

"Here lies one whose name was writ in water..."

Published online 8 August 2007 | Nature | doi:10.1038/news070806-6



Philip Ball

A survey of evidence for the 'memory' of liquid water casts little light on its putative role in homeopathy, says Philip Ball.

I suspect it will be news to most scientists that Elsevier publishes a peer-reviewed journal called *Homeopathy*. I also suspect that many, on discovering this, would doubt there is anything published there that it would profit them to read. But I propose that such prejudices be put aside for the current special issue, which collects a dozen papers devoted to the 'memory of water'¹. It's worth seeing what they have to say — if only because that reveals this alleged phenomenon to be as elusive as ever.

The inability of water to act as a memorial was a well known poetical trope before the poet John Keats chose as his epitaph the quotation that serves as a headline here; its ephemerality was noted by Heraclitus in the fifth century BC. But 'the memory of water' is a phrase now firmly lodged in the public consciousness — it even supplied the title for a recent play in London's West End.

Scientists, though, tend to side with the poets in rejecting any notion that water can hold lasting impressions. Indeed, *Homeopathy*'s editor, Peter Fisher of the Royal London Homeopathic Hospital admits that "the 'memory of water' casts a long shadow over homeopathy and is just about all that many scientists recall about the scientific investigation of homeopathy, equating it with poor or even fraudulent science."

The term was coined by the French newspaper *Le Monde* in the wake of the 1988 *Nature* paper² that kicked off the whole affair. The lead author was the late Jacques Benveniste, head of a biomedical laboratory in Clamart run by the French National Institute of Health and Medical Research (INSERM).

Benveniste's team described experiments in which antibodies stimulated an allergic response in human white blood cells called basophils even when the antibody solutions were diluted far beyond the point at which they would contain a single antibody molecule. The activity seemed to disappear and then reappear periodically during serial dilutions.

Uncertain memory

The results seemed to offer some experimental justification for the use of such high-dilution remedies in homeopathy. But they defied conventional scientific understanding, specifically the law of mass action that demands that the rates of chemical reactions be proportional to the concentrations of reagents. How could this be? Benveniste and colleagues suggested that perhaps the antibody activity was

'imprinted' in some fashion on the structure of liquid water, and transferred with each dilution.

The idea made no sense in terms of what was known about the structure of water — but what prevented it from being dismissed straight away was that liquid water has a complicated molecular-scale structure that is still not perfectly understood. Water molecules associate by means of weak chemical bonds called hydrogen bonds. Although in the main they form and break on timescales of about a trillionth of a second, nonetheless they seem to offer a vague possibility that water might form clusters of molecules with specific shapes and behaviours.

Benveniste's experiments were investigated by a team of 'fraud-busters' led by *Nature*'s then editor John Maddox, who demanded that the studies be repeated under careful observation. Although Benveniste acquiesced (and the results proved utterly inconclusive), he complained of a witch-hunt. Certainly, it was an unprecedented act of scrutiny that not even the proponents of cold fusion — the far more storied water-related pathology that blew up the next year — had to endure.

In any event, the results were never unambiguously repeated by others. Benveniste, however, progressed from high-dilution experiments to the claim that the activity of biomolecules could be 'digitally recorded' and imprinted on water using radio waves. Until his death in 2004, he insisted that this would lead to a new age of 'digital biology.'

Cabinet of curiosities

There are many good reasons — too many to fit in this column — to doubt that water molecules in the liquid state could mimic the behaviour of antibodies or other complex biomolecules in a way that persists through dilution after dilution. As water expert José Teixeira of the French nuclear research organisation's Saclay laboratories, outside Paris, says in the sceptic's perspective he provides in the *Homeopathyspecial* issue, "Any interpretation calling for 'memory' effects in pure water must be totally excluded." But the idea won't be squashed that easily, as some of the other papers show.

These papers report several experimental results that, at face value, are intriguing and puzzling. Louis Rey, a private researcher in Switzerland, reports that salt solutions show markedly different thermoluminescence signals, for different homeopathic dilutions, when frozen and then rewarmed. Bohumil Vybíral and Pavel Voráček of the University of Hradec Králové in the Czech Republic describe curious viscosity changes in water left to stand undisturbed. And Benveniste's collaborator Yolène Thomas, of the Andre Lwoff Institute in Villejuif, outside Paris, reports some of the results of radiofrequency 'programming' of water with specific biomolecular behaviour, including the induction of *Escherichia coli*-like 'signals', the inhibition of protein coagulation, and blood-vessel dilation in a guinea pig heart.

The volume is, in other words, a cabinet of curiosities. There is rarely even a token effort to explain the relevance of these experiments to the supposed workings of homeopathy, with its archaic rituals of shaking ('succussion') and 'magic-number' dilutions (one must always use factors of ten, and generally only specific ones, such as 10^6 , 10^{12} and 10^{30}). The procedures and protocols on display here are often unusual, if not bizarre, because the one thing you must not do on any account is the simplest experiment that would probe any alleged 'memory' effect: to

look for the persistent activity of a single, well-defined agent in a simple reaction — say an enzyme or an inorganic catalyst — as dilution clears the solution of any active ingredient.

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If that sounds bad, it is nothing compared with the level of theoretical discussion. This 'field' has acquired its own *deus ex machina*, an unsubstantiated theory of 'quantum coherent domains' in water proposed in 1988³ that is vague enough to fit anything demanded of it. Aside from that, the 'explanations' on offer seem either to consider that water physics can be reinvented from scratch by replacing decades of careful research with wishful thinking, or they call on impurities to perform the kind of miraculous feats of biomolecular mimicry and replication that chemists have been striving to achieve for many years.

The French philosopher Gaston Bachelard once wrote "We attribute to water virtues that are antithetic to the ills of a sick person. Man projects his desire to be cured and dreams of a compassionate substance." On this evidence, that dream is as strong as ever.

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• References

1. *Homeopathy* **96**, 141-226 (2007).
2. Davenas, E. *et al.* *Nature* **333**, 816 (1988). | [Article](#) | [PubMed](#) | [ISI](#) | [ChemPort](#) |
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