Generalized Entanglement: A New Theoretical Model for Understanding the Effects of Complementary and Alternative Medicine

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ABSTRACT

Background and problem: A main problem for the acceptance of many methods belonging to the broad spectrum of complementary and alternative medicine (CAM) is that there is no conceivable theoretical bridge between the mainstream biomedical model and CAM theories and practice. Although empirical evidence is one important side of the coin of credibility, theoretical feasibility is the other. History of science teaches that no amount of empirical evidence will convince sceptics and followers of more conventional paradigms as long as there is no good theoretical model to make empirical findings plausible.

Methods and solution: I therefore propose to broaden the spectrum of theoretical concepts beyond the reigning local-causalist model toward a non-local model that encompasses effects as encountered in CAM. Such a model can be derived from a generalized and weaker version of quantum theory recently developed and published by my colleagues and I as weak quantum theory (WQT). This theoretical model predicts nonlocal correlations analogous to Einstein-Podolsky-Rosen (EPR)-like correlations in quantum mechanics proper. The discerning moment, though, is that these nonlocal correlations within WQT are not EPR correlations postulated to extend into the classical world, but a broader, generalized version of entanglement not dependent on the strict quantum nature of the system under question. WQT predicts entanglement between elements of a system if two variables or observables are complementary: one describing a global and one the local aspects of the system. Entanglement then ensues between those local elements of a system that are complementary to the global description or observable of that system.

Discussion and conclusions: This paper explores this rather abstract and general notion and expands it into more concrete examples. It is at the moment a purely explanatory structure, which, however, lends itself to exact empirical testing due to rather precise predictions, which will be developed. Because this structure of generalized entanglement is ubiquitous and also operative in conventional medicine, and because it is derived from one of the strongest theories that science has developed so far, it would constitute a theoretical bridge between the different medical and scientific traditions.
INTRODUCTION

The dominant worldview defines what we take for granted: An example

There is no such thing as unobstructed preconceptual experience and observation, except perhaps in exceptional states of consciousness (for example, meditation) and maybe in minds well trained by such disciplines. Phenomenologists such as Husserl tried to achieve this as pure phenomenological awareness. For the rest of us, and science is no exception to that rule, our experience is guided by higher-order theoretical concepts of what elements are probably real, of what is “possible” and what is not. Modern theory of science has pointed this out cogently. Seminal thinkers were Collingwood, who stated that every scientific activity necessarily proceeds by resting on absolute presupposition,¹ and Fleck who pointed out that so called “scientific facts” were a result of convention within a group of similarly trained experts.² It is an interesting aside to the recent theory of science debate that Thomas Kuhn³ developed his theory of paradigmatic change starting from those thinkers.⁴

A classical historical example of such an inability to perceive what is obviously “there” because of preconceptions inoculated by a theoretical model is the resistance that William Harvey, the discoverer of the heartbeat and circulation, met when claiming that the heart was pumping blood through the vessels. His whole age adhered to the Aristotelian physiology that claimed that the heart was a kind of convection heater that heated the blood, which, rising up to the head, was then cooled down by the brain, which evidently was a cooler. When Harvey vivisected live animals and saw the heart actually contracting, he postulated that the heart was a pump. After his publication, a furious outcry infected the head, was then cooled down by the brain, which evidently was a cooler. When Harvey vivisected live animals and saw the heart actually contracting, he postulated that the heart was a pump. After his publication, a furious outcry lashed through Europe, led by the then-famous medical doctor and philosopher Emilio Parisano of Venice. It is worth quoting him at length⁵:

We have no problem to admit that, if the horse swallows water, we can perceive a movement and we can hear a sound. But that a pulse should arise in the breast that can be heard, when the blood is transported from the veins to the arteries, this we certainly can’t perceive and we do not believe that this will ever happen, except Harvey lends us his hearing aid. But above all, we do not admit such a transport of the blood . . . If blood is transported from the veins of the lungs . . . into the branches of the arteries, how could a pulse be felt in the breast, how a sound? I am completely innocent of such subtle speculations. Above all, Harvey has it that a pulse should arise from the movement of the blood from the heart into the aorta—no matter from which ventricle. He also claims that this movement produces a pulse, and, moreover, a sound: that sound, however, we deaf people cannot hear, and there is no one in Venice who can. If he can in London, we wish him all the best. But we are writing in Venice.⁶

Something as evident to us as the heartbeat was not perceived by many generations, simply because their world model did not offer a framework for perceiving and making sense of that phenomenon. They might have experienced the phenomenon; they even might have heard something; but they did not attribute any meaning and importance to it. This, then, is the function and the power of world models⁷ or absolute presuppositions. They guide our perception. They prestructure the world into things that make sense and are important and hence perceived, and into noise that can be neglected.

In the same sense our modern scientific worldview makes some absolute presuppositions, which most of the time are very useful in prestructuring the world. But it also precludes perception of phenomena, simply because we cannot make sense of them for lack of a sound theory. Some examples for such modern scientific absolute presuppositions that provide apriori assumptions of what can be expected of the world are as follows:

1. Individuals are primary. Relations, complexes, systems, and higher-order elements can be reduced to more basic individual constituents. Thus, we define organisms in terms of their organs and tissues; organs in terms of their molecular components; macromolecules in terms of simple molecules; molecules in terms of atoms; and atoms in terms of subatomic particles.

2. Complexity and higher-order function should be and can be explained in most instances by interactions of lower order elements. Although some more recent developments such as complexity theory cast doubt on this tenet, it is still widely believed.

⁴I owe this example to Marcello Truzzi, who used it in a presentation he gave at an NIH conference on CAM. When I first heard it, I did not believe it, and the references that Truzzi sent me did not inspire trust, since they were secondary and partially not traceable. So I set out to find the original document. The book I quote from is an original print, which contains Harvey’s tract together with comments of other authors. The University Library Bale has a copy with the signature Ea IX 85:68. The passage is on page 107, translation mine. Here is the original text: “In aquae ab equo deglutitione, et motum percipi, et aquae sonitum exaudiri, facile admirimus: at in sanguinis e venis in arterias traductionem pulsum fieri in pectore, et exaudiri, nec nos quidem percepimus, nec imaginione assequi possumus, nec etiam assequi nos unquam posse credimus, nisi ab Harveio suum aurium instrumentum acusticum mutuemur. Imprimis iam talem sanguinis traductionem non admirimus. . . Quodsi in pulmonibus, et cor undum venis... in arteriae venalis ramulos, peragitur: quomodo persentitur in pectore pulsus? quomodo sonus? Innocens ego sum ab huius speculationis subitilite. Adda praeterea, quod Harveio pulsus fit ex immisso a corde sanguine in aortam, seu in sacrum et urem; ut ita ex sanguine sequatur pulsus et (quod ulterior addit) sonitus: quem nos surdastri audire non possumus, nec Venetiis sunt qui audiant. si tantummodo Londini exauditur, faustum, felix, fortunatum esto, nos Venetiis scribimus.”
(3) Relations between individuals are secondary to and dependent on the individual components. In other words, forces and interactions are secondary to the parts that interact.

(4) Change is a change in movement, and brought about by local, causal interventions. Thus causes are conceived of as operating locally. If there is no contiguous contact between the cause and its effect we do not normally consider it a cause or we analyze the sequence of events until we find a contiguous, local intervention. Although, in a sense, my wish for light is the cause of the light coming on, we would consider my pressing the switch, and consequently the flow of electrical current and the glowing of the light bulb due to electrical resistance the proper cause of light, and not my wish. For if I wished the light come on, and it came on without me or anybody else pressing the switch, we would be disconcerted.

Every now and then a scientific discovery forces us to change those basic hypotheses about the world. And not infrequently this change happens very slowly, first impinging only on one part of the scientific community until others or the society at large follow. When the Ptolemaic worldview, which put the earth into the centre of the universe, changed into the Copernican view over several generations, this at first had little impact on how to travel, trade, or treat patients. Old astrolabes could still be used to determine the position of the planets. However, the Copernican notion was also coupled with the notion of the earth being round and that had impact on what was possible in seafaring. New routes, new countries, and new riches were discovered, which were there all along but not imagined to be attainable. Gradually this discovery took hold of the whole world and changed the planetary culture up to the present.

The dominant modern scientific worldview is still very much defined by basic assumptions derived from Newtonian physics. For instance, the notion that individual elements are primary, and their relations and the forces between them secondary, was introduced by Newton. Leibniz, his contemporary adversary, had a different model in which the relations between individuals constituted the individuals and were coexistent with them. Newton’s concept made more sense to his contemporaries and seemed to have been vindicated by the success of his theories, and thus it was adopted not only for physics and astronomy but for the whole of science, whereas the Leibnizian concept was relegated to history.

It was only with the advent of quantum mechanics that this situation changed.

**TOWARD A NEW WORLD MODEL: THE ADVENT OF QUANTUM MECHANICS**

The Newtonian worldview of material objects moving through space which is independent from them and which can be clearly defined at every point of their voyage through space and time prevailed, until it reached its endpoint in quantum mechanics. The theory of quantum mechanics was developed exactly from the anomalies that were posed by the Newtonian worldview. The energy emitted from heated objects could not be described continuously, as Planck realized, but it was necessary to postulate infinitesimally small chunks of energy—or quanta—that were emitted in a piecemeal fashion when a material object was gradually heated. To make things worse, those quanta, that we now take to be photons, and other members of the subsequently revealed quantum particle zoo, cannot be treated like classical Newtonian objects, which travel on mathematically well-described pathways and have unique identities throughout their lives. They have different properties that cannot take on sharp and defined values at the same time. Although a Newtonian particle, even if it moves on a convoluted trajectory, always has a clear position and a definite momentum, which are defined by differential equations, those quantum particles cannot be defined in the same way. This insight brought Niels Bohr, one of the founding fathers of quantum mechanics, to the formulation of complementarity. Complementarity means that there are certain properties of quantum elements that cannot, at the same time, take on sharply defined values. It is necessary for their respective measurement to install a measurement set-up that disturbs its relevant counterpart. For instance, if we want to measure the exact position of a particle, we have to scatter it with a beam of electrons. That operation, however, will alter and thus completely blur its momentum, and if we wish to measure the momentum exactly, we have to use an experimental setting that will make it impossible to tell anything about the particle’s location. Complementary observables, as they are called, thus are observables or properties of quantum particles that are necessary to completely describe a particle but that are impossible to gain knowledge about in the same measurement set-up. Thus complementarity was a theoretical subterfuge of Bohr’s to take apart and yet bring together what, in a Newtonian universe, defined a particle at the same time and independently of each other. In the quantum universe these properties are in a strange way mutually exclusive in measurement and thus are dependent on each other. For it is the decision of the experimenter as to which property to measure first that defines the results. Thus it is the sequence of measurements that comes into play. If we measure momentum first, we give up on the measurement of location and the other way round.

In the modern algebraic framework of quantum mechanics, this situation is formally and abstractly depicted by an algebra of noncommuting operators. In our normal algebra it is quite irrelevant if we take 2 first and multiply by 3 or the other way round. Our Abelian algebra is commutative, we say; both ways, the result is 6. The algebra used to model quantum mechanics is different. It handles noncommuting operations in the way that the sequence of operations is important. Formally this is depicted as

\[ ab - ba \neq 0 \]  
(Equation 1)
Substitute 2 and 3 for a and b and you can immediately see that this is a very strange situation compared to our normal everyday world. This is what is meant by complementarity. It describes operations that are mutually exclusive, the sequence of which does in fact matter, and that are both needed to describe a situation and yet cannot be applied at the same time. Complementary observables are maximally incompatible—not only contrary or contradictory, as for instance are our concepts of hot and cold—and yet belonging to one and the same instance or situation.

It is this complementarity of variables describing one quantum object that gives rise to Heisenberg-like uncertainty relations. If we translate the situation into formal language that precise measurement of one observable renders our knowledge of the other observable practically indeterminate and vice versa, we have a different form of equation (1), namely

$$\Delta p \Delta q > 0$$  \hspace{1cm} (Equation 2A)

where $\Delta$ is a term of dispersion, comparable to what we know from statistics as standard errors. If we imagine that we could measure both variables $p$ and $q$ with arbitrary precision, at least in theory, those dispersion terms $\Delta$ were zero (and in fact they are zero in statistical versions of classical physics, where with many measurements error terms would cancel out and become zero). Thus in any classical version of physics equation (2A) would contain an equal sign. Not so in quantum mechanics. For if we measure one variable with maximal precision, the other error term approaches infinity. Let us take a few seconds here and do our algebraic exercises. Let us postulate a very small magnitude for the quantity on the right hand side of the inequality, let us say $10^{-36}$, a value close to Planck’s constant that in fact is inserted in the Heisenberg inequality proper. Thus equation (2B) would read

$$\Delta p \Delta q > 10^{-36}$$  \hspace{1cm} (Equation 2B)

Now let us suppose that we managed to measure one variable, say $q$, with nearly perfect precision and thus our dispersion term for $q$ is very, very small indeed, let us suppose $10^{-80}$. To find out how big the dispersion term for $p$ is, we algebraically reformulate, bring $\Delta q$ to the right hand side and insert for it our imagined real value of $10^{-80}$ and thus our reformulated equation (2B1–2D) reads

$$\Delta p > 10^{-36}/10^{-80}$$  \hspace{1cm} (Equation 2B1)

$$\Delta p > 10^{-36}/10^{-80}$$  \hspace{1cm} (Equation 2C)

$$\Delta p > 10^{44}$$  \hspace{1cm} (Equation 2D)

We immediately see the consequence of this: if the term of the right-hand side of the inequality is a constant, however small (and in fact in quantum mechanics this is Planck’s constant with some cosmetic add-ons), then trying to make one term go toward zero means making the dispersion of the other variable approaching positive infinity.

Thus the mathematical formulation of the core concept of quantum mechanics, complementarity, leads to a Heisenberg-type inequality. Hidden behind those somewhat scruffy symbolic formulations lies another strange reality, which was first pointed out by Schrödinger and called “entanglement” by him. Soon afterward Einstein, Podolsky and Rosen used this phenomenon in a famous thought-experiment to make plausible, as they thought, that quantum mechanics cannot be a complete and rational picture of the world, and hence it is often called Einstein-Podolsky-Rosen (EPR) paradox or EPR-correlatedness. The fact can be circumscribed in the following way:

Whenever a system can be described in terms of such noncommuting or complementary variables, or more precisely, whenever observables pertaining to local elements of the system are complementary to observables describing the system as a whole, those local elements are entangled with each other.

This means that these entangled elements, for instance electrons or protons in a quantum system proper, behave in a coordinated and correlated fashion, without exchange of energy or signals between them. Loosely speaking it is as if these elements would intuitively know how to behave in the face of the behavior of the other elements. For instance, if a pair of two entangled photons are prepared and radiated out, any measurement of a property of one photon (for example, its polarization angle) will “cause” a corresponding measurement in the other photon, without them having material contact with each other, or without them communicating, or exchanging matter or energy. Any information exchange between them could happen only with the same velocity, namely that of light, at which the photons themselves are travelling, and thus could not be instantaneous. Thus such correspondences are called “nonlocal” because they are not conveyed by a material signal traveling at the speed of light. Hence the phrase that such a measurement “causes” the corresponding partner to exhibit a corresponding value is strictly speaking incorrect. For there is no signal conveying the measurement result, no exchange of energy or matter, and thus the verb “to cause” must, in this context, be understood as being within quotes. The reason for this strange, holistic behavior lies in the set-up of the system described by quantum mechanics. Einstein and his colleagues would not believe that this was a rational option and thus used it as a thought-provoking counter-argument against quantum mechanics.

For many decades this strange feature of nonlocality was only of a theoretical nature and interest, until in the 1960s John Bell formulated his famous inequalities. These consist of combinatorial algebra and define which values measurements of different states of quantum particles in a long series of measurements should have, if they behaved more like classical physics and Einstein would have it (namely independent of each other and not entangled) and which values measurements should take if the particles and their states
were intrinsically connected or entangled. After another two decades these theoretical predictions and operationalizations became experimentally testable, one of the more famous tests being those of Alain Aspect and his group in Paris.13,14

This and a subsequent series of other tests left little doubt: Quantum mechanics is correct. Elements of a quantum system that are complementary with global aspects of the system are entangled in a nonlocal manner. Further experiments also clarified that these correlations are very unlikely to be the expression of deeper structures in matter, so-called hidden variables, an explanation favored by a school of physicists close to Einstein and his followers such as Bohm, but are genuine.15 More and more loopholes pointed out by followers of a hidden variables interpretation of quantum mechanics were stuffed with ever more intricate experiments. All of them revealed that the basic nonlocality and entanglement between elements of a quantum system is an empirical fact that is genuine. It has been pointed out that, for the first time in history, a metaphysical question had been settled experimentally and not by rational debate.16 Meanwhile experiments have been conducted that show that quantum systems can stay in their entangled state over many miles if properly isolated.17

The question that is debated hotly at the moment is how far those quantum or EPR correlations can reach out. It is clear that with continuing interactions with their environment they decay and die out.18 But what if quantum systems are partially isolated? How far would entanglement go? This is at the moment debated under the term “decoherence.” It is very important for the further development of my argument here that decoherence and the isolation of quantum entanglement proper is not the route of argumentation adopted here. At this point in the flow of the argument we simply want to note that nonlocal correlations, or entanglement, obviously are a basic feature of nature at the quantum level. Thus, the modern concept of nature as derived from quantum mechanics is more in unison with a Leibnizian worldview than with a Newtonian (although, historically speaking, we would hardly have arrived at that insight had we not followed Newton’s idea to the end of the road, where they link up with where Leibniz would have it).

Whenever we have quantum systems governed by an algebra of noncommuting operators, we can expect the structures discussed above, such as Heisenberg-type inequalities and hence entanglement. This cannot be reduced further but is a basic feature of nature. Modern physics is quite enthusiastic about that fact and discusses potential technical applications such as quantum computing, quantum teleportation, and encryption.19,20 We depart from quantum physics proper at that point and make a more daring move.

**WEAK QUANTUM THEORY AND GENERALIZED ENTANGLEMENT**

This move follows a simple intuitive assumption: Something as basic as entanglement and nonlocality that reigns at the very core of our material reality is likely to be operative at other scales of the systemic order as well. To put it differently: what if quantum mechanical entanglement proper were just a special case of a much more generic and prevailing structure of the world? What if the structural rules governing quantum mechanics proper (QM) were more widely applicable and the mathematics used to reflect them also useful for other systems? It was this kind of intuitive reasoning that lead us to formulate what we called “weak quantum theory” (WQT), a generalized version of QM that does not restrict itself to the description of material systems but that could be applied to other systems as well.10 The power of QM derives partially from the fact that some definitions and boundary conditions are set that are quite precise, because they have been derived from a combination of empirical observation and theoretical mathematical reasoning. For instance, Planck’s constant fulfills such a role as a precise defining element that allows calculations and numerical predictions. This precision is bought, however, at the price of restriction, which is very wise if one wants to make clear predictions about experimental outcomes. If we drop those definitions and restrictions typical for QM but leave the minimum amount of algebraic formalism intact, we reach what we think is a minimal set of axiomatic definitions necessary for the description of any system, no matter what its function and material set-up. However, if we keep the single most important ingredient of QM—the handling of noncommuting, incompatible, or complementary variables or observables—we leave exactly that structure of QM intact which led to the discovery of quantum entanglement.

WQT does exactly that: it keeps the minimum structure of a systemic theoretical, abstract description that is used for QM proper, and drops all those restrictions and definitions that are typical for QM proper in the treatment of material systems. For instance, WQT has no constant that limits the ranges measurements or values of variables can take, such as Planck’s constant. It also does not provide for a probability calculus like the one offered by Hilbert space interpretation and thus WQT cannot make any precise numerical predictions without further definitions. However, WQT keeps the generic formal structure and handling of noncommuting, complementary variables. Therefore a generalized version of entanglement—generalized entanglement as we call it—can be deduced from WQT. In its most general and broadest formulation, the meaning of generalized entanglement is the following:

In any system that contains a clear description and systemic border (i.e., that can be analyzed as a separate system) and that contains at least two elements, those local elements within the system the description of which is complementary to a global observable describing the system as a whole, are nonlocally correlated.

This situation is graphically depicted in Figure 1.

Note that this prediction is, at the moment, a pure theoretical possibility, derived deductively from the structure of
FIG. 1. Graphic representation of generalized entanglement: Local elements (squares), the description of which is complementary to the global description (double arrows) are entangled and nonlocally correlated (curved lines), whereas other elements of the system are not.

WQT, which is a generalized version of QM. The fact that nonlocal correlations in quantum systems proper have been experimentally proven and that WQT is only a generalization of QM proper should make the assumption plausible that nonlocal correlations in other systems could be expected to occur also. Thus, let us, for the rest of the paper, assume that this is a rational possibility and discuss what the consequences of such a model are and what phenomena (if any at all) lend themselves to an analysis along the lines of WQT and generalized entanglement, and how this could profit both the practice and the scientific efforts in researching CAM.

A GENERALIZED ENTANGLEMENT MODEL OF SOME ASPECTS OF CAM

Before we proceed let us recapitulate what such an analysis would mean and what type of phenomena generalized entanglement would cover. Entanglement refers to the correlated behavior of elements of a system without interchange of energy or matter and thus brings nonlocality into the scientific debate. All of those phenomena for which we have difficulties in isolating clear causative agents could lend themselves to a discussion in terms of generalized entanglement. If our intuition is not very far off the mark, then entanglement in a generalized form would be far more ubiquitous as we suspect. It even could be a very mundane phenomenon that, for lack of theory, we normally overlook completely and only discover if something unusual happens or if the analysis is applied in a very formal manner. At the very least, if generalized entanglement can be proven to be real, this line of analysis would link areas of research and practice to the mainstream of science that at the moment are deemed to be unscientific or irrational. The prediction would in fact be that generalized entanglement is an important option to be taken into account also by mainstream science.

Methodological aspects

For instance, it could be the case that in blinded controlled clinical trials correlations of healing rates between treatment groups and placebo groups could be caused by generalized entanglement. These correlations are a well-documented fact by now. Several meta-analyses, starting from early data by Evans,21 followed by Kirsch and Sapirstein22 and analyses by my colleagues and myself,23,24 showed over and over that in clinical trials healing or improvement rates in treatment and placebo groups are highly correlated, which, if true, would be rather disconcerting, as pointed out by McQuay.25 Although McQuay could make plausible that the early correlations reported by Evans could be caused by skewed distributions of measures, this argument does not come into play with the correlations from those other publications, which used continuous improvement rates to calculate correlations. The correlations were as high as \( r = 0.89 \) for the depression studies used by Kirsch and Sapirstein, whereas improvement rates in sets of psychotherapy studies comparing wait-list controls with real psychotherapy studies did not correlate at all. The latter finding shows indirectly that those correlations are probably not only cohort effects but are genuine. Our own data found rather robust correlations of \( r = 0.59 \) in a first set of 29 long-term trials with different diseases and \( r = 0.78 \) for a set of 144 studies retrieved and analyzed according to a predefined scheme. In our opinion those correlations are an example of generalized entanglement at work in a closed systemic setting, among other factors responsible for those correlations. In all of those trials there is one global characteristic, and that is the blindness of the trial. Complementary to it is the fact that all patients are definitely allocated to one or the other group (the randomness of the allocation does not really matter but helps to strengthen the blindness of a study). Blindness, then, and definite allocation are the complementary variables here, blindness being global and definite allocation being local. Hence a correlation would be expected between those local elements that are definitely allocated (i.e., between the patients) and by extension between the treatment groups. This is exactly what we observe.

It is not by accident that I chose this example as an introductory one in our discussion of generalized entanglement in CAM. For this set-up of a possible nonlocal correlation between patients and patient groups in a trial holds for all sorts of studies, no matter what the intervention. However, contrary to many mainstream pharmaceutical interventions, where we have strong causal agents—receptor agonists and antagonists, immune-modifying agents, and the like—we do not have comparably strong causal signals in CAM interventions. Many CAM practices rely on exceedingly small stimuli of a more regulating or gently tipping nature than on conventional pharmacology, which follows more the doctrine of strong interventions. Hence it is not surprising to find the paradoxical fact that many CAM therapies work well in open comparison trials but have great difficulty showing superiority over placebo,26–28 and even
have placebo effects that are so strong that that one wonders why still bother with conventional interventions.27,28

If our supposition of generalized entanglement is correct and our analysis of placebo-treatment correlations in clinical trials valid as an example of generalized entanglement at work, then blinded trials of CAM are not a good idea at all. To keep potential correlations low, studies that are not blind would be better, such as pragmatic randomized comparisons between CAM and conventional treatment or any other type of control such as wait lists.

**Explanatory options**

**Homeopathy.** Generalized entanglement would also lend itself to a theoretical reconstruction of some CAM practices. I have recently elaborated such an entanglement model for homeopathy,29 after earlier hints about the necessity of such a nonlocal model.30 In brief, it would posit that homeopathy is a way of using generalized entanglement to bring about therapeutic effects. Homeopathy is using a double-entangled structure: the one between original substance and remedy through the potentization process of remedy production, and the second one between individual disease symptoms and generic symptoms of the remedy picture of the materia medica through the similia rule. In the first entanglement structure we have a complementarity between a global variable, the original substance, and a local variable, the actual dilution. The complementarity is between definite substance and uncertainty of localization. This forms a strong entanglement between the original substance and the actual remedy, and this entanglement should be the stronger, the higher the potency, just as homeopathic experience teaches. The second entanglement ensues between the individual’s symptoms and the generic remedy picture of the materia medica, the complementarity being between the individuality of the symptoms and the generic nature. I have argued and elaborated elsewhere29 that this double entanglement structure is reminiscent of double-entanglement as it is used for purposes of teleportation and quantum cryptography, which at least in prototypical cases has already been experimentally realized.15,19,20,31 The weak classical trace that has been postulated by many homeopathic researchers could be the classical channel which is necessary for quantum-teleportation to work. Although this model is highly speculative it makes some interesting predictions that could be experimentally tested.29

**Spiritual, distant, and ritual healing.** A nonlocal model along the lines provided by generalized entanglement would also be an elegant solution to the question of how rituals and distant healing could possibly work.32 The healing ritual, whether in situ or at a distance, creates a system through the ritual. It encompasses the healer and the healee and whatever else is necessary. Perhaps different healing rituals would need separate theoretical reconstructions, but here is one generic possibility. The healer creates a bond of community between him- or herself and the healee, either by a ritual or in the healer’s mind, and lets his or her own individuality merge to a certain extent with the one of the healee, thus creating a kind of unity or community. By still upholding a certain sense of individuality at the same time, entanglement between the healer and healee could become instantiated, since community or unity and individuality are complementary, the one being a global and the other a local description. By virtue of this connectedness with the healee the healer might be in a position to enact, on behalf of the healee, in the healer’s mind or in a symbolic reality, what would be a desired state for the healee, which then through this entanglement might be installed within the patient through a nonlocal correlated action.

This route of explanation could possibly also be used for many instances of native ritual healing, which is typical for many indigenous societies, such as the rituals described by Moerman,33,34 in which seemingly irrational (from a Western point of view) actions lead to the desired effects nevertheless. It seems to be a phenomenologically described experience of several healers (mainly from the areas of Reiki, massage, and therapeutic touch) who describe exactly that type of merging with the other that seems to be a necessary ingredient for the complementarity between union and individuality to become operative.1

Apart from that, another, yet-unexplored route of healing potential to be construed along the lines of generalized entanglement would be that of the power of consciousness. We have pointed out at other occasions35 that consciousness and brain, mind, and body, could and should be conceived as complementary notions. In a specification of that generic idea Atmanspacher40 has argued that the distinction between mind and matter could be caused by a symmetry break that lets this distinction arise as an emergent property out of an underlying unity. What would emerge, then, is not mind out of matter, but the distinction between mind and matter out of an underlying common unitary nature. Thus mental and material events could be nonlocally correlated. It would be worthwhile to study further the role of consciousness in many CAM practices along the lines hinted at here. It is to be expected that the results gleaned from this study would also have broad implications for conventional medicine at large.

**Acupuncture.** Many local models for the efficacy of acupuncture are in circulation. The most prominent of them certainly is a model for pain control. It postulates that, through peripheral stimulation, central inhibitory processes are activated and pain-enhancing pathways are attenuated, mostly through monoamines and endorphins. Although such theories certainly have a great explanatory potential, especially because they can link up with a host of research on
neuromodulation and psychoneuroendocrinology, they are mainly geared toward understanding antinociceptive effects. It is much more difficult to use such a model for the understanding of generalized constitutional effects of acupuncture, which are the most important ones for classical TCM therapists. Models valid only for pain control also have problems making plausible the effects of distant acupoints.

WQT and generalized entanglement predict a hyperfast communication system not necessarily linked to neural pathways or to any of the known pathways for signaling, for that matter. Because entanglement effects are nonlocal we would expect effects that do not necessarily have to follow the traditional neurotransmission routes. Such effects could at the same time affect a whole group of body systems in a nonlocal fashion. To understand that, we could conceive of the whole organism as one ordered system of nonlocally correlated subsystems. The global variable would be the definition of one genetically defined organism and the local variables would be all of the subsystems belonging to it. The complementarity would be again the one between union/community and individuality/singularity. Thus an effect brought about at one level of the system or at one site could instantaneously and nonlocally be mediated to distant systems seemingly unconnected by classical pathways. I submit that at that moment there is no clarity how distant acupoints at the leg could be, for instance, connected to seeing and not to other functions such as tasting, and so on. We also readily concede that much needs to be clarified before a nonlocal model based on generalized entanglement could put to work. The purpose of this sketch is to open up new venues for research and thinking more than to provide final clarifications.

Intuitive diagnosis, countertransference, and empathy. A phenomenologically well-known phenomenon within CAM and indeed other therapeutic disciplines as in psychotherapy is intuitive understanding or holistic and immediate knowledge of problems a patient experiences. This might even amount to a sudden grasp of the living reality of the patient and the history of suffering, without the patient telling much about his or her problems or even trying to hide them. In the psychoanalytic tradition this phenomenon has been handled under the headline of countertransference. Transference is normally well known as the process by which a patient sees in a therapist a significant figure of his or her past or projects his or her personal problems onto the actual therapeutic relationship. Thereby psychologic problems become activated and amenable to treatment. Countertransference, in a narrow sense of the word, refers to the same process but on part of the therapist (i.e., the therapist activating some of her or his problems within a therapeutic relationship). However, there is also a broader and more general meaning of the term countertransference. If used in that broader sense, countertransference relates to the fact that the therapist may feel, sense, or intuit some hitherto hidden aspect of the patient’s personality. This may surface in the therapist’s mind as a sudden impulse, affect, emotion, or image that the therapist is unable to connect with his normal mentation processes. For instance, although a patient might relate how well everything went last week and how proud he or she was of having had kind and meaningful relationships lately, the therapist might suddenly feel the impulse of getting up, shouting around, and using foul language. This impulse might arise all of a sudden in the therapist, without any background of an aggravating experience of any kind that could serve as a plausible explanation. The therapist might tentatively take his or her unusual mental activity and strange impulses, etcetera, as in reality “belonging” to the patient. The therapist could test that by asking whether the patient might have overlooked some elements of aggression or excitement because having peaceful relationships is so important for him. This might then trigger important insights and could lead to the patient’s acknowledging such implicit feelings.

Such a broader sense of countertransference might be a very generic instance of being immediately and nonlocally in communion with someone else, provided that there is a strong systemic tie between the two of them (note that this phenomenon is here treated as an interpersonal one between two persons for reasons of clarity but that it pertains to groups and large collectives also, provided that the systemic boundaries are there). It might be the basis for a broad variety of similar phenomena called by different names in different therapeutic traditions or by different groups.

For instance, intuition could be founded on, among other things, a nonlocal way of connectedness between persons who are belonging to one social unit, either by way of natural bonds (as in family relationships or tribal units) or by way of artificially created bonds. Such artificial bonds are normally provided in our human cultures across societies and ages through rituals. The most common ritual uniting persons not related by genetics into a new societal unit is marriage. It is an interesting fact in itself that there is, to my knowledge, no single human society around the globe that does not have a ritual for the purpose of forming new family units through marriage (and some also for dissolving such units in divorce). In the same way therapeutic rituals form new temporary units between therapist and patient. In every therapeutic modality there is a certain ritual to delineate what belongs to the healing unit and process and what does not. In such a unit we can expect nonlocal correlatedness of some kind between the elements forming the unit—therapist and patient, for instance, and between smaller sub-elements of those units—target problems in the patient and their perception through therapeutic intuition. All preconditions for generalized entanglement are met here:

3Hyland ME, Walach H, Holgate ST. Do some genes act as pattern specifiers? An explanation for the way genes make macrostructures and implications for complex disease. (Submitted for publication.)
We have a systemic bond between patient and therapist forming a temporary unit. The global description or variable would again be community or union. The local description would be the individuality of the patient and therapist. Both elements, that is, community and individuality, or union and separateness, are complementary. Hence the two units are nonlocally correlated. It remains a task for a more detailed analysis to work out how exactly and what exactly is being transferred in such nonlocal ways of intuition and communication. The intention here is to show that such a thing is at all possible for theoretical reasons.

Intuiting parts or even the whole of a patient’s problems by intuitive diagnosis need not be restricted to examples of direct contact. By the same token it could also happen at a distance, a fact that has been widely testified by anecdotal reports and that is very difficult to reconcile with local theories of information processing. For the model advocated here it would in fact not make much difference, whether a person is actually present, as long as the bonding tie that forms a unit out of two persons is strong enough. This could be provided by rituals often used explicitly or implicitly by healers, when they have images and pictures of the patient present or imagine the patient to be in the room.

This analysis also shows that for those processes to be optimal, complementarity is important. Neither a complete blurring of boundaries by focusing only on communion nor a strong emphasis on individuality would be conducive to nonlocal connectedness. On the contrary, it is exactly individuality with communion or unity at the same time that would maximize generalized entanglement between the two joined elements. Thus, such processes of countertransference or intuitive glimpses of the other person’s inner problems would be expected to be strongest if therapists could do two things at the same time: suspend their individual borders and at the same time maintain their sense of individuality. This might be achievable in a state of awareness that is slightly different from our everyday consciousness and thus might also depend on some special activity to induce altered states of consciousness.

The security button: Prohibition of causal (misuse). Why, then, is it that these processes are not used more frequently; why they are not seen more readily; and why is our whole culture built on local processes? We normally rely on local processes if we want to be sure that things happen. We talk to people if we want to get a message across. We give insulin if we want to control the blood sugar reliably. We use a telephone if we really want to speak to someone at a distance. All causal processes used in our culture are quite reliable and preferable if reliability is the top criterion. If something unforeseen happens, telephones, airplanes, insulin pumps, pacemakers, cars, and the rest of technology work. Those nonlocal processes seem to be less reliable and less amenable to technical control. Why is that so? And if so, why bother?

It has been made clear by theoretical analysis for quantum entanglement proper that for entanglement to be seen, an entangled system needs to be strongly isolated. Any interference with such a system, and any attempt to extract information from it, lead to an increase of entropy and thus disturbs the system. Whenever an entangled mode is to be controlled, then an interaction with the environment happens, which leads to an attenuation and finally to a breakdown of the entangled state. In other words, control and causal manipulation destroy entangled states. That is a straightforward explanation why such processes are strongest if they occur naturally and unexpectedly, and why they are difficult to implement in a systematic manner within a therapeutic system. If a therapeutic system is nearly completely based on entanglement processes, as in my opinion homeopathy is, then a strictly causal treatment of the system tends to destroy it or to make it unpredictable otherwise. Walter von Lucadou was the first to point that out for parapsychology, in which the unreliability and the unsystematic appearance of the phenomena are proverbial and have led to their being largely discarded by mainstream scientists. However, this phenomenal structure is genuine for all processes using generalized entanglement. In homeopathy, for instance, it is observable that all those controlled studies that leave some degrees of freedom (by using multiple outcomes, or by testing compounds, or by slightly altering the design of replication studies) have a chance of detecting effects, whereas very rigid studies testing for the causal-local nature by closing all loopholes of alternative explanations have generally created conflicting evidence. A classical interpretation would be, of course, that these results are suggestive of null effects, whereas an analysis along the lines of generalized entanglement would predict that through causal use of these processes entanglement is destroyed or breaks down.

A corollary to that statement would be that effects could be demonstrated only by multiple models and by second-order statistics, as in meta-analysis of many studies. If this were true, then therapeutic systems using generalized entanglement processes would be not as straightforward and would be less reliable than causal processes, because they tend to break down if probed too strong for their reliability. This also explains why, in the context of medical treatment, these elements play only a minor role at the fringe of any system. In ancient times, when the knowledge of causal-local processes as in pharmacology and surgery was minimal, there was a clear place for such nonlocal systems of healing as shamanic or ritual healing. Our increase in knowledge in causal processes seems to have done away with it. Why, then, bother to discuss its use and concomitant problems?

THE PLACE FOR NONLOCAL PROCESSES

I suggest that there is still a place for such processes because they form an elegant way of dealing with complex problems without disturbing the balance of the system.
Any causal intervention—pharmacological or surgical, for instance—also creates side effects, and the more potent the intervention the stronger the side effects. On the other hand, nonclassical interventions, which are possibly based on a use of generalized entanglement, are an elegant way of aligning the whole system without disturbing it too much at the same time. Hyland has introduced the concept of network pathology. This describes complex disturbances in which the self-regulatory capacities of the organism are not sufficient to bring a disturbed system back to normal and in which the organism creates the disturbance because set-points have been dysregulated. Normal pathology, on the other hand, includes pathologic conditions in which the network itself is disturbed on a material basis and cannot sufficiently function. Examples of network pathologies are all complex chronic diseases in which the organism cannot heal by itself, whereas examples of ordinary pathologies are acute diseases or emergencies in which the body needs help to regenerate back to normal but otherwise does so on its own.40,41

Modern medicine, using mainly causal processes, is very good at treating those ordinary, acute diseases; but it does not have many options for treating network pathologies, in which the organism’s self-regulating capacities are disturbed. CAM practices are directed mainly toward regulating those network pathologies and seem to do better at those than conventional practice. My suggestion would be that CAM practices based on generalized entanglement are better at regulating such complex network errors and that it is mainly here that they find their place. Because causal treatments for network pathologies are often not available, we have to live with the insecurity connected to the practical use of entanglement. It is a corollary of the thoughts offered in this paper that entanglement processes have probably been used by nature more widely than we are able to conceive at the moment, possibly for largely coordinated behavior among unities. The body itself, as already mentioned, could be viewed along those lines as a hierarchical assembly of units coordinated by entanglement processes. It is thus natural to assume that such processes can be instantiated to bring dysregulated behavior back to normal. The fact that detectors for local causes, such as clinical trials, are only partially efficient in discovering such effects does not mean that the effects are useless but, rather, that the detectors are not optimal. From a methodologic point of view, a broader methodologic outlook is called for to vindicate such processes on a scientific basis.42,43 The fact that nonlocal processes have not been discovered so far to play an important role is a result of our outlook and our detection devices. Because our worldview has largely been based on efficient causality in the Aristotelian sense as the only useful way of bringing about changes, our perception and our perception instruments are geared to detecting causal changes only. The situation seems to be comparable to the negligence of the heartbeat. Because there was no place in the Aristotelian physiologic model for it, no one paid attention and no one took it seriously. As our outlook is completely biased toward local-causal models of intervention, we do not even have the concepts, let alone the observational tools to discover other ways of interaction. I suggest that the time is ripe for a broadening of our outlook. The fact that entanglement processes do not lend themselves to a causal analysis and treatment does not mean that they are of not much use or even superfluous. It simply means that we have to change our way of looking at the world.

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The ideas developed in this paper were inspired by similar ideas developed by Walter von Lucadou. To my knowledge he was the first to point to the fact that Einstein-Podolsky-Rosen-like correlations could also be effective at the macroscopic level, mainly in the area of parapsychology. I subsequently developed the idea that there probably was a connection to other similar phenomena. This idea would have remained at a very figurative level had not Hartmann Römer taken it up and developed it into a formal framework. To him and to many discussions and informal tutorials I owe the deeper understanding necessary to proceed with the idea. What may still be unclear or even wrong in this paper is solely my responsibility. Funding for this work comes from the Samueli Institute, Newport Beach, CA.

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