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EDITORIAL

Local, entangled or both?

This issue of Homeopathy features three papers which revive the discussion about the locus of action of homeopathy. Traditionally it has been assumed that the method of production of homeopathic medicines induces structural change in the water/alcohol mixture in which they are made and that these changes are responsible for the actions observed in clinical trials and *in-vitro* and *in vivo* models. Hypotheses of this type are often referred to as 'memory of water', this phrase appeared in the course of the 'Benveniste Affair' of 1988, although not coined by Jacques Benveniste himself.[1–3]

Indeed until about 10 years ago, such hypotheses seemed to offer the only plausible explanation of the actions of the ultra-molecular dilutions which are characteristic of, and the source of most of the controversy around, homeopathy. However the seminal paper by Atmanspacher *et al.* published in 2002 introduced an original line of thought, based on 'weak quantum entanglement'.[4] This concept has been further developed, notably by Walach (who was a co-author of the original Atmanspacher paper) and by Milgrom. Weak Quantum Theory is a version of Quantum Theory which makes it applicable to macroscopic systems. Quantum mechanics is certainly valid at the microscopic level, accurately predicting counterintuitive phenomena including quantum entanglement, whereby subatomic particles with a common origin remain 'entangled', so that investigating one particle instantaneously influences the others, even when they are separated by enormous distances. This was famously described as 'spooky action at a distance', by Albert Einstein, who never fully accepted quantum theory. The reality of this phenomenon was proven by the 'Aspect' experiment, after the French physicist Alain Aspect, whose experiments on the polarization of photons published in the early 1980s provided some of the first conclusive proof of quantum entanglement at the microscopic level.

Various different versions of weak quantum theory applied to homeopathy have subsequently emerged; they vary particularly in the number of elements entangled. The most elaborate of these theories is that of Lionel Milgrom which involves three-way entanglement between patient practitioner and remedy. He has developed this into the intriguing but speculative possibility of multidimensional healing, drawing an analogy with the imaginary two-dimensional universe of Flatland in which, for instance, a cube is perceived as a series of polygons of changing shape and size.[5]

Testing entanglement

As I pointed out in a previous editorial, and as a Francis Beauvais notes in his paper in this issue of Homeopathy, weak quantum theories for homeopathy have never been tested; indeed no experimental test has even been proposed.[6] Until now that is: in this issue of Homeopathy, in a curious case of synchronicity, two papers suggest practical experimental methods whereby the involvement of nonlocal mechanisms in homeopathic treatment might be tested.

Beauvais, who was one of Benveniste's collaborators, applies a quantum-like statistical model based on single-particle quantum interference to randomized controlled trials of homeopathy.[7] This gives rise to a remarkable and testable prediction: that the difference between placebo and homeopathy groups vanishes in centralized blind trials due to 'smearing' (effects of homeopathy occurring in the placebo group). And that this could be avoided by *in situ* randomization and unblinding whereby all observables are measured and all operations from randomization to unblinding are performed locally, in a defined order, without central supervision, but recorded in an unalterable way. Along similar lines, Yannis Almirantis notes that if nonlocal factors are involved, there will be resistance to reproducibility, so effect sizes will be larger if control treatments were randomly selected homeopathic medicines, rather than identical blanks, since this introduces uncertainty.[8] These theories are testable and have important practical implications if verified.

Beauvais's theory hinges on a single enigmatic variable which he terms θ (theta), which connects expected effects with observed success/failure. He declines to define the nature of this variable although he says it may 'summarize cognitive and mental phenomena….and unknown mechanisms'. It is difficult to see how 'cognitive and mental phenomena' might be implicated in the human basophil degranulation experiments to which Beauvais refers, or how 'significance' conveyed to cell cultures, plants and physicochemical systems as hypothesized by Almirantis.

20 Years of NMR relaxation

However before getting too carried away, we should recall that there is substantial evidence of structural phenomena induced in water by homeopathic preparation methods, as required by 'memory of water' theories. Jean-Louis Demangeat's work has contributed substantially to this body of knowledge and in this issue of Homeopathy,

he summarizes his 20 years of work, including some previously unpublished findings. His work has focussed on the nuclear magnetic resonance relaxation spectra of ultra-molecular dilutions of histamine and triturated silica and manganese, including dilutions far into the ultra-molecular range.[9] In a long series of large-scale experiments he found increased T1 relaxation times and T1/T2 ratios. These indicate increasing structuring of water despite absence of the initial solute. All changes vanished after boiling. These findings are interpreted as reflecting the presence of nano-size (>4 nm) supramolecular structures involving water and gas nanobubbles. They suggest the existence of stereo-specific superstructures that originating around the solute after an initial destructuring of the solvent.

Are local and entanglement theories incompatible?

Demangeat's results are convincing and statistically robust. However the 'local', 'memory of water' hypotheses concerning the action of high dilutions and the 'non-local' weak entanglement hypotheses are not necessarily incompatible, as Milgrom has pointed out.[10] Other intriguing issues arise: for instance why should macroscopic entanglement occur in homeopathy? Again there seem to be two possible explanations: either it is not unique to homeopathy, it is simply that because of the controversial nature of homeopathy the evidence has been more closely scrutinized than elsewhere.

Or there is a factor specific to homeopathy. For instance as Bell *et al.* have recently pointed out in this journal, the process of preparation of homeopathic medicines, particularly trituration, results in nanoparticles of the source material, and this might account for entanglement.[11] Macroscopic entanglement may occur between spatially-separated quantum colloidal semiconductor nanocrystals. Such nanoparticle crystallites can possess 'pseudo-atom' quantum properties because of their extremely large surface to volume ratio and the delocalized position of source material electrons close to the particle surfaces.

Beauvais and Almirante propose, for the first time, methods which allow the testing of entanglement theories of homeopathy. In principle the experiments would be relatively simple, although in practice there would, no doubt, be complications. It appears that these hypotheses apply equally to clinical trials and to laboratory methods involving living systems. The first step would be the design of laboratory experiments testing impact of the variables suggested by Beauvais and Almirante: *in situ* randomization/unblinding and the use of randomly selected homeopathic medicines as controls respectively, on the outcome of experiments.

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