

# Biology and sign theory: homeopathy emerging as a biosemiotic system

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**Abstract** Diluted above Avogadro's number, homeopathic medicines allegedly do not contain any molecule of their starting-materials. As Western science is historically based on the notion of matter, alternative epistemological models are needed to account for the biological actions of homeopathic high dilutions. One such model is provided by biosemiotics, an interdisciplinary field devoted to the integration of biology and semiotics based on the fundamental belief that sign production and interpretation is one of the immanent and intrinsic features of life. Several experimental studies show that the information carried by high dilutions might be evidenced by means of measurable biological effects ranging from intranuclear epigenetic phenomena to inheritable adaptive processes, and regulatory physiological and behavioral phenomena. Therefore, when the action of homeopathic medicines is considered from the semiotic point of view, they become an endless source for studies aiming not only at therapeutic applications, but also to achieve a more refined understanding of living beings and their relationships with the environment.

**Keywords** Homeopathic high dilutions · Sign theory · Biosemiotics · Experimental evidences

## Introduction

“Message”, “encoding”, “transmission”, “translation”, “expression”: the current language of biology is deeply impregnated by notions originally belonging to information and communication science and technology. This phenomenon, however, is relatively recent. As a fact, its official birth date was 1953, when the structure of DNA was unveiled, although it was conceived about 10 years earlier.

In 1943, the reputed physicist and Nobel Prize winner Erwin Schrödinger (1887–1961) gave a series of lectures sponsored by the Dublin Institute for Advanced Studies at Trinity College, Dublin, which was published the following year under the title “What Is Life? The Physical Aspect of the Living Cell” [1]. This question, indeed, had caught the imagination of physiologists, zoologists, and botanists since the early decades of the nineteenth century [2]. However, that particular booklet was remarkable because its author, a specialist in the structure and behavior of matter, attributed the full operation of life to a single cell component, the chromosome. Curiously, rather than concerning himself with the matter composing the chromosomes, Schrödinger emphasized their nature as a “kind of code-script” that contains “the entire pattern of the individual's future development and of its functioning in the mature state. Every complete set of chromosomes contains the full code [...]” [1]. As we shall see below, this was the cue for James Watson and Francis Crick to solve the enigma posed by the structure of DNA.

Another notion explicitly approached by Schrödinger is also worthy of notice. According to him, although the crucial role of matter in the explanation of phenomena cannot be dismissed, reality and its meaning are not limited to the atoms composing molecules, “Does not a gold coin, for example, buried in a tomb for a couple of thousand

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years, preserve the traits of the portrait stamped on it?” [1]. This leads us straight into the basic assumptions underlying Western science. Those assumptions were established by Greeks more than 2,500 years ago and remained virtually unchallenged until a very short time ago. Thales of Miletus (7th–6th century BC), one of the Seven Sages of Greece, asked, “What things are made of?” His answer was “They are made of matter”. Some 300 years later, Aristotle based reality itself, what we might know about it, and even the way we think and speak, on matter, now reworked as the basic category of “substance”.

Every year, groups of so-called “skeptics” meet at some public place from Buenos Aires to Bucharest, from Sydney to London, to take large doses of homeopathic products to show that, as they “contain nothing”, they cannot have any effect. In addition, according to those self-defined “skeptics”, precisely because the homeopathic medicines have no matter whatsoever, homeopathy is unscientific.

Homeopathic medicines are prepared by serial dilution and agitation, most often reaching levels above Avogadro’s number. For that reason, no molecule of the starting-material expectably remains in the final product. Thus being, homeopathic medicines have no matter whatsoever, and as a logical consequence, they cannot be thought, discussed, investigated, known, or named within the framework of traditional Western reason. One might thus conclude that they are irrational and, to be sure, unscientific. To be sure, the clinical efficacy of homeopathy is still a matter of debate, with con [3] and pro [4–6] evidences. However, experimental, cellular, and epigenetic data demonstrate objective changes in biological parameters after exposure of live systems to homeopathic high dilutions.

The aim of the present article was not to debate the plausibility of the grounds adduced to use homeopathic medicine in clinical practice, but to explore its rationale and epistemological bases. Our leading questions are: how can we interpret the experimental data associated with the use of high dilutions? Is there some alternative approach to understanding reality able to account for those effects?

Indeed, there is one: the *semiotic model*.

### All is sign...

Semiotics is the discipline that studies signs, from the Greek, *semmn*. A sign is anything that *stands for* something else *to* someone. This is how we represent reality, and how things become meaningful to us.

Modern semiotics was formulated by the American polymath Charles Sanders Peirce (1839–1914). Peirce’s basic insight was that the sign has a triadic nature, including the sign vehicle, the sign object (that which the

sign represents), and the connection between them (the sign’s meaning). This is how Peirce defined the sign: “A sign, or representamen, is something which *stands to* somebody *for* something in some respect or capacity. It addresses somebody, that is, creates in the mind of that person an equivalent sign or perhaps a more developed sign” [7].

Semiotics posits that the image we make of the world is not immediate, but *mediated* through signs. From this perspective, homeopathic medicines may start making sense, as they involve a vehicle (the grains, drops, tablets, etc.) and stand to someone for something else.

### Biosemiotics, or the art of *not* reinventing the wheel

Application of semiotics to living nature is known as bio-semiotics, which merely means that all the processes in living beings must be investigated and understood as sign processes. Biosemiotics (term minted by Friedrich S. Rothschild in 1962) [8] emerged as an interdisciplinary field devoted to the integration of biology and semiotics (the sign science) based on the fundamental belief that semiosis (sign production and interpretation) is one of the immanent and intrinsic features of life. In 1970, Hogeweg and Hesper suggested the name “bioinformatics” for the study of informatics in biotic systems, as “one of the properties that define life is information processing” [9]; its current scope of research includes gene and protein expression and analysis of regulation—signaling systems (e.g., hormones) [10].

The discovery of the DNA structure in 1953 and later deciphering of the genetic code represented the first step into the understanding of the semiotic nature of life. Watson and Crick acknowledged that Schrödinger’s observation mentioned above—namely, that chromosomes carry a message written in code—was their immediate trigger to approach the study of the DNA [11]. To state that all the phenomena in living nature, from the subcellular level to full ecosystems, are sign processes does not mean to deny their physical and chemical bases. It merely points to the intertwining of the semiotic and molecular dimensions [12].

The fact that biologists prefer to talk about information exchange notwithstanding, the semiotic nature of life is an undeniable fact. Chemical reactions are now considered to be resources to generate, conserve, and convey information: “For information to be fixated from the structural point of view, definite classes of symbols are needed, like the alphabet letters (...) In addition, we need connections between the symbols of the words being formed, and syntax rules to arrange the words into sentences. Also devices to read the sentences are needed (...)” [13].

According to this biophysical chemist, Manfred Eigen (b. 1927), the most revolutionary feature associated with the elucidation of the DNA structure was the discovery that the chemical interaction among base pairs allows transcending chemistry itself, as the chemical units behave essentially as information symbols. The biologists John M. Smith (1920–2004) and Eörs Szathmáry (b. 1969) take the fact that the essence of heritability in living beings consists in the transmission of information as given, in addition to its status as *sine qua non* basis for the action of natural selection [14]. It is worth to emphasize that none of the authors just mentioned is a proponent of “alternative” approaches to biology, but contrariwise, they are some of the best-acknowledged representatives of the mainstream views.

The semiotic nature of the intracellular signaling pathways is widely acknowledged, and also intercellular pathways, such as the ones involved in the neuroimmunoendocrine network, reveal their ability to “interpret signs” [15]. Such signs might be chemical, electric, magnetic, thermal or mechanical. A paradigmatic example of the semiotic nature of a chemical sign is provided by cAMP, which increases within the cells of most microorganisms in the presence of carbon depletion, triggering a full cascade of intracellular events to compensate for such circumstance [16]. The behavior of cAMP is characteristic of the one of a mediator in a triadic situation: carbon depletion represents the sign object, increased cAMP the sign as such, and the cell with its full range of metabolic pathways the receiver that interprets the sign. Each and every triadic process involving mediation is, by definition, a semiotic process.

According to the philosopher Agnès Lagache (1940–2009), “Living beings are informed-informing structures, a network of relationships between their content and their surroundings. As a consequence, some biological elements should not be considered as material things, but as semantic objects. A semantic object is one that performs the functions associated to mediation” [17]. Together, Lagache and the immunologist Madeleine Bastide (1935–2007) formulated, along the 1980s and 1990s, the theoretical model known as “paradigm of corporeal signifiers”, which among other features, is seemingly able to account for the action of the homeopathic medicines based on the principle of meaningfulness that rules over information systems [17].

### Homeopathy emerging as a biosemiotic system

The paradigm of the corporeal signifiers represented a significant step forwards in the understanding of the biological effects of homeopathic medicines. To remind, those

medicines are so diluted that no molecule from the starting-materials remains, but nonetheless they would keep the corresponding information. Therefore, it is safe to assume that their action would involve a triadic situation, in which physical changes would be induced in the solvent by the process of dilution and agitation behave as the sign as such, i.e., the mediating component that conveys information.

The physical changes undergone by solvents as a function of the process of preparation of homeopathic high dilutions are a major focus of current research [18], while actual transmission of the information they carry might be evidenced by means of measurable biological effects [19, 20] at various levels of organization, ranging from intranuclear epigenetic phenomena [21–24] to inheritable adaptive processes [26] and regulatory physiological and behavioral phenomena [27–29].

Curiously, in those experimental studies, the effects of the homeopathic high dilutions are opposite to the ones of the corresponding starting-materials in ponderable amounts. However, it is precisely such “inversion of effects” that accounts for the use of homeopathic medicines in human and animal clinical practice, and even in the case of plant diseases [26, 30–32]. Then, the fact that one and the same substance might exert opposite effects points to active processing or interpretation of the drug information by living systems, and consequently, to triadic mediation, i.e. semiosis. Finally, these phenomena are at the basis of one of the most striking characteristics of homeopathic treatment, to wit, its ability to reorganize the biological cycles so as to adjust them to the patient’s (or living system) current condition.

Fundamental experimental research conducted with animals, plants, and cells brought the abovementioned phenomena to light by means of objective evidences. For instance, the treatment of pregnant rats with dexamethasone 15cH ( $10^{-33}$  M), i.e., without any molecule of starting-material dexamethasone, does not induce any adverse effect on the development of the offspring. However, it does induce subtle changes at the cell level that modulate the inflammatory response pattern of the offspring in adult life. As a result, when those animals are challenged with an irritant liable to cause inflammation, they exhibit a predominantly acute pattern of inflammatory response, characterized by increase of the number of degranulated mast cells at the site of irritation, and greater number of neutrophils relative to monocytes. In addition to the reduction in their number, the monocytes exhibit earlier maturation and differentiation into active phagocytes [26]. This example is an accurate illustration of the notion of “opposite effect” relative to the starting-material, as the anti-inflammatory action of dexamethasone is very well known. To summarize, the exposure of rats to dexamethasone 15cH in intrauterine life induced a particular

configuration in their ability to respond with inflammation to irritant stimuli.

Starting in the 1990s, Italian and Swiss researchers approached the study of the effects of homeopathic medicines on plants [33]. In addition to representing a highly relevant contribution to fundamental research in high dilutions, as they cannot be attributed any placebo effects on plants, such studies paved the way for agricultural applications of homeopathy, which were shown to exert considerable impact on the amount and quality of food products, as well as on the preservation of forests and other natural environments. Recently, a new method was introduced for the study of the action of homeopathic medicines in plants fit to demonstrate the high level of complexity of the effects observed. We allude here to biocrystallography, which, for instance, allowed adding precise morphological analysis (using copper crystals deposited on glass plates) to the quantitative measurement of the growth of cress seedlings treated with homeopathic dilutions of tin beyond Avogadro's number. The biocrystallograms are objectively analyzed by computer textural image analysis, which showed that, under the homeopathic medicine treatment, the copper crystals exhibited specific textural characteristics, which corresponded to the effects on plants [34]. This novel methodological approach allows for satisfactory reproduction of results, as well as for application of exclusive mathematical models to assess complex biological parameters. In the case just described, the information was concomitantly assessed and measured by two different sensitive systems, the results of which might be correlated one with the other.

Also in vitro cell culture systems might be sensitive to the information conveyed by homeopathic high dilutions. Such systems proved to be particularly useful for the study of the corresponding mechanisms of action. Recently, a study conducted by the research team chaired by Prof. Paolo Bellavite, in Verona, showed that in vitro exposure of human neurons to various dilutions (2–30c) of homeopathic medicine *Gelsemium sempervirens* (yellow jasmine) induced significant changes in the transcriptome of 56 genes associated with cell signaling pathways, calcium transport, peptide receptors, and the inflammatory response [25]. Those findings have crucial relevance, as they show that also the DNA is sensitive to the information carried by dilutions much above Avogadro's number (30c =  $10^{-60}$  M).

## Final remarks

To conclude, when the action of homeopathic medicines is considered from the semiotic point of view, their biological effects become naturally plausible, that is to say, the starting-material (sign object), the physical properties

specific to the information carrier (homeopathic medicine, sign vehicle, agent of mediation) and sensitive biological recipients (interpreters, at the various biological levels, from systems to genes) are depicted as the three “tips” of Peirce's triad. Contrariwise, they become an endless source for studies aiming not only at therapeutic applications, but also to achieve a more refined understanding of living beings and their relationships with the environment.

**Conflict of interest** None.

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