Science & Society

EMBO reports

Homeopathy—where is the science?

A current inventory on a pre-scientific artifact

Natalie Grams

Homeopathy is a medical system devised by the German physician Samuel Hahnemann (1755–1843; Fig 1), who first postulated it at the end of the 18th century and codified it in 1810 in the first edition of his *Organon*. It arose during the transition period from the ancient teachings—theories about the deficiency or excess of four bodily fluids or theories about "corrupted juices"—and the beginning of the scientific age, unlike most pre-scientific medical theories, has survived until this day. One of the reasons for its persistence is the fact that homeopathy was much less intrusive and harsh and did not harm patients as other drastic cures of that time did.

> *"The almost unanimous view of the scientific community is that the basic assumptions on which homeopathy rests are either refuted or implausible."*

As a result of its survival, homeopathy has repeatedly come into conflict with science and modern medicine: By the criteria of modern, evidence-based medicine, it is not efficient at all and should not be practiced. However, its adherents and practitioners persist that homeopathy is effective, using different, often contradictory arguments to try to demonstrate its validity. On the one hand, they bend and interpret studies to the effect that homeopathy does have an impact beyond the placebo effect and clamor for its recognition by the scientific and medical community. On the other hand, adherents of Hahnemann's method are quick to dismiss science and evidence-based medicine altogether as being insufficient to explain its effect. This is not just an example of several cognitive biases, but it has real and serious consequences. If patients or their parents refuse medical treatment in lieu of homeopathy, it can prolong sickness and suffering and even cause death. It wastes valuable healthcare resources that are lacking elsewhere. And by subverting science and the scientific method, it feeds to the dangerous rise of post-science, post-truth attitudes that slowly degrade trust in scientific institutions and science itself.

The basic assumptions of homeopathy

The almost unanimous view of the scientific community is that the basic assumptions on which homeopathy rests are either refuted or implausible. First, the *principle of similarity* is a pre-scientific premise that today has no scientific evidence or support. Hahnemann, like his entire generation of physicians, was strongly influenced by various forms of the ancient principle of similarity, beginning with a primitive "magic of similarity" up to the signature doctrine of Middle Age medicine and the early modern period. In essence, similarity is a teleological-anthropocentric concept: External similarities of things occurring in nature were "sensuously" related to corresponding human categories. Thus, the walnut had to be effective for treating diseases of the brain, since its shape resembles the human brain. Similarly, beans were thought to have healing powers for kidney diseases. Even pure name similarities were sufficient to consolidate contexts of meaning. Man's natural tendency to put seemingly similar things into context was a characteristic attempt at rationalization in pre-scientific times to protect one's self-image from feeling completely arbitrary.

> *"Homeopathy has been marketed offensively as a gentle medicine free of side effects and in line with natural medicines – which it is obviously not"*

From these primitive forms of the similarity principle, Hahnemann developed his idea that a substance that triggers a disease in a healthy person should be able to cure the same disease in a sick person. This school of thought had existed before: There had already been arguments about the value of similia for drugs, from which Hahnemann drew his inspiration (William Cullen and John Brown; *De curatione per similia (Treatment according to the similarity principle)* by Michael Alberti). Undoubtedly, *Paracelsus* had great influence on Hahnemann too. It is therefore not surprising that Hahnemann based his ideas on a misinterpretation of an experiment that might have determined his fixation on the principle of similarity: After he ingested cinchona bark, he observed the very same symptoms that were otherwise fought with quinine.

Another pillar of homeopathy—based on the principle of similarity—is testing *drugs on healthy people*, which was a completely new idea. Hahnemann thought he only needed to a test a certain substance on healthy people to see which symptoms they developed after taking it. This would inevitably lead him to the conclusion that this substance would equally be suitable as a remedy for patients with the same symptoms.

Gesellschaft zur wissenschaftlichen Untersuchung von Parawissenschaften (GWUP e.V.), Roßdorf, Germany. E-mail: grams@gwup.org
DOI 10.15252/embr.201947761 | EMBO Reports (2019) 20: e47761 | Published online 14 February 2019

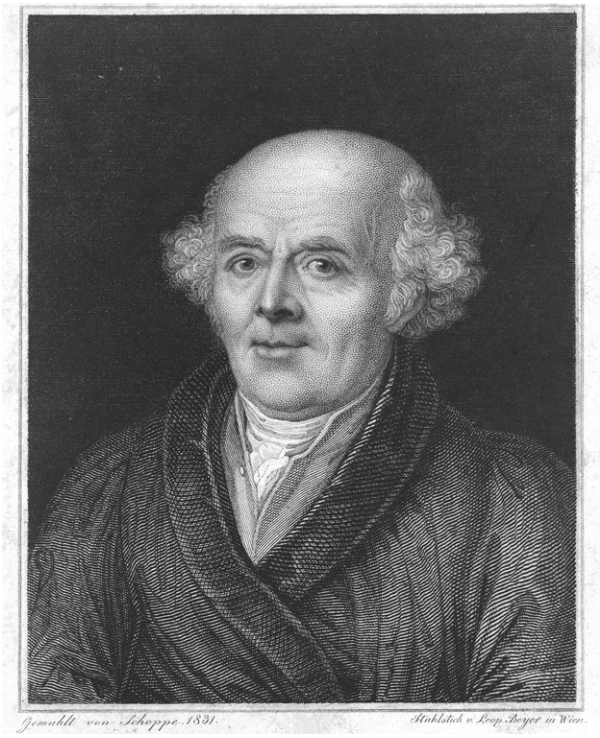

Figure 1. Samuel Hahnemann first postulated homeopathy at the end of the 18th century—unlike most pre-scientific medical theories, it has survived to this day.
(Figure Credit: Wikipedia/L.B Wellcome.)

Of course, this does not show a cause–effect relationship, because of the false premise of the principle of similarity and because the substance is not tested for treating pathological symptoms. But such drug trials also do not hold up to today's standards. The test persons often take the substances over a longer period and record all changes and symptoms at all levels for subsequent evaluation. How could this show a reliable causality between ingestion of the test substance and all possible changes of state? Indeed, large-scale tests against placebo have revealed no correlations between the reports of the test persons.

The third pillar of homeopathy is the one that has met the most intense criticism from science. It is the assumption that a "spiritual healing power" is transferred from the original substance into the solvent by a dilution process called "potentiation" that is accompanied by ritual shaking blows. This "spiritual healing power" is intended to bring an "out-of-tune" spiritual life force in a sick person back to the "normal state" by causing an "artificial disease". This is an occult-vitalistic idea of illness and its causes that had definitively become untenable from a scientific point of view with Rudolf Virchow's discovery of cellular pathology [1] a few years after Hahnemann's death.

Homeopaths often speak of "energy" or "information" that is released during potentiation and passed into the solvent. However, this contradicts physical and chemical principles where an amplification of effect with increasing dilution is completely unheard of. The potentiation increasing in steps of 10 or 100 quickly leads to dilutions that contain no pharmacologically effective amount of the primary substance while, at the same time, the impurities in the solvent exceed the proportion of the primary substance. Potencies of 30C—a dilution of the original substance by the ratio of $1{:}10^{60}$—are widely used in classical homeopathy and much higher dilutions are not unusual. The principle of potentiation, to obtain anything "more" than the starting material as a result of a dilution process, contradicts the second principle of thermodynamics while the use of highly diluted solutions contradicts the dose-to-effect relationship and the law of mass action [2].

Homeopathy and scientific reality

Despite the fact that homeopathy's assumptions are not supported by scientific evidence, homeopathy exists, and it is even supported by the healthcare systems of many countries [3]. In Germany, its country of origin, it is even privileged by law and approved for statutory health insurance reimbursements. Homeopathic sales in Germany amount to hundreds of millions of Euro (according to German Federal Association of Pharmaceutical Companies); in the United States, they amount to around three billion dollars according to Food and Drug Administration, a threefold increase during the past 10 years. The German medical profession officially grants an "additional homeopathy designation" through training under the direction of the German Central Association of Homeopathic Doctors. Approximately 7,000 physicians have this designation and are entitled to offer homeopathy with statutory health insurance. It means that many physicians in Germany practice evidence-based medicine alongside an unproven sham method.

It is a pragmatic principle of evidence-based medicine to examine therapeutic methods independently of their initial plausibility to determine whether their specific effectiveness can be proven. Before a drug candidate is allowed on the market, it has undergone extensive studies and tests to demonstrate both its specific efficacy and its safety. There are hundreds of studies on the efficacy of homeopathy of different quality, which homeopaths use to clamor for reputation. However, it is no longer standard of proof to rely on a single study, but to demand successful reproduction and/or meta-analyses or reviews to obtain reliable information. Since 1991, 10 such reviews have been published [4], including by representatives of the homeopathic scene. Although some of the results are euphemistically formulated, none of these reviews found any indication of sound evidence for homeopathy's effectiveness. The largest review conducted on homeopathy to date by the Australian health authority NHMRC in 2015 came to the conclusion that "Based on the assessment of the evidence of effectiveness of homeopathy, NHMRC concludes that there are no health conditions for which there is reliable evidence that homeopathy is effective" [5]. These results do not differ from those carried out by homeopath's own

reviews (*Mathie* 2014, 2017, 2018 [6]). The European Academies' Science Advisory Council (EASAC) 2017 verdict on homeopathy is as follows: "Scientific mechanisms of action—where we conclude that the claims for homeopathy are implausible and inconsistent with established scientific concepts. Clinical efficacy—we acknowledge that a placebo effect may appear in individual patients but we agree with previous extensive evaluations concluding that there are no known diseases for which there is robust, reproducible evidence that homeopathy is effective beyond the placebo effect" [6]. As Edzard Ernst put it, "The debate about homeopathy is over" [7].

The longing for scientific reputation

But this has not stopped the homeopathic scene to try to present "scientific" proof or to hide the lack of such proof behind apparently spectacular "research". These attempts aim to demonstrate that homeopathic high potencies exhibit "specificities" against the solvent despite the absence of molecules of the original substance. These efforts are generally referred to as "high-dilution research". It is abundant with catchwords such as "water memory", "nanoparticles", "subtleness" or "vibration transmission" that are often construed to refer to "quantum-physical effects" but without plausible explanation. Among the best known and disproved projects of this kind are those of Benveniste ([8] and http://www.bbc.co.uk/science/horizon/2002/homeopathytrans.shtml) and Montagnier *et al* [9,10], the latter of which has been overinterpreted by homeopaths according to the author.

> *"The notion that homeopathy is an alternative to medicine is more based on ideology, faith and belief than on rationality"*

All this, however, does not address the basic problem, namely the lack of proof of a specific medical effect. What is the value of measuring a small thermoluminescence deviation between pure solvent and a solution diluted beyond the Avogadro limit for the assertion that a globule, sprayed with 0.001 g of this solution, is an efficient malaria prophylaxis? There is neither a causal nor a logical connection between this measurement and the homeopathic postulate. High-dilution research is a logical impasse, because it cannot prove the physiological effectiveness of high potencies in the human body, nor addresses the false premise of the principle of similarity, nor the arbitrariness of homeopathic drug testing. The desire to achieve scientific recognition in particular seems to obscure this.

"Dogmatism" and "pluralism" in science

The representatives of homeopathy have also looked for support from the theory of science in order to dismiss criticism from the scientific community. They claim that the principles of critical rationalism and the scientific method for obtaining knowledge through falsification are "dogmatic"; instead, they seek to legitimize homeopathy by embracing "scientific pluralism", which would include "alternative forms of medicine" or even "alternative ways of doing science". Such demands for alternatives to medicine and to science are just absurd calls for complete arbitrariness.

"Pluralism of science" is an outdated concept from the 1990s that arose in opposition to the emerging principle of evidence-based medicine, which many physicians initially saw as a restriction of freedom to prescribe a therapeutic action. But there is a clear distinction between effective and ineffective, between proven and unproven, which leaves little room for "pluralism". Science is not pluralistic, but pragmatic: It uses the scientific method as the most reliable and proven approach to separate knowledge from myths and speculations. The homeopathy lobby's call for an "alternative concept of science" is therefore a fundamental attack on science *per se*. It defines arbitrariness as freedom and thus misuses a rational approach to gather evidence and gain knowledge. Furthermore, the fact that homeopaths also clamor for scientific reputation and repeatedly claim that the effectiveness of their method has been proven by scientific studies shows a remarkable cognitive dissonance.

The "social reputation" of homeopathy and the public opinion

The most important point though is the practical and social aspects of homeopathy, in particular the question why its counterfactual attitude is still alive and growing? An essential reason is that homeopathy has been marketed offensively as a gentle medicine free of side effects and in line with natural medicines—which it is obviously not. Hahnemann conceived it as a specific drug therapy that, apart from its speculative and esoteric parts, is conceptually far closer to pharmacy than classical naturopathy. Nonetheless, this gentle, natural image, combined with a critique of established medicine, makes homeopathy an attractive alternative for its disciples and adherents.

This does not mean that homeopathy does not use the veil of science for advertising. As the reviews and meta-analyses do not support any of homeopath's claims, campaigns, often in the form of branded contents in high-circulation periodicals, usually cite authorities of the homeopathic scene, who assure the public with pseudo-scientific gestures that the method is both proven and effective. The manufacturers of homeopathic remedies, however, focus primarily on the emotional aspect: "gentle, natural, free of side effects and well-tried", skipping the problem of lack of evidence. A more recent strategy is to oppose the increasing criticism of homeopathy by appealing to patients' personal responsibility for their health and by "advocating the freedom of therapy".

> *"Homeopathy is an example of how a lack of understanding of how science and the scientific method work contributes to beliefs that can have drastic consequences for patients"*

In Germany, where homeopathy is well established, the past 3 years have seen an increasing public debate about homeopathy, not least prompted by my first book "*Homöopathie neu gedacht" (Homeopathy reconsidered*), first published in 2015 (now available in English). Our "Information Network Homeopathy", a non-profit organization, is reaching more and more interested parties with information via the web and especially social media. Healthcare facilities and institutions have also become partners in this discourse. My personal experience is that many people are interested in reliable and comprehensive information about homeopathy. But the vehemence with which homeopathic

practitioners and users are defending the method is just as remarkable. The character of homeopathy as a doctrine of faith becomes clear in these discussions—and the homeopathy lobby relies on the solidarity of their believers.

And here lies the fundamental problem: The notion that homeopathy is an alternative to medicine is more based on ideology, faith, and belief than on rationality. The discourse between supporters and critics does not take place on the same level. It is rarely possible to reach out to convinced supporters of homeopathy with factual information, even if such information often meets open ears among those still undecided or uninformed.

Impact of homeopathy on the public health and on the perception of science

Homeopathy cannot be regarded as medicine because it cannot prove specific efficacy beyond context effects, such as the placebo effect. Nevertheless, it is established and even privileged in Germany by pharmaceutical law, and, unlike normal pharmaceutical products, it does not have to demonstrate efficacy for market access. This privileged treatment is mainly the result of intensive lobbying. This situation has contributed significantly to the "social reputation" of homeopathy, the "appearance of credibility". In the meantime, a paralyzing *status quo* has emerged. On the one hand, public confidence in homeopathy is largely based on this statutory privileged status; on the other hand, it is precisely this public confidence that prevents political decisions to remove homeopathy from the public health system. It is regrettable that, so far, German health policy has not followed the development of other European countries where homeopathy either is no longer supported by public health systems or who consider removing it from public health reimbursement schemes. Are on their way there. After all, there is substantial evidence and statements by scientific boards that show homeopathy's claims are not based on evidence. This is where the efforts of critics come in, as the situation can only change by providing the public and politicians with reliable information and facts. We critics are also concerned that the popularity of homeopathy promotes a latent or open hostility to science. Criticism of homeopathic as well as pseudo-medicine in general thus helps to differentiate between facts and opinion, and, above all, to make clear that science is not an ideology, but a proven and reliable method for the acquisition of knowledge.

Summary and outlook

Homeopathy is an example of how a lack of understanding of how science and the scientific method work contributes to beliefs that can have drastic consequences for patients. Similar mechanisms also affect other areas. The public opposition to green gene technology is another case where subjective opinions have trumped public debate at the expense of rationality. One particularly worrying trend is the highly virulent opposition to vaccines by a small but loud and persistent minority that is feeding an increasing scepticism about vaccination among the population despite an enormous wealth of scientific evidence that vaccines are safe and efficient. Again, rationality is suppressed by subjectivity, a latent distrust of science, and a misguided freedom to make health decisions not just individually but also for children.

Is it always hostility to science that feeds these beliefs? Partly, but often it is insufficient knowledge. Mainly, it is the clash of beliefs and personal worldviews with facts and evidence. To a certain extent, it is also a *Zeitgeist*, an exaggeration of individuality. This is not only a sociological phenomenon, but also a psychological one.

"There is no magic formula to resolve this. But there are some crucial elements that are needed to address anti-scientific beliefs: authoritative and objective public information, more efforts in science communication and science journalism, improvements in the education system, and above all political and social decisions based on rational criteria and not on political opportunism or economically motivated lobbying."

Modern cognitive psychology has developed the idea that individuality is an important guiding basis for deciding on actions. Albert Bandura (see Further reading) established the concept of self-efficacy beliefs: That difficult situations and challenges can be successfully mastered by the individuals' own agency. The feeling of being able to determine the meaning and the course of one's life autonomously is therefore a reason for satisfaction. Even though it is a theory of behavioral change, it also helps to explain the exaggerations of the concept of individuality mentioned before. To what extent these self-efficacy beliefs have a wider effect depends on the ability and willingness of the individual to recognize where subjectivity ends and intersubjectivity with the rest of the world begins.

If this limit is not recognized, the rest of the world is perceived as an obstacle that restricts individual self-efficacy. This can help to explain an often determined and emotional refusal to acknowledge scientific facts if they are regarded as limiting one's agency. In medicine, which affects people on a very personal level, this can have a strong effect. The more pronounced the self-efficacy beliefs, the greater the tendency to prefer and defend "individual" and "holistic" means and methods instead of established medicine. Criticism of pseudo-medicine is therefore perceived as an attack on one's self-efficacy beliefs. Since I have begun to openly criticize homeopathy, I have constantly encountered such reactions by homeopathic followers: They refuse to consider the inter-subjective realm and insist on their self-efficacy beliefs, which often turns into aggression. Although this is certainly only a partial explanation, it is a major obstacle to a rational dialogue. In my experience, it is almost impossible to discuss with people who are completely convinced of their beliefs.

There is no magic formula to resolve this. But there are some crucial elements that are needed to address anti-scientific beliefs: authoritative and objective public information, more efforts in science communication and science journalism, improvements in the education system, and above all political and social decisions based on rational criteria and not on political opportunism or economically motivated lobbying. To improve both public and personal health will require the involvement of research, medicine, education, and health policy through public education campaigns and a more

Further reading

Grams N (2019) *Homeopathy reconsidered what really helps patients* (*Homöopathie neu gedacht – Was Patienten wirklich hilft*.) Springer Nature Switzerland 2019 (2nd edn); English edition published in January 2019 https://www.springer.com/de/book/9783030005085

Ernst E (2016) *Homeopathy – the undiluted facts: including a comprehensive A-Z Lexicon*. Springer International Publishing

Kahneman D (2012) *Thinking, fast and slow*. Penguin, reprint edition

Bandura A (1977) Self-efficacy: toward a unifying theory of behavioral change. *Psychol Rev* 84: 191–215

Informationsnetzwerk Homöopathie (INH) https://www.netzwerk-homoeopathie.eu/neuigkeiten/156-short-english-version

personalized approach to health by both physicians and patients. It will require scientific research to develop new medicines and therapies and to demonstrate their efficacy and safety. What it does not require is more pseudo-medicine and anti-scientific attitudes.

References

1. Virchow R (1858) *Die Cellularpathologie in ihrer Begründung auf physiologische und pathologische Gewebelehre*. Berlin: Verlag von August Hirschwald http://www.deutscheste xtarchiv.de/book/show/virchow_cellularpa thologie_1858
2. Hopff W (1991) *Homöopathie kritisch betrachtet*. Stuttgart: Thieme
3. Memorandum #2 Homeopathy as Pseudo-science. Commission on Pseudoscience and Research Fraud of Russian Academy of Sciences, 7 February 2017 http://klnran.ru/en/2017/02/memorandum02-homeopathy/
4. Systematische Reviews zur Homöopathie – Übersicht, in: Homöopedia Informationen zur Homöopathie http://www.homöopedia.eu/index.php/Artikel:Systematische_Reviews_zur_Homöopathie_-_Übersicht
5. National Health and Medical Research Council (2015) NHMRC Information Paper: Evidence on the effectiveness of homeopathy for treating health conditions. Canberra: NHMRC https://nhmrc.gov.au/about-us/publications/homeopathy
6. Homeopathic products and practices: assessing the evidence and ensuring consistency in regulating medical claims in the EU (2017). European Academies' Science Advisory Council EASAC, Halle (Saale) Brussels https://www.easac.eu/fileadmin/PDF_s/reports_statements/EASAC_Homepathy_statement_web_final.pdf
7. Ernst E (2017) The debate about homeopathy is over. These verdicts prove it. *The Spectator*, 9 June 2017 https://health.spectator.co.uk/the-debate-about-homeopathy-is-over-these-verdicts-prove-it/
8. Hirst SJ, Hayes NA, Burridge J, Pearce FL, Foreman JC (1993) Human basophil degranulation is not triggered by very dilute antiserum against human IgE. *Nature* 366: 525–527
9. Montagnier L, Aïssa J, Ferris S, Montagnier JL, Lavallée C (2009) Electromagnetic signals are produced by aqueous nanostructures derived from bacterial DNA sequences. *Interdiscip Sci* 1: 81–90
10. Luc Montagnier, in: Homöopedia Informationen zur Homöopathie http://www.homöopedia.eu/index.php/Artikel:Luc_Montagnier