The Possible Mechanism of Memory through Nanoparticles and Exclusion Zones

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Abstract

Pure water is neither affected by magnetic field nor keeps memory of its past experience. But amazingly, this property of water alters if it is exposed to air (oxygen), as liquid crystalline exclusion zones (EZ) build up, especially around nanoparticles present as impurities. The nanoparticle structure is not kinetically trapped, but responsive to environmental changes. Further, the EZ could contain surface-specific information. Based on these facts and on certain pharmaceutical and clinical observations in homeopathy, in this paper a novel "The Nanoparticle - EZ Shell Model" is developed. The goal is to understand the retention of memory of a source drug through serial succussed dilutions, where it physically no longer remains. This model suggests that during a few initial dilutions, nanoparticles adsorb the source drug which modifies their structure. Such nanoparticles, along with the adsorbed source drug as nucleator, build up modified EZ shells around them. Both the structurally modified nanoparticles and their modified shells have information about the source drug in "crude and condensed" form. In successive dilutions, during violent strokes at each dilution, the modified EZ shells strip off to spread as further modified EZ templates to nanoparticles present in that dilution, modifying their structures accordingly. Thus the source drug information passes, "evolving" from one dilution to the next, beyond even Avogadro. This model also explains other bizarre and wildly diverse aspects of homeopathic medicines. The proposed model provides a rational base for further research, as understanding homeopathic medicine may prove pivotal for understanding nanoscience, water and its so called memory.

Introduction

An increasing number of scientists (Gang *et al.*, 2012; Szczes *et al.*, 2011; Holysz *et al.*, 2007; Otsuka and Ozeki, 2006) are studying the properties and effects of magnetic or electro-magnetic (EM) field treated water. Such water has been found beneficial economically and ecologically in several applications like descaling pipes and boilers, reduction of the corrosion

rate of steel, enhancing water evaporation and cement hydration, and improving agriculture and medicine. (Colic and Morse, 1999; Otsuka and Ozeki, 2006; Toledo *et al.*, 2008).

In spite of all this, such a study has not been taken seriously in science. There are two reasons for it. First, it has been considered impossible scientifically and secondly, results on properties of such water have been found not very reproducible (Toledo *et al.*, 2008). The cause of poor reproducibility is that being a universal solvent, pure water is a myth. Many impurities, including the magnetic ones, and the quantity of dissolved oxygen affect experimental results (Toledo *et al.*, 2008). Otsuka and Ozeki (2006) showed that under conditions of extreme purity, physicochemical properties of magnetic field-treated water can be studied with scientific precision along with reproducible results. They confirmed earlier observations of others (Colic and Morse, 1999) that degassed water remains unaffected by magnetic fields. But after exposure to oxygen (or better air), water can be "magnetized" by the magnetic field (Otsuka and Ozeki, 2006). It retains this experience in "memory" for up to 200 hours after the field ceases (Coey and Cass, 2000).

Can the memory of water – that it was magnet-treated – be extended for a prolonged period? There is a therapeutic system of healing known as homeopathy (Fisher, 2012; Bellavite and Signorini, 2002; Vithoulkas, reprint 1993); which claims that yes, it can, and uses it as one of the sources for preparing medicines (Mandal and Mandal, 2002 p. 150).

Like magnet-treated water, homeopathy is a challenge to science (Fisher, 2012; Bellavite and Signorini, 2002). Here, a source drug is serially diluted with succussions (violent strokes) at each dilution level. This process, known as potentization (development of medicinal power) can be carried out in unlimited numbers, even going far beyond Avogadro. It is observed that the process often increases the curative power of the medicine so developed. Such medicine has therapeutic properties typical to the source drug. Medicines so developed are "medicines without molecules" and have always been controversial.

In spite of scepticism, homeopathy is widely practiced. It claims a holistic approach to healing, with "like cures like" as its central tenet (Fisher, 2012; WHO, 2009). There is worldwide increase in the use of these medicines, with rapid expansion of its global market (WHO, 2009). The medicines are time-tested and also cover infants and even animals (Oberbaum, 2013). They can even be applied to agriculture (Brizzi *et al.*, 2000; Betti *et al.*, 2003). Such dilutions are now increasingly attracting more physicochemical (Bellavite *et al.*, 1, 2013) and pharmacological (Bellavite *et al.*, 2, 2013) research.

Like magnet-treated water, reproducibility of results of scientific experiments in homeopathy has been a problem too. The much talked about Benveniste – *Nature* controversy (Thomson, 2007) leading to the "memory of water" debacle could be an example.

However, Konovalov *et al.* (2014a, 2014b) are confident of reproducibility of their results. They observed that physicochemical and biological properties of highly diluted aqueous succussed solutions ("homeopathic" dilutions) are due to the formation of nanosized (up to 400 nm) molecular assemblies mainly consisting of water molecules, under the influence of two effectors: solute, and geomagnetic or low frequency electromagnetic fields. They call such nanosized assemblies "nanoassociates," and they observed that in the hypoelectromagnetic conditions when they were not formed, bio-effects were absent.

Montagnier *et al.* (2009a) detected EM-signals from extreme dilutions of bacterial DNA and HIV DNA (2009b) (in the blood of AIDS patients treated by antiretroviral therapy) in water, but only with those dilutions where vortex agitation was carried out. The dilution level was so high that not even a single molecule of DNA was left (Enserink, 2010). Here Montagnier accepted that a homeopathic high potency is "not nothing." (Enserink, 2010)

Recently, Chikramane *et al.* (2010) reported that extreme dilutions reach non-zero asymptotes of the source drug from the sixth centesimal dilution onwards. They claimed to find the presence of nanoparticles of source drug in these extreme dilutions. This led them to the assumption that all afterward dilutions were only apparent, retaining the drug concentration of the previous dilutions. Consequently, a hypothesis of surface monolayer (1% of total volume but containing the entire source drug) formation, its floatation and then its retention, as poured out 1% "seed" in subsequent dilutions, was proposed as the working cause of homeopathic medicine (Chikramane *et al.*, 2012). But in practice, homeopathic medicine from a bottle is used up to its last drop, both for prescribing and for raising a higher potency. The Korsakoff method of potency preparation also contradicts this hypothesis (Bellavite *et al.*, 1, 2013; Ives *et al.*, 2010). Further, medicine is prepared in solid form too, by trituration, taking lactose as diluent. So this hypothesis is not applicable there.

Presently there are two main theoretical models (Bellavite *et al.*, 1, 2013) for "memory of water," namely, hydrogen-bonded clusters or clathrates (Anagnostatos, 1994) and quantum electrodynamic (QED) superradiance (Del Giudice *et al.*, 1988) whereby particles oscillate in coherent domains in phase with an ambient EM field.

The clathrate model is very speculative (Bellavite *et al.*, 1, 2013). However, the presence of clusters in water is well established both by computer simulations and analytical evidence (Bellavite *et al.*, 1, 2013). But liquid water essentially loses the memory of persistent correlations in its structure within 50 fs (Cowan *et al.*, 2005). Further, NMR spectroscopy could not provide evidence of pockets of fixed H-bonding (Anick, 2004). Chaplin (Web ref. 1) argues that the life of a cluster is independent of the transitory life span of hydrogen bonds. It should be noted that except in mother solutions and some very low potencies, homeopathic medicines have virtually an unlimited shelf-life without an expiry date. (Although safety issues are now compelling addition of expiry dates on these medicine labels in some countries (WHO, 2009). This may be required because of deterioration from aging of the supporting material.) The fact that these medicines can also be prepared in solid form, taking lactose as a vehicle, does not go well with this model either.

The coherent domains model of Del Giudice *et al.* is well rooted in quantum field theory, but lacks direct experimental support (Bellavite *et al.*, 1, 2013). It suggests that interaction between the ambient electromagnetic field and liquid water induces the formation of stable coherent domains of about 100 nm in diameter, "responsible for all the special properties of water including life itself" (Ho, 2014), as observed by Konovalov *et al.* (2014a,b). Del Giudice *et al.* (2010) also suggest that exclusion zone (EZ) water is a macroscopic coherent domain. S-Y Lo *et al.* (2009) have long been observing large supramolecular water structures in serially diluted aqueous succussed solutions of polar solutes. These stable structures do not contain silicon or other contamination and could be taken as coherent domains or EZ water (Ho, 2014).

At present, there is still no satisfactory

understanding of the observed memory phenomenon (Bellavite *et al.*, 1, 2013). Even quantum entanglement, fractals and chaos are considered for any possible explanation (Bellavite *et al.*, 1, 2013). Scepticism remains, hindering growth of homeopathy. So, "It is time to move ahead with research initiatives appropriate to the nature of this uniquely holistic system of complementary and alternative medicine" (Bell, 2012).

In this paper, new concepts are developed leading to a novel model for wholly understanding the memory retention phenomenon associated with magnet-treated water and homeopathic medicine.

The Seemingly Bizarre Homeopathy

The founder of homeopathy, Samuel Hahnemann (1755-1843), (Haehl, reprint 2003) first diluted drugs to make them gentle. Later, he observed that his medicines were more potent (effective) when he administered them to the patients at their homes. While going to these housecalls in a horse-cart, he got the idea of violent strokes (succussions) at each dilution level, and called such dilutions, potencies. These potencies are medicines in different powers (dilution degrees), having properties typical to the initial source drug from which they were developed. Hahnemann realized that his medicines could not be material-based and so he perceived them as "spirit-like."

For dilution, centesimal (1:99) or decimal (1:9) scale is often used, taking a suitable vehicle like water, alcohol (ethyl) or lactose (for preparation in solid form by trituration). The centesimal scale is more prevalent and its potencies are designated "C" or simply with no letter as designation. The decimal scale potency levels are designated by "X". A 6X potency has been diluted 6 times using decimal scale. It is materially equal to 3C potency and so they may be taken as equivalent to each other.

Liquid potentization is carried out with those source drug materials which are soluble in water or alcohol. When the source material is insoluble in water or alcohol, solid potentization (trituration) of the source drug is carried out to raise its potencies.

Medicines are routinely used often in a series of centesimal potencies like 30, 200, 1M, 10M, 50M and CM (Vithoulkas, reprint 1993 p. 165; Kent, reprint 1986 p. 280). The highest potency available in market is often CM, where Roman numerals "C" and "M" stand for 100 and 1000 respectively, denoting 10^5 times dilution in the scale 1:99. The chance of presence of source drug in homeopathic dose decreases serially with increasing potency and becomes increasingly trivial after 12th centesimal potency, the Avogadro limit.

One drop of this medicine may saturate 50 poppy-seed sized cane-sugar globules and one such globule may be sufficient to bring about therapeutic action. What a tiny dose! If 10 globules are taken instead of 1, therapeutic action remains the same (Kent, reprint 1986 p. 305).

In homeopathic therapeutics, a series of medicine potencies are not in vain (Vithoulkas, reprint 1993 pp. 213-217; Kent, reprint 1986 pp. 278-281), though each and every potency can effect a cure. A lower potency may act quickly, gently but comparatively superficially, in comparison with a higher potency which is often more suitable for chronic cases. This higher potency, which is a higher succussed dilution, often acts strongly (causing more aggravation) for a longer period, covering far more symptoms than can be cured by that medicine. Often a single dose of the medicine is prescribed in a suitable potency as long as its action lasts. A medicine often works only twice in a potency. In order to achieve further responses, its potency has to be changed by a large difference to a different, generally higher one (Kent,

reprint 1986 pp. 275, 278-281). This is why a clinic keeps a series of potencies of a medicine and how one potency is different from another.

Important Recent Developments

In the recent past, three major works have been carried out which may help to understand homeopathic medicine.

First, after the "memory of water" debacle, there were hints that leached silica from glass containers might be playing a role (Witt *et al.*, 2006; Roy *et al.*, 2005; Walach *et al.*, 2005). A silica hypothesis (Anick and Ives, 2007) was proposed, suggesting a physical entity responsible for homeopathy. It was realized that while (bulk) water itself has been studied, very little attention was paid to solid phases suspending in water, creating "ultra dilute aquasols" (Rao *et al.*, 2008). Silicates and other solutes are present at micromolar levels in all glass-exposed solutions (Ives *et al.*, 2010). A decade ago, Ullman (Web ref. 1) had a vision that homeopathic medicine is nanopharmacology.

Thus, it was perceived that instead of so called "memory of water" (Chaplin, 2007), leached silica (Witt *et al.*, 2006; Roy *et al.*, 2005; Walach *et al.*, 2005; Anick and Ives, 2007) or such nanoparticles (Anick and Ives, 2007) could memorize highly diluted source drugs in some way. Afterwards, silica-rich nanoparticles were observed in homeopathic medicines (Upadhyay and Nayak, 2011). It was suggested that these nanoparticles may do such memorising along with interfacial water on their surface, and the potency of a medicine could mean the "size" of information of the source drug they have (Upadhyay and Nayak, 2011).

Secondly, *Nature* published an interesting article (Zhang *et al.*, 2003) showing that a nanoparticle undergoes structural changes at room temperature in response to changes in surface environment, i.e. the nature of the surrounding molecules. This amazing property, that nanoparticle structure is not kinetically trapped, but responsive to environmental changes, lead to post–synthesis control of its structure and use of its structural state as an environmental sensor (Zhang *et al.*, 2003). The excellent suitability of the surface of silica nanoparticles for biochemical functionalization suggest the feasibility of using them for biosensing and biomarking applications (Qhobosheane *et al.*, 2001).

Thirdly, after the discovery of interfacial water forming massive exclusion zones (EZ) on a hydrophilic surface, it was realized that the previously understood water H_2O was "bulk water" and there is a new phase of water, H_3O_2, which is liquid crystalline in nature and very little is known about its amazing properties (Pollack, 2013). It forms exclusion zones which exclude practically everything suspended or dissolved in water (Chai and Pollack, 2010). "The exclusion phenomenon seems to fly in the face of the tenets of modern chemistry" (Pollack, 2013 p. 28). Its properties are so strange that it can rightly be called the fourth phase of water (Pollack, 2013 pp. 66-68).

Can this water retain information? "A subtle implication is that the nucleator imparts information to the EZ layer" (Pollack, 2013 p. 62). The information coding may be possible through removal of oxygen atoms from the hexagonal lattice of the generic EZ without impairing its structural integrity (Pollack, 2013 pp. 62-63). The phenomenology of homeopathic dilutions is found to be very similar to that of EZ water (Elia *et al.*, 2013). Pollack's work and his way of looking at nature (Pollack, 2013) suggests that nature is simple - indeed a grand vision.

Development of New Concepts leading to a Novel Model

Certain common pharmaceutical and clinical observations in homeopathy are quite thought provoking:

- A simple dilution without succussions is devoid of therapeutic value.
- A higher potency of remedy is often more powerful, covering more symptoms than a lower potency.
- Some therapeutically inert substances become wonderful medicines, especially at very high potencies, while their initial potencies (for certain medicines even up to 30C) are therapeutically inactive.
- At 3C trituration, an insoluble source drug becomes "soluble" and its further potencies can be raised in liquid form too.
- Initial potencies up to 6X of unstable source drugs cannot be kept for long. For example, the potencies of silver nitrate ($AgNO_3$) up to 6X (or 3C) are kept in sealed containers protected from light (India Ministry of Health,1971 p.56). This caution is not for potencies above 6X. Further, the potencies of ammonium sulphate (NH_4SO_4) up to 6X (or 3C) are to be prepared fresh in water for immediate use (India Ministry of Health,1971 p. 43). Its higher potencies have prolonged shelf-life, like that of other medicines.
- A virgin vial is required to keep the potency of a medicine.

Considering the above observations, a novel model/mechanism is proposed to understand the baffling memory phenomenon in the ambit of modern science. This model is an advancement of our previous work (Upadhyay and Nayak, 2011).

Keeping in view that homeopathic medicines contain silica-rich nanoparticles (Upadhyay and Nayak, 2011), a nanoparticle is sensitive to its surface environment (Zhang *et al.*, 2003), the EZ may contain surface-specific information (Pollack, 2013 pp. 62, 172), and nanoparticles along with their interfacial water, may memorize the source drug (Upadhyay and Nayak, 2011), the following hypotheses are proposed to complete this model:,

1. When adsorbed by nanoparticle, the source drug changes its structure up to 3C potency. With the adsorbed source drug as nucleator, this structurally modified nanoparticle builds up a modified EZ shell. By such structural modifications, the nanoparticle and its EZ shell both acquire source drug specific information.

2. The 3C potency is the optimal potency for completion of acquisition of source drug specific information. But the presence of source drug is still required at this potency, for reinforcement or consolidation of the acquired information. However, its presence is not required at 4C and higher potencies, as modified structures of nanoparticle and its EZ shell become stable.

3. The acquired source drug specific information is in "crude and condensed" form and evolves gradually with each homeopathic dilution, becoming more "decipherable" to biological systems.

4. In raising higher potencies after 3C potency, during succussions/ trituration, the EZ shells of those nanoparticles present in 1% "seed" strip off and spread as templates for further evolved information, to all the

nanoparticles present in the whole dilution. These nanoparticles then acquire new EZ shells which modify their structures accordingly. Thus the information evolves, passing from one potency level to next via the modified EZ water.

This proposed novel model may be called "The Nanoparticle - EZ Shell Model." Besides magnet-treated water, it has been applied to the various physicochemical, pharmaceutical and clinical observations of homeopathy, including preparation of medicines, to see whether it explains them satisfactorily.

Medicine Preparation: Memory Mechanism in the Proposed Model

Information Storage during Liquid Potentization

The simple looking succussion can have profound scientific meaning in the process of retaining information. It creates pressure in the 10 kbar range (Roy *et al.*, 2005), mixing air (oxygen) as nanobubbles at high speed, charging particles negatively on their way. Such a situation is like violent vortexing. The vortexing in the presence of air (oxygen) is very suitable for profound EZ building (Pollack, 2013 p. 180).

During violent strokes, silica and other constituent materials of glass will heavily leach from the wall of the vessel and even their nanoparticles may be scratched into the solution which already has its own nanoparticles, mostly as impurities. But as any hydrophilic surface present in the solution is suitable for EZ build up, and even hydrophobic surfaces can build EZ because of asperities (Pollack, 2013 p. 235), the presence of silica does not seem to be a compulsion.

The first solution of the source drug, prepared pharmaceutically in water or alcohol, is the most concentrated one. It is called the Mother Solution. During potentization, one drop of the source drug Mother Solution is added to 99 drops of water or alcohol (90% v/v). Then 10 violent strokes (succussions) are given to raise its 1C potency, and so on.

As per the first hypothesis, in the initial potencies up to 3C (or 6X), enough source drug material still remains present in the solution. During the violent strokes of potentization, EZ shells are stripped off from the nanoparticles present in the solution. During this period, these nanoparticles would adsorb the source drug. The structure of these nanoparticles are modified according to this adsorbed source drug. It is because any nanoscale material can face unpredictable structural change if exposed to adsorbates (Zhang *et al.*, 2003), and silica is especially suitable for surface modification (Qhobosheane *et al.*, 2001). During the above initial potencies, the structurally modified nanoparticles, along with the adsorbed source drug as nucleator, build up modified EZ shells around them. As per the second hypothesis, the complete source drug specific information is acquired, up to 3C potency of the medicine, by the nanoparticle and its EZ shell through their structural modifications. This acquired information is in "crude and condensed" form, according to the third hypothesis. The EZ, being negatively charged, would form a capacitor-like physical condition with the concentration of protons (H^+) at the boundary of EZ and bulk water (Zheng *et al.*, 2006), and this might also help in information storage (Gang *et al.*, 2012).

As per the fourth hypothesis, during succussions raising potency to 4C, the modified EZ shells on nanoparticles present in 1 drop (seed) of the 3C potency medicine would strip off to spread in the whole 1+99 drops of solution. This spreading EZ

would break up into small pieces, seeding (as template) further modified EZ shell buildup around nanoparticles present in the solution, which are acquiring new interfacial water cover after succussions. The structure of all the nanoparticles would now be changed in the newly modified EZ environment, while giving us 4C potency of the medicine. A higher potency can be raised in a similar fashion, evolving the acquired source drug information at each dilution.

Here, it becomes clear that mere serial dilution without succussion would rightly be devoid of therapeutic value, as observed in practice.

Information storage during solid potentization (trituration)

One part of the source material is added to 99 parts of lactose and grinded vigorously for 1 hour in an unglazed porcelain mortar as described in homeopathic pharmacopeia (Mandal and Mandal, 2002 pp. 159-166). The 1C potency of the medicine is thus produced. The very first level trituration alone reduces the particle size of the 80% source material to less than 10μm, leaving nothing more than 50μm in size (Varma and Vaid, 2007 pp. 2722-2745). It is a top-down approach of nanoparticle formation, where the lactose interaction stabilizes formed nanofractions from aggregation, segregating them from the coarser particles (Chikramane *et al.*, 2012).

Now 1 part of the above prepared 1C potency of the medicine is added to 99 parts of lactose and grinding is carried out as before for 1 hour reducing the particle size further. Thus the 2C potency of the medicine is obtained, which is followed by 3C and higher potencies in a similar way.

In the grinding process, a very small amount of constituent material is generated by the wear of unglazed porcelain mortar and pestle surfaces . Such contamination from mortar and pestle material, even by mild grinding, has been found to have substantial effects on the microstructure and transformation kinetics in material science (Dachille and Roy, 1960; Yarbrough and Roy, 1986).

During trituration, suitable inorganic nanoparticles (present as impurities or generated from the wear of mortar and pestle surfaces) may adsorb nano-fractions of source material, up to 3C potency, causing their structure to modify accordingly, as per the first hypothesis. These modified nanoparticles, along with their drug adsorbates, build up modified EZ shells, extracting complete information of the source drug up to 3C potency, as per the second hypothesis. Water can be acquired from the atmosphere to form EZ layers (Pollack, 2013 pp. 241, 296).

The 4C and higher potencies are often raised in liquid, as doing so is more convenient and labour saving. Pharmacopoeias state that from 3C triturated potency onwards, insoluble source drug material becomes "soluble." This common perception is taken here as a clue. It is perceived that by reaching 3C triturated potency, the inorganic nanoparticles and their EZ shells acquire the complete information about the "insoluble" source drug, which is no longer required in raising the next potency. The second hypothesis states this. The information acquired, however, is in "crude and condensed" form, as the third hypothesis suggests. In raising higher potencies, the source drug information is passed by evolving via the modified EZ water, as the fourth hypothesis suggests.

A variant may be possible here. Instead of inorganic nanoparticles, nanoparticles of lactose themselves could adsorb source drug, modifying their structure. In inorganic phases, however, structure can easily be changed without any change of composition (Roy *et al.*, 2005).

Vehicle, Nanobubbles and Shelf-life of Medicine

Potencies can be raised in purified water, if administered within a day or two. Hahnemann observed that if charcoal was put into water-made potencies, their shelf-life increased. This is perhaps because charcoal arrests microbial growth. Manufacturers often prepare intermediate potencies (say, between 1000C and 10000C, etc) in water to save alcohol. Moreover, as homeopathic medicine is also prepared in solid form by trituration taking lactose as diluent, it can be concluded that only water plays a role in memory retention, while alcohol serves as a diluent and preservative. This observation alone would make research in homeopathy less complex. However, ethanol also forms EZs much like water (Chai and Pollack, 2010).

For carrying out liquid potentization, it is necessary that at least 1/3 of the bottle remains empty (Mandal and Mandal, 2002 p. 166). Literature suggests that this is required to provide necessary friction during succussions. But what seems more important is that it would provide enough scope for mixing of air. A lot of bubbles are formed during succussions. Much hope has been pinned on these nanobubbles (Roy *et al.*, 2005; Demangeat, 2015). These cavities can speed up reactions involving gases by increasing surface area between air and the medicine under preparation (Witt *et al.*, 2006). They play an important role in the EZ buildup as particles moving against air get negatively charged. Being an air-water interface, they are rich in EZ themselves. Thus their essential role during liquid potentization cannot be denied.

However it should be noted that the medicine can be stored for a prolonged period, a higher potency can be raised from it, as in the case with a freshly prepared medicine. Further, it can be done in solid form, too, taking lactose as a diluent. Thus nanobubbles cannot be a part of the finished medicine. The success of even decades old medicine-soaked cane-sugar globules for dispensing also supports this view. Further support comes from the fact that potency in liquid form can be raised from triturated solid form medicine (potency) and *vice-versa*.

In clinical practice, it is not an uncommon observation that even thirty year old medicated cane-sugar globules act brilliantly, if selection of the medicine as remedy is right. These globules may even have turned dark brown. As they have seen thirty hot tropical summers of India, it is unlikely that they have any ethanol remaining in them. This inference is supported by the fact that ethanol is even less polar than methanol. Methanol, owing to its low molecular polarity, could be removed from the surface of ZnS nanoparticles at 50°C by Zhang *et al.* (2003) in their experiments. That is why Zhang *et al.* (2003) observed reversible methanol-driven structural change in nanoparticles. But water-driven structural change was found to be irreversible. In fact, Zhang *et al.* (2003) could not remove water from the surface of ZnS nanoparticles because of strong interaction between surface and water. Thus water could create permanent structural change because of its high polarity.

In the example described above, cane sugar can be seen, acting as preservative. Being hygroscopic, it would also help in maintaining enough interfacial water on the surfaces of nanoparticles. These nanoparticles are from the medicine in which globules were soaked three decades ago.

Nanoparticles like that of silica, present in homeopathic medicine, are hydrophilic and water is highly polar. This indicates strong interaction between the surface and water leading to large stabilization effect on the structure of nanoparticles.

EZ would prevent, by its nature, Ostwald ripening of nanoparticles with aging. Being charged (negative), it would also prevent their coalescing or forming agglomerates with time. This is why the shelf-life of homeopathic medicine is too long to have an expiry date label.

Limit of Successive Dilutions and Evolution of Medicine

Generally homeopathic medicines are used up to CM potency. But there do exist ultra-high potencies which go to 5CM, 10CM, 500CM, 1000CM, 10,000CM etc, which have been used in clinical practices with success (Vithoulkas, reprint 1993 p. 165; Kent, reprint 1986 p. 280). In fact, there is no upper limit for raising potencies. It is in conformity with the model/ mechanism proposed here.

A potency of a medicine may be considered the "size" of information of its source drug (Upadhyay and Nayak, 2011). Such a perception may also be induced by some medicines which act contradictorily at very low versus very high potencies. For example, *Hepar Sulphuris Calcareum* (Hahnemann's calcium sulphide) may promote suppuration in lower potencies but abort it in higher potencies (Boericke, reprint 2007 p. 290).

The information acquired about the source drug by nanoparticles and their EZ shells during initial potencies up to 6X or 3C, as per the third hypothesis, is "crude and condensed". With increasing homeopathic dilution, as per the fourth hypothesis, this acquired information would gradually "spread" (or amplify), becoming more "decipherable" to the biological systems. But once this source drug information becomes fully "readable", raising its potency further would be futile. Instead, it may give an opportunity for impurities to interfere with the medicine, as there would be no evolving majority component to suppress them. This agrees with common clinical observations that a few medicines work better in lower potencies, some in middle potencies and many in higher potencies. Those source drugs which are therapeutically inert in their crude form often come out as wonderful medicines, especially at very high potencies. Their low potencies, for some even up to 30C, are often devoid of therapeutic values as the acquired source drug information could still be too "crude and condensed" to be deciphered by the biological systems.

Contaminations and Silica as Medicine

Absolute purity in nature is not possible. As water is a universal solvent, even "pure" water contains abundant impurities (Pollack, 2013 p. 48). The obvious sources of contaminations are containers and glassware, diluents, environment, and for initial potencies, impure source drug material. Consequently, homeopathic medicines, though in extreme dilutions, cannot be extremely pure. Even laboratory samples contain a lot of impurities (Witt *et al.*, 2006). Commercial samples are naturally far more impure (Zacharias, 1995). Ironically many impurities are starting source materials (drugs) for preparing the same or different homeopathic medicines. As per the proposed model, the entire decreasing source drug remaining after 3C potency is not required, since the complete information about it has already been drawn, so it then becomes an impurity. The work of Chikramane *et al.* (2010) may be viewed as evidence that the same source drug may be present even in higher potencies made commercially. Impurities seem very significant to spoil the medicine in extreme dilution. Their presence is a big challenge to the very existence of the medicine itself.

As discussed previously in this paper, an

insoluble impurity can be "soluble" only by its trituration carried out up to 3C potency. So insoluble impurities in themselves would not interfere with the medicine (potency). But during potentization, when EZ shells are stripped off, impurities may affect structure of nanoparticles by adsorption and then building up "corrupt" EZ shells on them. However, this would be a minority effect and could be suppressed by the evolving majority effect, derived from the source drug, taken initially in far larger quantity in relation to the present impurity. So while triturated flint evolves into the medicine *Silica*, silica as an impurity remains in medicine as a non-affecting suppressed minority. Further it should be noted that it is structure, not composition, which largely controls properties (Roy *et al.*, 2005).

The above observations have lead to the fifth hypothesis proposed in this paper, as follows:

5. A threshold amount of a source drug or an impurity is required to initiate and then sustain the process of being memorized during potentization.

Further protection for medicine against impurities should come very strongly from EZ. The EZ shells can easily protect their nanoparticles and themselves from impurities, as EZ excludes almost anything. This protection against impurity is the fundamental feature of the proposed model.

Therefore, it makes sense that homeopathy could take birth two centuries ago at the time of impure chemistry when Hahnemann, at times, even made his medicines in whisky. Similarly, it also explains why homeopathy has survived to the present without any high-tech manufacturing.

A Virgin Vial Requirement to Keep Medicine

If a potency of a medicine is kept in a vial, that vial cannot be used to keep another potency of the same medicine. It cannot be used to keep any potency of any other medicine either. Only the same potency of the same medicine can be kept in it again.

The drying or rinsing of the vial with water or alcohol will not help. Since there would be enough nano-projections in the rough inner surface, the vial can be reused only if it is made near red hot once. This will remove the sticking EZ water from the surface of the vial and its nano-projections. Consequently, reversal of their structural transformations would take place, losing memory of the medicine (potency) from the inner surface of the vial. This observation suggests that homeopathic medicine is not material but memory of the source drug.

In the Hahnemann method, a new vial is used for every stage of potentization. Korsakoff observed that when such a vial is emptied, nearly 1% of the medicine (potency) remains adhering to its inner surface. So throwing out the rest, this 1% can be taken as "seed" to raise the next potency in the same vial by just adding 99% of the vehicle and performing 10 succussions.

Thus, in the Korsakoff method, a single vial is used again and again to raise serially higher potencies of a medicine. The adhering "seed" medicine on the inner surface of a hydrophilic glass vial is mostly EZ water. So along with this EZ water, the memory of the inner surface of the vial could be utilized for raising the next potency.

Magnet-Treated Water

The study of magnet-treated water is included to understand memory

phenomenon in a broad perspective, and to explore its role beyond medicine.

It has been reported that only aerated water gets affected by magnetic or EM fields, modifying its properties and functions (Colic and Morse, 1999; Otsuka and Ozeki, 2006). The stronger field affects more. But varying magnetic flux is far more effective than a static one (Otsuka and Ozeki, 2006). The "magnetized" water enhances viscosity, surface tension, evaporation rate, refractive index, etc (Toledo *et al.*, 2008). These physical properties are also observed with EZ water (Pollack, 2013 pp. 38, 282). Even the increasing degree of "magnetization" of water can be studied quantitatively by evaluating its reducing contact angle (Otsuka and Ozeki, 2006). The EZ water is also found to have reduced contact angle (Pollack, 2013 pp. 243).

For "magnetization" of water, oxygen is essential. Oxygen is required for EZ build up, too, as EZ water contains more oxygen than bulk water. Further, the negative charge acquired by substances moving past air promotes EZ buildup (Pollack, 2013 pp. 180). Interestingly, the solubility of gases is seen increasing in sea water, even with very small magnetic fields (Chaplin, Web ref. 2).

Colic and Morse (1999) suggested that for the observed phenomena by magnetic or EM fields, perturbations of air-water interface should be a major cause. But because of high oxygen content near the surface, this air-water interface is rich in EZ water (Pollack, 2013 p. 287). Holysz *et al.* (2007) suggested that magnetic field treatment causes changes in the hydrating water structure around the ions. Higashitani and Oshitani (1998) repeatedly showed by AFM study that in presence of air, magnetic field thickens hydration layer around ions and colloids in water. It should be noted that suspended particles and dissolved solutes interact much the same way, with water forming EZs around them as hydration (Pollack, 2013 pp. 133-134). Thus EZ water is present around ions, colloids, and in the air-water interface. So it is fair to suggest that EZ is involved in the "magnetization" of water, as it is involved in the existence of homeopathic medicine.

The biological effects of magnetic fields have been known for centuries (Bassett, 1994). The source drugs of three medicines, namely *Magnetis poli ambo*, *Magnetis polus arcticus* and *Magnetis polus australis,* are prepared in homeopathy by exposing water or lactose to the whole magnet, and north and south poles of the magnet respectively (Mandal and Mandal, 2002 p. 150). Interestingly south and north poles of a magnet give rise to the water structures of respectively higher and lower energy states than normal (Rai *et al.*, 1995).

The homeopathic medicine *X-ray* is a comparatively more frequently used medicine of this class. Its source drug is prepared by exposing alcohol or lactose to EM-radiation X-rays (1000 rads) (Varma and Vaid, 2002 p. 2526).

Discussion

In the structural study of information storage, source drugs which are very precise and can be varied at will may be of immense value (Upadhyay, 2003b). The best examples of such source drugs are magnetic fields, and EM fields such as X-rays. Different field strength, exposure time, and polarity or frequency could be utilized for this study (Upadhyay, 2003b).

Potencies prepared in an atmosphere of N_2 were found therapeutically ineffective by the Boiron group (Fisher, 1991). Water also cannot be "magnetized" in the atmosphere of N_2 or CO_2 (Otsuka and Ozeki, 2006). So it is justified to suggest that EZ water is an essential part of the memory retention process for which the presence of O_2 is necessary.

Thus, both magnet-treated water and homeopathic medicine contain EZ water. Both keep memory of their past experiences. But the memory of "magnetized" water is for a short period. As evident by medicines prepared from unstable source drugs, the source drug memory of homeopathic medicine, up to 3C potency, is also for a short period. The second hypothesis suggests that this happens because by 3C potency, modified structures do not become stable and further, the EZ naturally erodes with time. Such erosion takes place by combining a hydronium ion (H_3O^+) with EZ structural unit (OH^-), resulting in two water molecules (Pollack, 2013 pp. 95-97). A steady-state is reached when energy-driven EZ growth balances natural EZ attrition (Pollack, 2013 pp. 95-97). Thus, the EZ alone cannot be expected to keep memory for extended period. For a prolonged memory, the support of hydrophilic nanoparticle which has a high affinity for water seems necessary. As materially "3C" is equivalent to "6X", the optimal amount of source drug seems important to complete the source drug specific structural modifications of a nanoparticle and its EZ shell. Thus homeopathic medicine beyond 3C potency has prolonged memory of its source drug. It is true even for unstable source drugs, including magnet-treated water.

Tongue, mouth and stomach are the most effective routes for administration of remedies. Olfaction (sniffing a bottle) or rubbing on the skin may also be used as a route. Explaining olfaction for medicinal action in homeopathy is a big challenge (Walach *et al.*, 2005). However, it is not difficult with the proposed model. The earth is negatively charged and an evaporated vesicle has the EZ shell of negative charge (Pollack, 2013 p. 268). In this way, electrostatic repulsion pushes the vesicle up and the act of sniffing, by reducing pressure above, suck it into the mucus membrane of the nose or mouth cavity for medicinal action. Enveloped by EZ shells, vesicles can have nanoparticles (Pollack, 2013 pp. 233-279) and thus have memory. Administration of medicine through rubbing on the skin can also be easily understood as nanoparticles can easily get in because of their size.

Elia *et al.* (2013) observed an absorption peak at around 270 nm in UV-vis spectroscopy of homeopathic dilutions. It is very characteristic of EZ water presence. In fact, vortexing of water alone gives the 270 nm absorption peak, suggesting the creation of EZ water, as such a peak is not observed in case of bulk water (Pollack, 2013 p. 179). Succussion (violent stroke) is even more forceful than vortex. So it becomes clear again why a serial dilution without succussion cannot produce medicine, as has also been verified in agriculture with wheat seedling experiments (Brizzi *et al.*, 2000). Vortexing puts enormous energy into water. There are several groups in Europe studying this phenomenon right now (Pollack, Web ref. 3). So simple looking succussion has a profound scientific meaning. Further, the sensitivity of homeopathic medicine to UV-radiation also becomes meaningful.

Endler and colleagues (Oberbaum, 2013) observed that the effect of extremely diluted and succussed thyroxine occurred in the development of tadpoles, even if sealed in a vial suspended in the tank, without coming in direct contact with the water in which the experimental tadpoles lived. They suggested emission of EM-signals from potentized thyroxine for this effect to be possible. Montagnier *et al.* (2009a) too observed that the extremely diluted and vortex agitated aqueous solution of DNA emitted EM-signals when not even a single DNA molecule was expected to be present. What supply of energy would feed such a continuous activity? One possibility puts it to be from the quantum vacuum (Upadhyay, 2002a) while another possibility from current water research suggests that water

absorbs energy from environment and radiates mostly from bulk water, but the EZ also radiates some energy characteristic of its structure (Pollack, 2013 p. 172).

Montagnier *et al.* (2009a) observed that heating at 70°C for 30 min irreversibly suppressed the EM-signal emission activity from their samples, as did freezing it for 1 hour at –20°C. Interestingly, homeopathic medicines are also permanently spoiled at these temperature conditions. Otsuka and Ozeki (2006) found "magnetized" water losing memory above 54°C. It is noteworthy that while frozen and boiling waters do not have the EZ, it is tremendously developed at higher than room temperatures because of the higher energy involved (Pollack, 2013 p. 306). An inference may be drawn that higher temperature, where homeopathic medicine is spoiled, is too favourable for EZ buildup to retain the acquired modified EZ structure. The source drug information gained is lost by reverting to the generic EZ. This is equally true for sunlight, which also spoils homeopathic medicine. Water absorbs sunlight strongly in infrared, particularly at 3,000 nm wavelength, most effectively driving EZ growth (Pollack, 2013 p. 88).

Recently, Elia *et al.* (2012) reported on the conductometric study of homeopathic dilutions of fullerene and carbon nanotube and samples of water spaced 0.5 cm apart, to establish that these two aqueous systems are able to transmit their variations over time, via EM fields. In practice, homeopathic medicines are often closely packed for storage without vitiating them. Homeopathic pharmacy does not forbid this practice (Varma and Vaid, 2007; Mandal and Mandal, 2002). An inference may be drawn that possible EM communication between closely packed medicines, as suggested by the experiment of Elia *et al.* (2012), would not overpower the source drug information stored in them. However, a study is suggested here to evaluate physicochemical and therapeutic properties, if any, of a control (90% v/v alcohol) kept with a single medicine in isolation for a prolonged period.

For homeopathic remedy actions in living systems, Bell and colleagues (2012, 2013, 2015) have been developing "The Nanoparticle - Allostatic Cross – Adaptation - Sensitization Model". They consider homeopathic medicine as containing nanoparticles. These nanoparticles are taken as having the source drug as an active agent, in spite of its extreme dilution. Such a materialistic concept is currently floated by the hypothesis of Chikramane *et al.* (2010, 2012). This hypothesis is in fact untenable as described above (see Introduction). It was proposed in void of a viable model. The proposed "The Nanoparticle-EZ shell Model" seems to fill this void, providing a better and rational option. It suggests that instead of a nanoparticle having the source drug, a nanoparticle along with EZ shell having the source drug specific information should be considered. Such a nanoparticle could transfer this information as an active agent to biological systems through the EZ, for an extended period. Long action of a homeopathic dose may now be better understood. Where the nanoparticle cannot reach, its subtle information can. It may justify why size (quantity) of a dose is immaterial in homeopathy (Kent, reprint 1986 p. 305). The primary pathways for homeopathic remedy actions may remain the same as suggested by Bell *et al.*, i.e. adaptive reactions rather than direct pharmacological (local ligand-receptor) actions in the body. "The Nanoparticle-EZ shell Model" proposed here for understanding the structure of homeopathic medicine is not only compatible but may even be complementary to the model that Bell *et al.* proposed for understanding therapeutic actions of this medicine.

For both acute and chronic cases, prescribing a single dose of remedy in

a suitable potency as long as its action lasts has been the cardinal principle of homeopathy. It forbids repetition, warning that it can cause violent aggravation and even spoil the case (Upadhyay, 2003a). However, for chronic cases, another method of prescribing is also possible, in which a high potency of remedy is repeated frequently throughout the treatment until that remedy is no longer required (Desai, 1991; Upadhyay, 2003a). Paradoxically, in this method, the remedy acts gently without any aggravation. But if this remedy repetition is very infrequent before the exhaustion of the previous dose, violent aggravation may ensue as the cardinal principle warns. For chronic cases, it is suggested that a single dose palliates, early doses spoil and continuous doses cure (Upadhyay, 2003a). Such observations are clues which may help in understanding of the mechanism of homeopathic medicine as well as its pharmacodynamics.

It is noteworthy that a biological system is mostly water and most of this water is EZ. Being negatively charged, EZ offers a ready source of electrons that could drive any number of biological reactions (Pollack, 2013 p. 333). This observation may be extended to electrons driving most of the chemistry. The memory retention phenomenon could be possible with any adsorbates on suitable nanoparticles (Zhang *et al.*, 2003). Water participates in virtually everything and has a capacity to organize itself differently next to different surfaces (Pollack, 2013 pp. 25-41). Thus the memory phenomenon seems not exclusive for medicine but a general one (Upadhyay, 2002b). Its wide applications, as already seen in case of magnet-treated water, could be possible in different disciplines. Further, without using extremely precious, rare, toxic or unstable material, information about it may be stored for further use whenever so required.

Conclusion

Evidence suggests that EZ water (H_3O_2) builds up both during the "magnetization" of water and homeopathic potentization of a source drug.

While water plays an essential role in homeopathic medicine, alcohol seems a mere preservative. This can reduce, to a great extent, the confusion in understanding homeopathic medicine.

The high molecular polarity of water and hydrophilic nature of the concerned nanoparticles can provide prolonged shelf-life to medicine. Ethanol cannot provide such a long shelf-life because of its much lower polarity.

Though nanobubbles play an important role in the EZ buildup during liquid potentization, they seem not to become part of medicine itself.

The novel "The Nanoparticle – EZ Shell Model" proposed here explains memory retention as observed in magnet-treated water and homeopathic medicine, and suggests that this seemingly baffling phenomenon, in fact, is quite simple, at least, in its basic mechanism. The salient features of this model are as follows:

- Medicine can be prepared both in liquid and solid forms.
- Seemingly simple succussion and trituration have profound scientific meanings.
- The EZ shells protect medicine from impurity. However, a threshold amount of impurity (or source drug) is required to initiate and then sustain memory retention during potentization.
- The EZ shells provide stability and longevity to medicine by preventing

Ostwald ripening, coalescing and agglomeration of nanoparticles with aging.

- There is no upper limit for raising potency, but once the source drug specific information is revealed fully, raising potency further would be futile.
- The medicine vial holds the memory of the potency of medicine put in it, even just once.
- Homeopathic medicine may do EM-emission or communication.
- High temperature or sunlight is too favourable for EZ buildup to retain the modified EZ structure. The modified structures of EZ shells and consequently that of nanoparticles would then revert to the generic ones, losing memory of the source drug.
- Boiling or freezing spoils the medicine as the EZ water then loses its structure.
- Medicine can be administered through olfaction, as an evaporated vesicle has the EZ shell and can even have nanoparticles.
- A single dose can act for an extended period.
- Silica is an impurity but triturated silica is a medicine because its information has been acquired for subtle use.

The size (quantity) of dose is immaterial in homeopathy, as its medicine contains source drug specific information, not the source drug itself. So one may consider this medicine as "spirit-like," as Hahnemann did.

Homeopathy is full of seemingly strange paradoxical observations. These observations should be exploited scientifically for the clues they provide. The proposed model is a rational base for doing so. Exploring homeopathy in this way is likely to open new research activities in nanoscience and water, which may lead to scientific development of homeopathy at par with modern medicine. Further, the observed memory retention phenomenon does not seem exclusive to medicine and could have wider applications in our life.

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