

# Conspicuous by its absence: the Memory of Water, macro-entanglement, and the possibility of homeopathy

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**In order to fully comprehend its therapeutic mode of action, homeopathy might require both 'local' bio-molecular mechanisms, such as memory of water and 'non-local' macro-entanglement, such as patient–practitioner–remedy (PPR) descriptions.**  
*Homeopathy (2007) 96, 209–219.*

**Keywords:** homeopathy; locality; non-locality; memory of water; macro-entanglement

## Introduction

Despite increasingly sterile debates over 'whether' homeopathy works,<sup>1</sup> the 'how' and 'why' have yet to be seriously addressed by science. One need not look far to see why.

Formerly a successful allergy researcher,<sup>2</sup> Jacques Benveniste spent the last 20 years of his life out of the scientific mainstream because of his fascination with the 'Memory of Water'.<sup>3</sup> Despite democratic appearances, when it comes to dealing with what it considers 'heretical' (eg, homeopathy), science can be as narrow-minded, unforgiving, and vicious as any inquisition. Disregarding the burning stakes of peer opprobrium however, some are seeking answers to the question of how homeopathy might be possible.

Two types of hypothetical 'mechanism' are under consideration. Labelled 'local' and 'non-local', they depend, respectively, on conventional scientific positivism,<sup>4</sup> or appeal to generalised quantum theoretical concepts of complementarity and entanglement.<sup>5</sup> Local hypotheses envisage homeopathic remedies behaving in a way similar to any other medicine, ie, 'pharmacologically'. The problem is that most homeopathic remedies are diluted out of molecular existence. In

order therefore to comply with the causal principles of positivist science, a mechanism has to be envisaged by which some kind of information transfer (usually thought of as electromagnetic) can occur to a molecular substrate (eg, water), via homeopathy's unique method of remedy production.<sup>6</sup> Involving successive iterations of dilution followed by violent agitation collectively known as succussion, it is this information transfer to the solvent which has been called the Memory of Water (MoW).

Non-local hypotheses,<sup>7</sup> are concerned less with the remedy *per se*, proposing generalised forms of quantum entanglement as the basis for homeopathy's efficacy. They suggest instantaneous, acausal correlations are somehow established between various combinations of patient, practitioner, and remedy, ultimately leading to an observed change in the patient's state of health. These ideas are in their infancy and even more controversial than MoW: indeed, to many the idea that quantum theory might be applicable in our macroscopic domain is anathema. The received conventional wisdom is that non-deterministic quantum theory describes the world of sub-atomic particles, atoms and molecules, while deterministic Newtonian (classical) and Einsteinian (relativistic) theories are sufficient for the macroscopic world of material objects. Non-local hypotheses however, have the advantage of being generalisable outside homeopathy to other healing disciplines.

The purpose of this paper is to review the two types of descriptions of homeopathy's effects. Then, viewing

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Received 23 February 2007; revised 8 May 2007; accepted 14 May 2007

these different approaches as complementary, not contradictory, and realising that some local explanations are also 'tarred' with the brush of entanglement (albeit at the molecular level), to consider how a more complete picture of the homeopathic process might be possible, ultimately leading to new experimental tests.

## Locality, non-locality, and philosophy

Most, but by no means all, of science is based on a set of assumptions about the universe collectively known as Local Reality.<sup>8</sup> This may be summed up as follows:

- The universe is real and things in it exist whether we observe them or not.
- It is legitimate to draw general conclusions and predictions from the outcome of consistent experiments and observations.
- No signal can travel faster than light.

This is very much a 'common sense' view of the universe as (a) it defines 'reality' as something obviously 'out there' separate and independent of us and (b) it is 'local' because parts of the universe out of speed of light contact cannot possibly be in communication. For most of the time, this assumption of Local Reality 'works': it is an accurate descriptive model of how most things in the universe interact. However, recent quantum physics experiments on photons, electrons, atoms, and even molecules demonstrate beyond doubt that particle interactions result in non-local correlations.<sup>8</sup> This means that although there is no signal transfer in the classical sense between these particles, nevertheless, they can be instantaneously 'connected' over vast distances and across time itself, a phenomenon known as *quantum entanglement*.<sup>9</sup> It is as if at a deep level, everything in the universe is instantaneously linked together in a vast holistic matter-energy network of interacting fields which transcends ordinary concepts of space and time. And we, composed of trillions of particles are an inseparable part of it: far from what reason seems to tell us.

The three Local Reality points above have been expanded into seven propositions, which are essentially 'articles of faith',<sup>10</sup>:

- (1) *The universe is consistent over all space and all time.*
- (2) *The universe is understandable, ie, predictable.*
- (3) *What is valid here is valid elsewhere.*
- (4) *The universe is material and not spiritual.*
- (5) *Everything that is physical is observable.*
- (6) *The universe can be described and ascertained mathematically.*
- (7) *Experiment validates theory.*

This 'catechism' arises out of science's primarily inductive logical structure. Philosophers have described two types of reasoning called deductive and

inductive logic. In the former, one can draw true conclusions from true starting premises. For example, consider the following statements:

- *All swans are white.*
- *The creature in front of us is a swan.*  
Ergo, from these two premises, we can conclude (especially if we choose not to look) that:
- *The creature is white.*  
With inductive logic however, we move from the particular to the general from premises about objects we have examined, towards conclusions about objects that we have not yet examined. Thus:
- *Every swan I have ever seen has been white; Ergo....*
- *The next swan I see will be white.*

What this simple example demonstrates is that many of our beliefs are based on extrapolations from observed (past or present) events to situations which are unknown, unobserved, or in the future. It was the 18th century philosopher Hume who pointed out that inductive reasoning is based on custom or habit, and in so far as it predicts the future will resemble the past, cannot actually 'prove' anything, for instance the impossibility of a swan being black. Hume also pointed out that the principle of induction cannot itself be proven by induction. The word 'proof', in fact, should be applied strictly only when reasoning deductively, as in mathematics. As most science is rooted in inductive logic, it follows that it too is predictive and actually incapable of proving or disproving anything.

In addition, Peirce drew attention to abduction which refers to the creative process prior to induction and deduction, by which scientists arrive at their initial hypotheses in the first place.<sup>11</sup> It involves ordering disparate pieces of information into a first hypothetical structure and may be likened to pattern recognition: something humans seem particularly good at. Reductionist scientific theories generally overlook or are incapable of considering the process of abduction.

So what tends to happen in practice is that the **more** often a premise's predictions turn out to be fulfilled, the more it is taken as 'proof' that the premise must be true. Eventually, the 'truth' of the premise becomes ingrained: it changes from 'Every swan I have ever seen has been white' to 'All swans are white.' From that moment, black swans are 'impossible'.

Most people assume that science starts from secure reproducible observations out of which 'facts' about the world are distilled, an ideal enshrined in logical positivism. Its core beliefs are that scientific questions can be answered completely objectively; that experiments allow scientists to compare theory directly with facts; and that science is a sure route to 'truth'. In this respect, it is scientifically established 'evidence' that is now supposed to provide the only basis for the 'facts' on which medical decisions are to be based, regardless of practitioners' empirical 'hands on' experience and intuition.<sup>12,13</sup>

However, since the second half of the 20th century, logical positivism has been under sustained attack as being too simplistic from Post-Modernist philosophies of science.<sup>14</sup> There is no such thing as unbiased observation free of any sociological or cultural conditioning, even in science and even under the most stringent experimental circumstances. Therefore, our acceptance or rejection of 'evidence' is also open to serious question. Our tendency is to reject evidence which does not fit with currently-held theory. Consequently, positive results from even the highest standard scientific trials are rejected by those who will not accept homeopathy's claim that remedies diluted out of molecular existence might have any effect. For black swans, read homeopathy.

Kant, in the 18th century, pointed out that observation depends on our individual senses, assumptions, and background beliefs.<sup>15</sup> He suggested that our picture of the world is structured by a combination of sensory data ('phenomena') and fundamental concepts of reason, eg. 'causation', that are culturally 'hardwired' into our minds. Consequently, we cannot know anything about how the world 'really is'. Recent interpretations of quantum theory<sup>16</sup> take this idea further by suggesting there is no world 'out there' separate from and independent of our observation of it. Or even more starkly, information is all there is.

## Local hypotheses and the memory of water

Benveniste did not coin the phrase 'Memory of Water' (MoW), as research into solvent effects dates back to the 1960s. However, his research was highlighted by Nature in 1988,<sup>3</sup> and subsequent failed attempts to repeat it.<sup>17</sup> A multi-centre European trial involved modifications to Benveniste's original method (eg. the use potentised histamine instead of anti-IgE), and was statistically significant only on pooling the results from all the laboratories involved.<sup>18</sup> Though still controversial, MoW is based on the same conventional scientific notions of atoms and molecules that inform chemistry, biochemistry and molecular biology. I shall deal with this on a general basis only as excellent and more detailed contributions will be found in this issue from Anick, Chaplin, Elia, Rey, Rao and others.

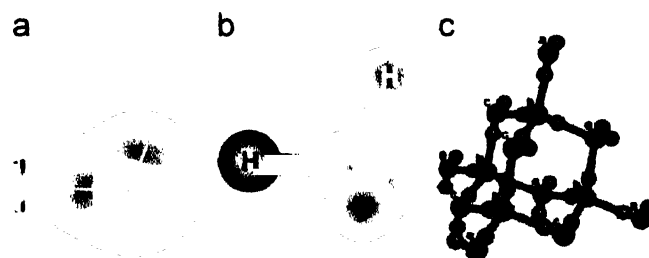
As Albert Szent-Gyorgyi pointed out, 'Water is the mater and the matrix, the mother and the medium of life.'<sup>4</sup> Without water, life as we know it would be impossible. Yet, water is more complex than the simple chemical formula H<sub>2</sub>O suggests. Oxygen, at the top of Group 16 in the Periodic Table, is a gas while the other members of this column (sulphur, selenium, and tellurium) are solids. With the di-hydrides of these elements we notice another major difference. H<sub>2</sub>S, H<sub>2</sub>Se, and H<sub>2</sub>Te, are highly toxic, inflammable,

evil-smelling gases, while H<sub>2</sub>O is a clear, tasteless, odourless, life-giving and sustaining liquid (see Table 1). This is due to electrical forces originating within the oxygen atom. Apart from establishing the main chemical bonds between each oxygen and two hydrogen atoms, they also give rise to extra more complex forms of weak bonding (hydrogen bonds and even weaker van de Waal's interactions). At room temperature these loosely bind individual water molecules into large rapidly-changing (in the order of pico-seconds) dynamic 'structures' (Fig. 1).<sup>4</sup> These, in turn influence interactions between chemical and biochemical entities.

Adopting a theatrical metaphor, if nucleic acids, proteins, carbohydrates, lipids and hormones, etc are the principal 'actors' in the unfolding biochemical 'drama' that is life at the molecular level, then water provides the stage, set, theatre, and direction. From this perspective, it could be that conventional biomedicine places too much emphasis on bio-molecules at the expense of the solvent in which they perform. Because of individual patterns of electrically charged and neutral atomic constituents, each type of bio-molecule will have associated with it an ever-changing 'halo' of loosely bound and interconnected water molecules.<sup>19</sup> At the charged sites on each bio-molecule,

**Table 1** Some physical constants for dihydrides of the Group 16 elements

| Compound          | Molar mass (g/mol) | Melting point (°C) | Boiling point (°C) |
|-------------------|--------------------|--------------------|--------------------|
| H <sub>2</sub> O  | 18                 | 0                  | 100                |
| H <sub>2</sub> S  | 34                 | -85.5              | -59.55             |
| H <sub>2</sub> Se | 81                 | -65.73             | -41.25             |
| H <sub>2</sub> Te | 130                | -49                | -2                 |



**Fig. 1** Molecular models of water: (a) shows a so-called 'space-filling' model and a representation of the electronic charge distribution over the water molecule. The green-to-pink envelope represents the distribution of electrical charge within the molecule, biased towards the oxygen atom. In (b), we see the more classical 'ball and stick' model. The red ball represents the oxygen atom while the white balls represent hydrogen atoms, the white spheres without inscribed 'H's' are hydrogen-bonded hydrogen atoms from a neighbouring (unseen) water molecule: the short white 'sticks' between the balls represent static chemical bonds between hydrogen and oxygen atoms. In (c), we see a representation of how water molecules might loosely bind to each other via hydrogen bonding (the longer white sticks) to form a coherent but short-term structure.<sup>20</sup>

water molecules will congregate, while few water molecules gather at the neutral sites. Thus, electric fields generated by bio-molecules will be modified and modulated by their surrounding ever-changing but coherent 'halo' of water molecules, and this could be transmitted extremely rapidly partly via water's rapidly switching network of interconnecting hydrogen bonds, throughout the whole solvent and received by other bio-molecules.

There is much about water yet to be discovered, so that even if scientific attention were to shift away from bio-molecules to their aqueous medium, the experimental and theoretical problems would be enormous. For example, within a single cell, there are huge differences in the water content and properties of its various parts, from the jelly-like consistency of the cytoplasm, to the more fluid content of vacuoles. Modelling such diversity is likely to be a computational nightmare.<sup>19</sup> However, modelling water itself shows that its molecules can form short-term coherent 'structures', whose life is of the order of pico-seconds ( $10^{-12}$  s) similar to icosahedra (Fig. 2) around central cavities that may contain, or may have once contained solute species.<sup>20</sup> From here, it is not hard to imagine that such dynamic aqueous 'structures' could be the bearers of a 'memory' of things once dissolved but now dissolved out.

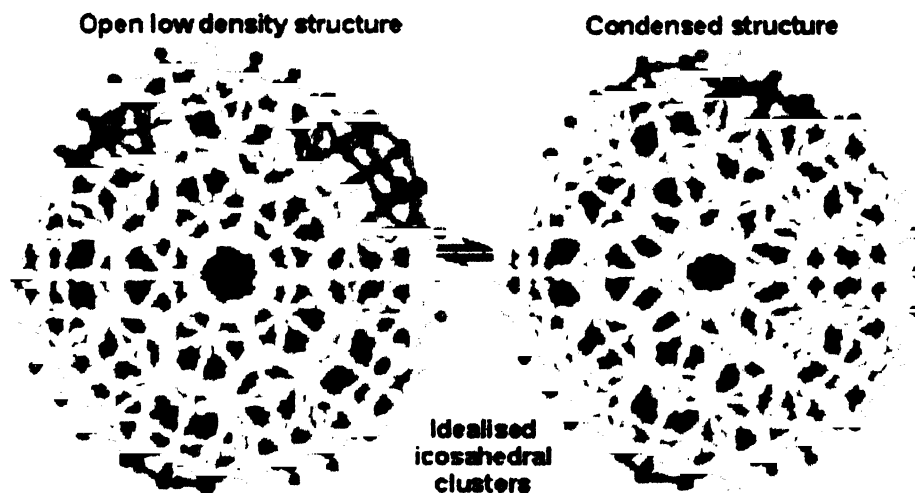
Using chemical terminology, MoW might be considered a supra-molecular phenomenon involving many water molecules. This means that MoW would be an emergent dynamic property of bulk liquid water (ie. involving many trillions of water molecules: in other words, the whole is more than the sum of its individual molecular parts). This would defy explanation in terms of the usual ideas of static chemical bonds and purely additive behaviour between individual water molecules alone. Certainly water molecules' ability to dynamically switch hydrogen bonding to each other would be of crucial importance here, as are other weak intermolecular interactions (eg. van de

Waal's forces). Chaplin gives a compelling description of this behaviour on his website.<sup>20</sup>

Sceptics often quote the laws of thermodynamics as grounds for the impossibility of MoW. They are correct if one attempts to understand MoW effects in terms of a system at thermodynamic equilibrium. However, the principles of *equilibrium* thermodynamics cannot explain what happens to a system far from equilibrium, especially at what are called *critical points*. These are temperatures and pressures where, for example, a gas is just about to liquefy. In this *critical state*, a gas is much denser than under normal equilibrium conditions. It remains as a single phase system but is exquisitely sensitive to even the slightest externally-induced fluctuations, which can cause separation into gaseous and liquid phases.

Now, highly metastable far-from-equilibrium critical states develop patterns of chaos and self-similarity better described by Prigogine's seminal work on non-equilibrium thermodynamics than by classical thermodynamics. Such states occur during the chemical reactions within living cells.<sup>21</sup> Hankey has presented a plausible hypothesis that might help explain MoW effects in terms of such critical points acting as local dynamic attractors of a system. This led him to a novel model of the life force, capable of predicting the correct relationship between it and cure in several systems of complementary medicine, including homeopathy.<sup>22</sup>

The key to such models is the recognition that fluctuating instabilities at critical points necessarily exist in quantum form, and require quantum descriptions to predict their effects. It turns out these quantised instability fluctuations can serve the highly unusual function of 'lifting' quantum properties out of their confinement within the microscopic domain of atoms and molecules, and into our macroscopic world of bulk material properties. Under these exceptional circumstances, macroscopic systems may exhibit similar properties to microscopic quantum systems, such as



**Fig. 2** Two coherent icosahedral water 'structures' formed from dynamic hydrogen bonding between water molecules. These diagrams represent 'snapshots' and are not meant to depict long-term chemical structures.<sup>20</sup>

coherence, and this has been observed and recognised with low-temperature superconductors and superfluids.<sup>23</sup>

Interestingly, support for the MoW concept has come recently from the field of materials science.<sup>24</sup> Using a large interdisciplinary research base, Roy *et al* examined the structures of many non-crystalline, inorganic, covalently-bonded condensed liquid phases, including liquid water. They predicted that at ambient conditions, typical samples of water likely contain many dynamic water structures. These consist of a statistical mixture of single water molecules (monomers) and different-sized water molecule clusters (oligomers), the largest consisting of several hundred H<sub>2</sub>O units. From this, they arrived at the important conclusion that it is solution structure not solution composition which is important in determining the plausibility of MoW effects. From the materials science perspective, although an ultra-diluted solution (where the solution is diluted out of existence) up having the same *composition* as the original solvent water, their *structures* could be entirely different.

In quantum physics there is also support for the MoW concept. For example, Smith has for many years argued for electromagnetic coherence and memory effects in water.<sup>25</sup> While Del Guidice *et al* predicted that given a large enough number of water molecules (of the order of 10<sup>15</sup>–10<sup>17</sup>, an amount visible to the naked eye), the sum total of all the hydrogen-bonded interactions between the water molecules could, under the right circumstances, lead to a dynamic, rapidly fluctuating yet correlated state where they all resonate together, spontaneously organising themselves into so-called 'coherent domains'.<sup>26</sup> Del Guidice *et al* went on to show that such dynamic and correlated 'coherent domains' could not only be triggered by homeopathy's potentiation process (ie, serial dilution and strong agitation), but that they would survive removal of all trace of the original dissolved substance. In other words, a possible theoretical mechanism for MoW effects exists and fits neatly with Roy *et al*'s conclusions on the importance of solution structure over composition.

Critics of MoW incorrectly assume that that the physical and chemical properties of a solution are not dependent on its history. Samal and Geckler have reported such historical dependence in a series of experiments, using solutions of a wide variety of substances including common salt, starch and DNA at different non-homeopathic dilutions.<sup>27</sup> This work demonstrated that molecules of a substance aggregate on dilution rather than getting further apart as common sense might suggest. Also, the size of these molecular aggregates relates to the starting concentrations of the original solute: in other words, they show an **historical** dependence.

In a completely different field, Rey obtained thermoluminescence data from highly agitated ultra-high dilutions of lithium and sodium chloride, suggesting

reproducible differences from pure water diluted with itself.<sup>28a</sup> However, replication of this study by van Wijk though to some extent reproducing Rey's original findings, failed to show statistical significance until the solutions had been standing for several weeks prior to obtaining thermoluminescence data.<sup>28b</sup> This could suggest the possibility of the data being artefactual as a result of the D<sub>2</sub>O used in the experiments leaching traces of silica from the glassware. Such silica leaching artefacts have previously been noted in high-dilution experiments.<sup>29</sup> However, Elia has obtained thermodynamic and conductivity data which strongly suggest that the process of sequential dilution and succession is capable of permanently modifying many of the structural features of water. Elia concludes that, thermodynamically speaking, such systems are far from equilibrium and capable of self-organising themselves as a result of only small perturbations, confirming Roy *et al*'s conclusions.<sup>30</sup>

It is perhaps sufficient to say that an explanation for the efficacy of highly diluted homeopathic remedies within the 'local' paradigm of the molecular sciences, though difficult is not as improbable as homeopathy's critics claim.

## Non-local hypotheses and macro-entanglement

In which case, why bother with quantum theoretical non-local hypotheses? Simply because deterministic local hypotheses could have the effect of confining attention to the medicine as the sole therapeutic agent, at the expense of the perhaps equally important contextual dynamics of the patient–practitioner relationship. Having said that, it is worth pointing out that some local explanations of homeopathy's effects, eg Del Guidice *et al* and their concept of 'coherent domains' of water molecules moving in some correlated fashion, are strongly suggestive of entanglement at the molecular level.<sup>26</sup> Consequently, it is worth remembering that the sections in this paper headed 'local hypotheses' and 'non-local hypotheses' are not intended to suggest that they are mutually contradictory. On the contrary, it is far more likely that both will be required in order to fully explain homeopathy's effectiveness: a prediction consistent with the complementary nature of quantum theory.

Biomedicine takes little account of patient individuality or therapeutic context. From this point of view, perhaps the time has come for the discussion of homeopathy (indeed of all therapeutic modalities) to move out of the narrow confines of deterministic biomedicine. Theoretical models need to be developed that more fully encompass and make sense of its experiences, while at the same time not losing sight of the 'local' importance of the medicine. But why invoke non-local explanations based in something as seemingly exotic as quantum theory? How could it

possibly apply to 'macroscopic' objects, especially people? And does not that play right into the hands of sceptics who accuse homeopaths of clutching at ill-understood scientific straws so that they can justify the patently unjustifiable? It is probably worth noting that homeopathy's sceptics do not have a monopoly on the understanding or indeed misunderstanding of quantum theory. As the Nobel-prize winning physicist Richard Feynman once famously remarked, 'Anyone who thinks they have understood quantum theory has probably got it wrong!'<sup>31</sup> For example, a common assumption is that quantum theory and its implications apply only within the confines of particle physics, not in our macroscopic world.

It is true quantum theory's algebraic language is dominated by an incredibly small number called Planck's constant ( $6.626 \times 10^{-34}$  Js), commensurate with observations and measurements of events occurring at the sub-atomic through to the molecular domains. However, it turns out that one of the strangest outcomes of quantum theory—the notion of entanglement—need not be size-limited.<sup>32</sup> Entanglement is said to occur when the parts of a system are so holistically matched, measurement of one part of the system instantaneously (ie, not limited by the speed of light) provides information about its other parts, regardless of their separation in space and time.<sup>9</sup> What is important is whether the elements of the system are correlated (ie, act as one coherent indivisible whole), and whether such a system's processes can be described using a 'non-commuting algebra of complementary observables'.<sup>33</sup> This means when two separate operations of observation are performed sequentially, *the overall result depends on the sequence and what is being measured*. This is readily understood when considering a set of operations involved in, say, cooking. Here the operational sequence is paramount, for in a different order, instead of a tasty meal, one is likely to end up with any number of disagreeable and inedible offerings. Expanding on this concept leads to another key idea from quantum theory: *complementarity*.<sup>31</sup>

Thus, a single explanation or model might not adequately explain all the different observations that can be made on a quantum system. For example, in order to explain how electrons are diffracted when they strike the atoms in a crystal lattice, it is necessary to assume that each electron behaves as a wave. However, when considering the photoelectric effect and electrons being expelled from a solid when struck by photons of the right energy, it is necessary to assume that the electrons and the photons are behaving as particles. This results in the well-known apparent contradiction of particle-wave duality. The point is, in order to fully explain quantum phenomena it is necessary to have two different but complementary concepts. It is almost as if the answer one obtains on performing the two observations depends entirely on how the (experimental) question is asked; and *both* are

necessary in order to acquire a complete picture of a quantum process or system.

But notions of complementarity and entanglement have implications far beyond the specific meaning ascribed to them in the orthodox quantum theory of particles, atoms and molecules. Using less formal approaches, examples have been cited from engineering, the cognitive sciences, especially psychology, and philosophy.<sup>5</sup> Atmanspacher *et al* took the radical approach of developing a more generalised version of quantum theory which relaxes several of orthodox quantum theory's axioms, including dependence on Planck's constant. Called Weak Quantum Theory (WQT),<sup>5</sup> it differs from orthodox quantum theory in that:

- Complementarity and entanglement are not restricted by a constant like Planck's constant.
- WQT has no interpretation in terms of probabilities.
- Complementarity and indeterminacy are epistemological in origin not ontological.

As a result, WQT explicitly allows quantum theory's application into such macroscopic areas as philosophy, psychology and information dynamics and into possible explanations of the dynamics of healing.

## Quantum theory and homeopathy

Classical physics and quantum physics differ in an important respect. The former enshrines common sense, for everything considered physical is observable and therefore measurable: this is the *leitmotif* for all reductionist science and underpins the whole of biomedicine. However, in quantum physics this is not always the case: *not everything considered physical is observable or measurable*.<sup>33</sup> So, in quantum physics, there is the concept of the wave function which is not a directly observable entity as such: only its effects are. A wave function is considered to be a multi-dimensional descriptor of a system's state, whose existence may only be inferred from the observable effects it produces in our 'reality'.

The reason for this is not because of any fault in measurement; it depends on the mathematical language we use to describe those measurements. Thus, measurement of a quantum state, as with any experiment, provides data in the form of what are called *real numbers*, eg, the numbers we use everyday like 1, 2, -6,  $\pi$ , e, 1/2,  $\sqrt{2}$ , etc. But because mathematicians and physicists think in many more than four dimensions, they need a much more versatile number system. And in mathematics, the real numbers are seen as a special case of much larger number sets. One of these is called the complex numbers,<sup>34</sup> used to fully describe the multi-dimensionality of quantum states in a way that the real numbers cannot. Complex numbers are irreducible aggregates of real numbers

and 'imaginary' numbers, based on  $\sqrt{-1}$ , which cannot be understood in terms of real numbers.

Real numbers are part of the larger set of complex numbers but not vice versa. Trying to fit a state or a system whose full description requires complex numbers into the real number set is like trying to squeeze a three-dimensional cube into a two-dimensional plane: it does not fit and some information invariably gets lost, notably in this case, the cube's three dimensionality. It is a similar loss of information in trying to make sense of a quantum state's complex number description by translating it into the real numbers of hard data, that leads to much of what is considered to be 'quantum weirdness'.<sup>33</sup>

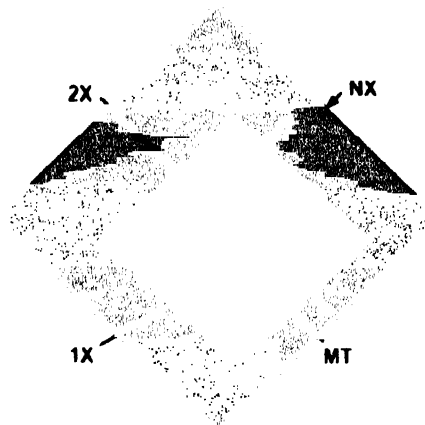
The consequences of the quantum description of reality for our view of the universe are profound. Ultimately it means relinquishing any notion of knowledge of things 'out there', 'in themselves', separate from our observation of them. We have to come to terms with the unsettling fact that in quantum theory, like the parts of a complex number, the observer and the observed are intimately and irreducibly connected. But what is it about quantum theory that could resonate with homeopathy and other forms of complementary and alternative medicine (CAMs)?

In homeopathy and other CAMs there is a notion of an all-pervading vital force (Vf) which strives to hold the whole organism in balance.<sup>35</sup> However, this Vf is not a directly observable entity: like the wave function in quantum theory, it is observed only indirectly through the effects it produces, in this case the patient's state of health. Thus, through this descriptive similarity of wave function and Vf, there is a similarity in discourse between quantum physics and homeopathy and other CAMs which include a concept of Vf. Perhaps quantum theory's language of non-commuting operations, non-locality and entanglement could be used to describe the homeopathic process.<sup>36</sup>

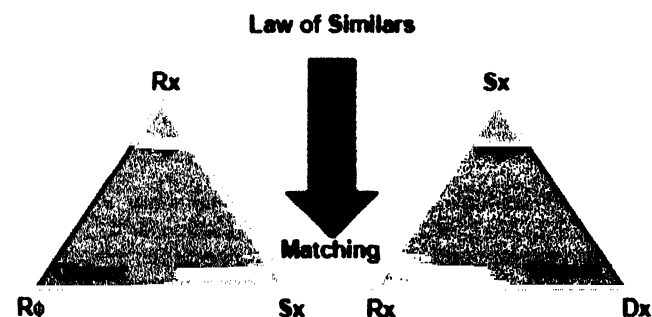
## Entanglement in the homeopathic process

There are several ways ideas derived from quantum theory can be used to describe the homeopathic process which may be ordered nominally in terms of the complexity of entanglement between different types of entities.<sup>7c</sup> Space limitations do not allow for their detailed consideration here, but see Weingaertner's contribution in this issue on possible non-local correlations between the different particles of solvent and solute.<sup>37</sup> Weingaertner's model attempts to understand the homeopathic process solely in terms of the potentised medicine as a pharmacologically-active substance, so only one type of entity is considered (Fig. 3).

Walach's semiotic model combines WQT with two-way entanglement (Fig. 4) between the patient and the remedy,<sup>7b,38</sup> while Hyland has developed a two-way



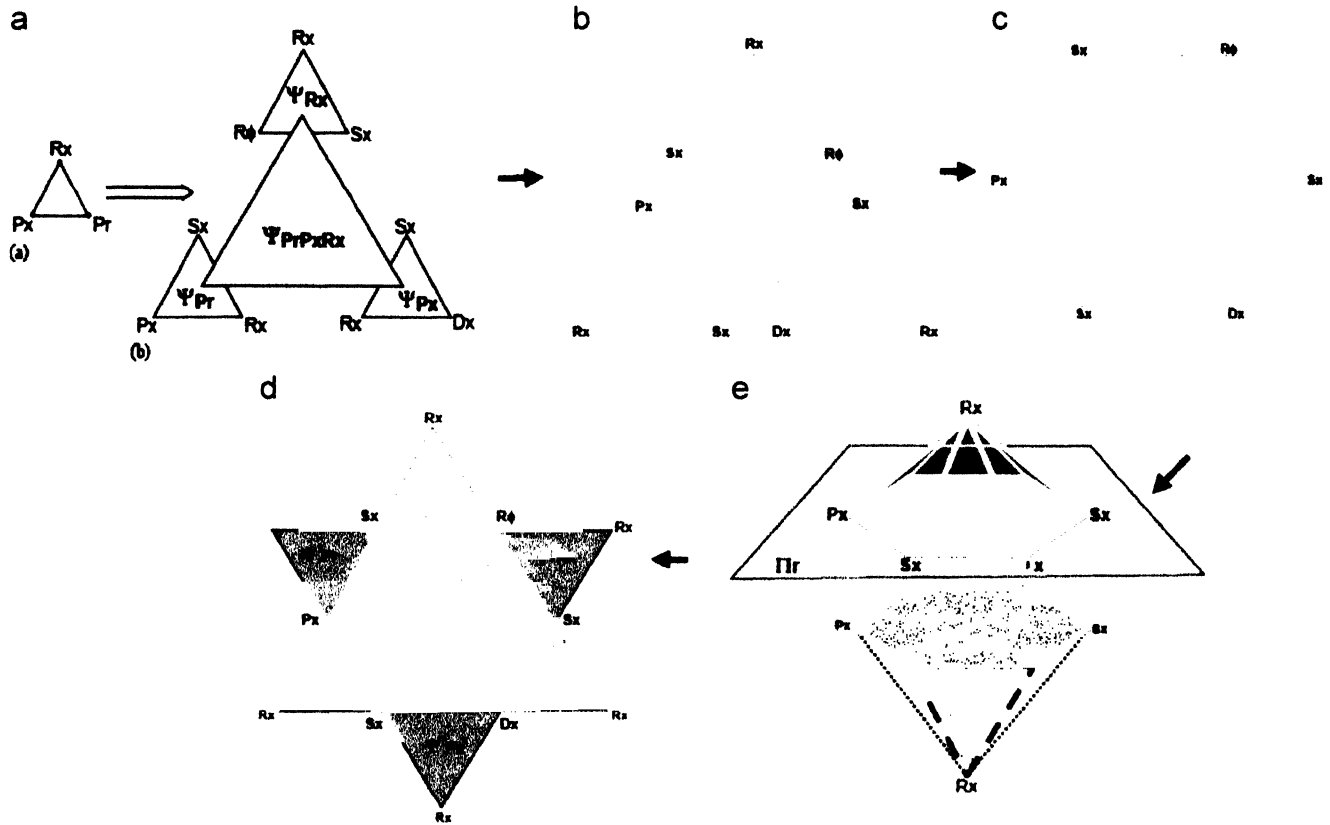
**Fig. 3** Diagrammatic representation of 'sequential box' model. It proposes the theoretical possibility of keeping a constant volume of mother tincture physically present in every potency. MT = mother tincture; 1x = ten times bigger box 9/10ths full of solvent into which MT is poured and succussed, and so on into 2X...NX.<sup>37</sup>



**Fig. 4** Walach's double entanglement model. Two semiotic processes linked by the Law of Similars. On the left, object = the remedy substance,  $R\phi$ ; sign = remedy, Rx; meaning = remedy picture, Sx. On the right, object = the patient's 'disease', Dx; sign = the patient's symptoms, Sx; meaning = the required remedy, Rx.<sup>7b,38</sup>

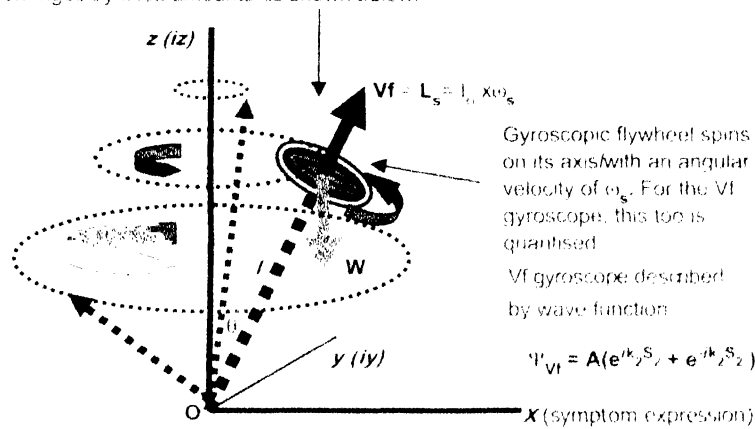
patient-practitioner entanglement model called Extended Network Entanglement Theory.<sup>39</sup> In the entanglement metaphors I am developing (Fig. 5), three-way patient, practitioner, remedy (PPR) entanglement is considered.<sup>7</sup> These are based on ideas derived from Greenberger-Horne-Zeilinger three-way entanglement of particles,<sup>40</sup> and quantum field theory.<sup>41</sup>

Here, the homeopathic process is regarded as a set of non-commuting complementary observations made by the practitioner. These are *local* (observations of the patient) and *global* (observations of the practitioner's own inner state, how that fluctuates during the consultation, and the state of the patient-practitioner relationship), resulting in the prescription of an homeopathic medicine. Patient, practitioner, and remedy comprise therefore a three-way entangled therapeutic entity, so that attempting to isolate any of them 'collapses' the entangled state,<sup>42</sup> represented geometrically in Fig. 5.



**Fig. 5** PPR entanglement represented geometrically. In (a), Walach's two semiotic triangles for remedy and patient (also wave functions,  $\Psi_{Rx}$  and  $\Psi_{Px}$ ) are joined by a third for the practitioner  $\Psi_{Pr}$ , which are entangled into the PPR 'state' represented by  $\Psi_{PPR}$  in (b). The multi-dimensional geometry of this state is represented in (c)–(e) and shows the action of the homeopathic operator  $\Pi r$  in 'reflecting' this state (d). But the reflection is not passive: by opening out the polyhedra in (d) and superimposing them, it is seen that the reflecting plane also twists the reflection through  $60^\circ$  (e). The 'space' in which these wave functions and 'operations' take place is a therapeutic state space created by the homeopathic operator  $\Pi r$ , which also functions within it.<sup>7,42</sup>

A gyroscope precesses about z axis with an angular velocity of  $\Omega$ . For an ordinary gyroscope this changes gradually, for the Vf gyroscope, on the other hand,  $\Omega$  changes by fixed amounts as shown below.



**Fig. 6** Schematic of the Vf gyroscope: a real gyroscope in 3-D space precesses around the z-axis sweeping out gradually increasing 'orbits' in the x–y plane. The metaphorical Vf gyroscope precesses in fixed quantised 'orbits' as shown and the y and z axes are complex. Symptoms are observed along the real x-axis. Thus, the Vf only 'appears' when it expresses symptoms in real space and time, represented by the x-axis in the figure.<sup>43</sup>

In addition, the Vf may be envisaged as observable only from the amount and severity of the *observed* signs and symptoms it produces. From this, it is possible to construct a mathematical metaphor for the Vf as a *multi-dimensional quantised gyroscope* (Fig. 6).<sup>43</sup> The slower the Vf gyroscope 'spins', the less upright it stands against the braking effects of disease: it begins to 'wobble', or, in this metaphor, to express symptoms. Conversely, the therapeutic remedy increases the Vf's spin rate, throwing off the disease. Thus remedies and diseases may be understood as accelerating and braking 'torques' acting on the Vf gyroscope.<sup>43</sup>

Mathematically, Vf, diseases, and remedies can be represented as 'wave functions' (without yet specifying the 'particles' involved or 'interactions' between them), leading to the prediction that the more potent a remedy, the *greater* its effect on the Vf. At very low potencies, when a homeopathic medicine is used in a material dose as in conventional medicine, the gyroscopic metaphor approximates in such a way as to deliver predictions about the *lack of therapeutic efficacy* of highly-diluted homeopathic remedies in line with those of conventional medicine.<sup>44</sup>

In other words, the Vf gyroscope metaphor may be pointing towards a more inclusive paradigm about the effects of remedies that contains both homeopathy and conventional medicine and explains their apparent contradictions. In this sense, the metaphor could be said to parallel theoretical developments in conventional science, where new theories supersede older ones, yet generally include them. Perhaps it suggests that conventional medicine is a smaller subset of a much broader holistic paradigm that includes homeopathy.

## Conclusion: a therapeutic Uncertainty Principle?

One application of the PPR entanglement metaphor I have described is to provide a rationale for why RCTs of homeopathy often return equivocal results.<sup>45</sup> It suggests the double blind RCT 'collapses' the three-way patient-practitioner-remedy entangled state in a way analogous to that by which observation collapses a particle's wave function in the Copenhagen Interpretation of orthodox quantum theory.<sup>46</sup> Thus, while unobserved, a particle exists in an indeterminate state: its evolution in time expressed as a wave function. Observation causes the wave function to 'collapse' to a particle whose complementary position and momentum are related via Heisenberg's Uncertainty Principle. The profound meaning of this is that the act of observation in part creates that which is observed. Or, even more starkly, "The price of knowledge is the loss of an underlying ontological physical reality".<sup>47</sup> In a similar way, the observational procedure of the RCT may 'collapse' the three-way entangled state, leading to

the loss of the underlying homeopathic effect, a therapeutic equivalent of Heisenberg's Uncertainty Principle.

But some trials of non-individualised homeopathic remedies have generated positive results.<sup>45</sup> This could be due to some surviving relic of entanglement from the production process, ironically as a result of a water memory effect. The work of del Guidice *et al* mentioned earlier, suggested the formation of 'coherent domains' within water's dynamic hydrogen-bonded 'structure'.<sup>26</sup> Such mass correlation over huge numbers of water molecules suggests a form of molecular entanglement.

The tantalising prospect emerges that there could be several levels of entanglement operating during the homeopathic process: the molecular (created during production of the homeopathic medicine), contextually integrated into that occurring between patient, practitioner, and remedy.<sup>48</sup> Consequently, although double-blind RCTs on non-individualised homeopathic remedies rule out the possibility of over-arching three-way PPR entanglement, the residual molecular entanglement built into the remedy via water memory effects could survive, explaining the positive effects observed in many homeopathic clinical trials.

Ultimately, it will be necessary to find experimental protocols that demonstrate entanglement in the therapeutic process. This is not easy, but clues have been uncovered in double-blind homeopathic pathogenetic trials (HPTs, provings). Many HPTs have not been conducted in a double-blind placebo-controlled manner. After symptoms have been gathered, collation of the data allows a remedy picture to emerge, traditionally one of the central 'pillars' of homeopathy.<sup>49</sup> In two recent double blind placebo-controlled provings, although there were differences in proving symptoms between remedy and placebo groups, there was also overlap or 'leakage' of symptoms between them.<sup>49,50</sup> Walach *et al* concluded that as a result of blinding, remedy and placebo groups had become entangled, another demonstration of a possible therapeutic Uncertainty Principle, perhaps? Interestingly, there has been some independent confirmation of this result recently by another research group,<sup>51</sup> and an explanation couched in terms of the PPR entanglement metaphor.<sup>45a,52</sup>

Another approach might be to set up a therapeutic analogue of the famous Aspect experiments of the 1980s that demonstrated entanglement between photons.<sup>8</sup> These experiments depended on the violation of Bell's Inequalities (our 'intuition' based on local realism, makes predictions which differ markedly from those made by quantum mechanics: these predictions are enshrined in Bell's Inequalities: if they are violated, then the predictions of quantum mechanics, e.g., entanglement, must be true and our intuition wrong). A way forward might be to use the much more general Information Theoretic Bell's Inequalities—if local realism does not hold, then two systems must carry

information inconsistent with the inequalities. The design of suitable experiments is currently being explored.<sup>53</sup>

In conclusion, what this all seems to be pointing to is that, far from being competing, contradictory explanations, 'local' MoW and 'non-local' contextually 'entangled' effects (like wave-particle duality in orthodox quantum theory) could be complementary and both are necessary in order to make sense of homeopathy's effects.

## Acknowledgements

I thank Bill Scott, Kate Chatfield and Professor Harald Walach for introducing me to the consolations of philosophy.

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