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DEBATE

Modern or post-modern? Local or non-local? A response to Leick

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Most debates in science and the humanities that cannot be settled are not about truth, nor about data, but about beliefs and world views. Philippe Leick's comment on entanglement models of homeopathy are a good example. Because of this, no argument, however, convincing to some, will settle that debate. The only thing that can resolve it is a large cultural shift. My own ideas about non-local models, for a whole category of possibly similar events of which homeopathy is but one example. *Homeopathy* (2008) **97**, 100–102.

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Most debates in science and the humanities that cannot be settled are not about truth, nor about data, but about beliefs and world views. Philippe Leick's comment on entanglement models of homeopathy[1]: mine[2,3] and Lionel Milgrom's,[4–10] and indeed the whole public debate around homeopathy[11,12] are a good example. Because of this, no argument, however, convincing to some, will settle that debate. The only thing that can resolve it is a large cultural shift. My own ideas about non-local models, for a whole category of possibly similar events of which homeopathy is but one example, albeit a nice and methodologically well established one, are meant to contribute to this shift.[13–17] Without such a shift, and I am quite frank here about my own bias, I do not see much hope for our culture, indeed for our world as a whole.

No doubt Dr Leick and his colleagues will see it differently. They view likes of Milgrom, Walach, and others as charlatans, a danger to enlightenment, progress and rationality. I argue that they are quite wrong, and this is where the world views start clashing. Hence we need to elaborate on those, and not debate at a seemingly factual and data driven level.

Take an historical example: most people think it was not until Columbus sailed West in 1492 that the belief that the earth is flat was shaken. In fact, Aristarch of Samos, in the 3rd century BC, and later Roger Bacon in the 13th century had proclaimed that the earth was a globe and not a flat plate. Bacon was a medieval scholar-scientist who died in 1292. He was enormously influential in shaping future ideas about science – indeed some think that Columbus took an excerpt of Bacon's work on his first voyage.[18,19]

Bacon gave a perfectly convincing, geometrical argument for the world being globe shaped. It runs like this: If the world were flat then two people on a ship, one on the mast and one on deck should see the shore (or a distant ship) at the same time, as they have then roughly the same distance from the point in question. In fact, whoever is on a mast will see a distant object sooner than someone on deck. This is due to the curvature of the earth which prevents the person on deck from seeing and in fact brings the person on the mast ever so slightly closer to the distant point.

A perfectly convincing argument, based on experience and geometrical reasoning and well known. In 1309 a prelate at the University in Paris suggested using Bacon's mathematical writings as textbooks for students.[20] So why did it take another 200 years for the obvious to become acceptable? The problem was the general accepted world view, and its implications. If the world were a globe, why did the water not fall off into space, let alone people, animals, and stones? Even worse, the idea of a centre of the earth, such as Jerusalem, would be meaningless. Also, Aristotle's concept of heavenly spheres would have to be revised. A can of worms, to use modern parlance, would have been opened, if the idea of a round earth had been accepted then. People chose to rather not do that. In addition, a really

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convincing proof, one that would force even the most violent sceptic into acceptance, was still lacking. After all, no one had yet travelled round this globe.

The issue was, and is, mostly about such world views: about entities, facts and possibilities that we suspect are meaningful. Our current world view has a certain structure, part of which is that only local, contiguous causes can produce effects, that causes always precede their effects, and that non-locality (the view that there is such a thing as regular order, across time and space, not mediated by direct exchange of energy and particles) is crazy. Part of that world view also is that only matter matters, and that everything mental and spiritual are derived from it. This view I call the ''modern scientific world view''. There are various corollaries to that view, which I will not elaborate on here.[21,22]

This world view is the outcome of our collective scientific enterprise since Grosseteste and Bacon in the 13th century. But it limits our concepts and our potential for new discoveries. And it is here that Leick, on the one side, and Milgrom and myself, on the other side, differ. While Leick sticks to the modern scientific world view, we argue that this world view is outdated when it comes to understanding complex phenomena. Physics itself has long since produced all the elements to question this world view.[23] Our attempt, in the generalised quantum theoretical model,[14] attempts to pull those elements together into a consistent, meaningful model. This model then predicts what is at the core of quantum theory proper[24] and for non-quantum systems: non-locality as an inescapable consequence of how our world is built up.

The ''crime'' which we are committing in Leick's view is that of imagination, and extrapolation. By analogy with the historical example of the globe: we do not know yet, why people do not fall off the earth and water sticks to the seas. In our model: we do not know the parameters of a generalised entanglement model. In quantum mechanics these parameters are precise – for instance Planck's constant. We do not yet have precise definitions of operators and variables that Leick, justly, demands. But it is also unreasonable to demand everything at once. What we have provided is a formal model that says: it is reasonable to consider a world view which includes generalised non-locality. Lionel Milgrom and I have shown that this general reasoning can be used to reconstruct tricky phenomena such as healing, homeopathy and some other things that defy current understanding.[25]

New types of experiments, which have both been suggested and in part conducted,[26] are required to prove the concept. I agree with Leick: without experimental proof the whole concept is science fiction. But he should also know that only new types of experimentation will be able to provide the proof. By sailing round the Mediterranean Columbus, Magellan and others would not have proved that the world is a globe. Neither will we by sticking to the demand that anything worthwhile has to conform to the supposed gold standard of randomised experimentation.

In fact, entanglement proper cannot be proven by direct experimentation, i.e., by establishing a baseline through experimental comparison. It is only by theoretical reasoning that the combinatorial argument that yields Bell's inequalities can be derived. Then an experiment yields the data that can be compared against the theoretical prediction. It is no small challenge to derive an experimental analogue, and it is unreasonable to demand everything at once and for free. Because we do not have the precise formalism a Bell-type argument cannot be easily derived, and a proper experiment is difficult to devise. At the moment we are still devising such experiments.

But with hindsight, more openness, and some experimental intuition it is clear that there are too many anomalies to fit neatly into the box of the ''modern scientific world view''. It took over 200 years after Bacon until Magellan showed that you could really sail around the globe, and even then people did not believe him.

I do not expect Leick and his colleagues to believe us. But our position is similar to Bacon's about the world being round: we have a good theoretical structure, and some empirical evidence to back it, although decisive proof is missing. In a couple of 100 years we might have such data. The question is, whether we have that much time. The traditional world view is failing. Medical treatment of chronic problems is unsatisfactory, social systems are decaying, world politics and distribution of wealth, catastrophic. I am not sure that more of the same would help. But something quite different, a world view that allows for non-local connectivity might.

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