on the fantasy side, like an account of the successful construction of a perpetual-motion machine.

Other scientists have faulted *Nature* both for publishing the French paper in the first place and for later investigating the claims. Arnold Relman, editor of the *New England Journal of Medicine*, said *Nature* should have required confirmation by an independent group of biochemists before running the article, and that it was not its function to serve as an investigative body. This view was shared by Henry Metzger, a colleague of Stewart at the NIH. He said he had urged this approach when he refereed the paper for *Nature*. Immunologist Avrion Mitchinson, at University College London, thought the French paper not worth publishing. However, he did not believe it would do much harm. He said, “Anyone who thinks the great ship of science can be damaged in such a way is greatly mistaken.” (On such criticisms see “More Squabbling Over Unbelievable Result,” in *Science*, 241, August 5, and “The Ghostbusters Report from Paris,” in *New Scientist*, August 4.)

Nature’s correspondence section (August 4) ran four letters from scientists who proposed conventional explanations for the French results. In the same issue the editors defend themselves in an editorial headed “When to Publish Pseudo-science.” When one-fourth of French doctors prescribe homeopathic medicines, they argue, “there is plainly too much at stake for the issue to be dropped.”

The editorial recalls an earlier publication in *Nature* (238, 1972, pp. 198-210) of the claim that, when the protein scotophobin is extracted from the brains of rats trained to run a maze and then injected into untrained rats, there is a transfer of maze-running ability. The paper was followed by a "devastating critique" by Stewart, and that ended the matter. "Is not a little of the 'circus atmosphere' inescapable on these occasions?" Why did *Nature* not withhold the French report until they made their investigation, then publish the two reports side by side? The editors have replied elsewhere that they did not do this because Benveniste had leaked information about his paper to the French press and, had they withheld his paper until after their investigation, he would have refused to allow *Nature* to print it.

INSERM (the letters stand for Institut National de la Santé et de la Recherche Médicale) has refused to take sides in the controversy. Next spring, it has announced, Benveniste's work will be subjected to its regular examination and a judgment made then. Benveniste has taken this to mean that INSERM is tossing him to the wolves. "*Nature* sends a magician to check my research," he declared, "and INSERM doesn't even protest. It's the limit!" I quote from Peter Coles's article, "Benveniste Controversy Rages in the French Press" (*Nature*, August 4). He also reveals that Boiron, a 51-percent shareholder in another firm, Laboratoires Homéopathiques de France, has purchased all remaining shares.

"Look," Randi said to the French group, "if I told you I keep a goat in the backyard of my house in Florida, and you happen to have a man nearby, you might ask him to look over my garden fence. He would report, 'That man keeps a goat.' But what would you do if I said, 'I keep a unicorn in my garden?'"

The point of course is that no extraordinary verification is needed to establish the existence of a goat in Randi's garden. But a unicorn? As the *Nature* authors write sadly at the close of their indictment, "We have no way of knowing whether the point was taken." ●

Martin Gardner's "Notes of a Fringe-Watcher" column will return in its usual format next issue. His latest book, The New Age: Notes of a Fringe-Watcher (Prometheus Books), consists in part of past columns and updates.

Skepticism Isn't an 'Ism'

Despite its suffix, skepticism is not an "ism" in the sense of a belief or dogma. It is simply an approach to the problem of telling what is counterfeit from what is genuine. And a recognition of how costly it may be to fail to do so. To be a skeptic is to cultivate "street smarts" in the battle for control of one's own mind, one's own money, one's own allegiances. To be a skeptic, in short, is to refuse to be a victim.

—Robert S. DeBear, "An Agenda for Reason,
Realism, and Responsibility," *New York Skeptic*
(newsletter of the New York Area Skeptics, Inc.), Spring 1988