

# Quantum Nonlocality: Does Nature also Perform the Trick via a Biological Route?

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## Abstract

While we do not yet know *how* Nature is nonlocal, interdisciplinary research in the areas of physics, biophysics and neuroscience going back over 4 decades, reveals that Nature *is* nonlocal. Nonlocality appears to have been observed between human subjects' brains, human neural stem cells and in quantum coherence in muscle contraction in single actin filaments. And, since the neurons are entangled, this introduces the concept of biological quantum nonlocality being 'generated' or 'accessed' each time that they fire, and an action potential is achieved. This could then provide not only for a resolution of the binding problem and the reverse direction problem, since this biological quantum nonlocality containing information, is not only being 'generated' and shared by the neurons continuously and instantaneously but, could lead to biology pointing the way to new physics!

**Key Words:** action potential, binding problem, biological quantum nonlocality, neuron, nonlocal information, reverse direction problem

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## Introduction

In 1935 Einstein-Podolsky-Rosen wrote a paper in which they claimed that if quantum mechanics were a complete model of reality, then nonlocal correlations between particles had to exist (Einstein *et al.*, 1935). This has become well known as the EPR paradox or effect and, is based upon the assumption that correlations exist between particles which have interacted in the past and then separated, which interaction has resulted in the particle states becoming what Schrödinger termed *entangled* (Schrödinger, 1983). To account for correlations between

these particles Bell considered theories, which invoke common properties of the pair (Bell, 1964). With the addition of a reasonable locality assumption, he showed that such classical-looking theories are constrained by certain inequalities that are not always obeyed by quantum mechanical predictions and, proposed certain experiments to test for locality assumptions. Years later Aspect performed an experiment which showed that nonlocal influences do indeed exist after these particles (in this instance photons) interact and separate and, that a polarization measurement on one of them using variable polarizers, resulted in the other photon possessing the same degree of polarization (Aspect *et al.*, 1982). This does not imply any transference of energy or a signal to accomplish this feat, as this would

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be in conflict with special relativity. These space-like separated photons are connected or *entangled* by virtue of having interacted in the past and, even though no energy or signal passed between them, there appeared to be a superluminal transfer of *information* or *influence* (Stapp, 1977).

That the experiments revealing this quantum nonlocality have been performed numerous times over the years using entangled photons and polarization measurements and, that all the experimental evidence points to one conclusion: Nature is nonlocal and, that this has implications both for our world view and for future technologies (Gisin, 2009). After a period of years the locality and detection loopholes have been separately closed, so that now there is no doubt as to the legitimacy of this quantum nonlocality. The nonlocal correlations of quantum physics appear to be of a nonsignalling nature and, that in a nonsignalling world, correlations can be nonlocal only if the measurement results were not predetermined. That if the results were predetermined and accessible with future theories and technologies, then one could exploit nonlocal correlations to signal (Gisin, 2009).

### **Evidence for biological nonlocality**

The Nobel laureate Brian Josephson had earlier raised the issue of whether we may have to differentiate between two types of nonlocality, one related to quantum mechanics and the other to what he termed the *biological utilization of quantum nonlocality* (Josephson, 1991). If we examine this whole process from a *biological* perspective, based on existing research, it is beginning to appear that one might be able to not only determine *how* Nature performs this trick but, *how* we might be able to utilize quantum nonlocality not only for signalling purposes but, to resolve the reverse direction problem (whether mental processes can influence, control or initiate neuronal ones) and the binding problem (or how it is that the brain can fuse together the many disparate features of a complex perception). (Penrose, 1994; Penrose and Hameroff, 1996; Thaheld, 2003; 2005).

Research has been slowly accumulating over a period of 4 decades

regarding the possibility of the existence of biological nonlocality between separated human subjects' brains (Grinberg-Zylberbaum *et al.*, 1994; Standish *et al.*, 2003, 2004; Thaheld, 2003; 2005; 2006; Wackermann *et al.*, 2003), human neural stem cells grown on microelectrode arrays (MEA's) (Pizzi *et al.*, 2004), and quantum coherence in muscle contraction in single actin filaments (Hatori *et al.*, 2001). In all the instances involving human subjects and human neural stem cells, the results appear to be predetermined. I.e., the experimenters are able to get rudimentary correlated results by varying the stroboscopic light (human subjects) or LASER stimulus (neural stem cells) Hz rate. The resulting electroencephalogram (EEG) of both the stimulated and nonstimulated human subjects reveals co-variations or state correlations between two separated brains at the  $\mu\text{V}$  level (Grinberg-Zylberbaum *et al.*, 1994; Standish *et al.*, 2003; 2004; Wackermann *et al.*, 2003). Stimulation of the MEA's with low energy laser pulses, reveals that the separated, nonstimulated MEA displays correlated electrical signals with the stimulated MEA signals in the mV range (Pizzi *et al.*, 2004). One can exploit these nonlocal correlations to signal, since the results can be predetermined by the experimenters.

### **The role of the neuron and its action potential**

Thus, while at the moment, we cannot answer the question as to *how* Nature does this; the evidence reveals that it *is* doing this in a *biological* setting. This means that at some future date, we will be able to explore the *how* question by subjecting the neuron to selected empirical studies, focusing on the action potential mechanism (Thaheld, 2005; 2006). It is beginning to appear that individual neurons can tell us a lot about biological nonlocality each time that they fire, and we get an action potential. First, this action potential reveals the usual electromagnetic component. Second, an extremely minute amount of gravitational radiation is also emitted, just like what one would get when you activate any type of electrical circuit. Except, that it is orders of magnitude lower in energy than that coming from any electrical circuit, which itself in

turn is orders of magnitude lower than the energy levels of gravitational radiation arising from the movement of massive or violent objects in the universe, which have yet to be detected! Third, and here is the most interesting and surprising point of all, since biological quantum nonlocality appears to exist between entangled, separated human subjects' brains and entangled, separated human neural stem cells on MEA's, it is seemingly being 'generated' or 'accessed' (one can take their own choice of terms since nonlocality appears to be so ubiquitous) *naturally* and on a continuous basis every time that a neuron fires on its own and we get an action potential or, as a result of our stimulating the human neural stem cells (Thaheld, 2005; 2006)!

This would mean that *Nature* has found a way, based upon over 2 billion years of experimentation, to naturally and continuously 'generate' or 'access' quantum nonlocality within a *biological* setting, each time that a neuron fires. And, that since we are responsible in this particular instance for initiating and controlling the stimulation and, we will be able to predetermine any results arising from this nonlocality, it can be used for signalling purposes, although of a very rudimentary nature at the present time. Since a neuron can fire approximately once per ms, with the action potential starting out from a resting potential of approximately -40 mV and proceeding to a peak of approximately +60 mV, information can be transferred and received using a digital 1 or 0 series, based upon a Morse code type input (Grinberg-Zylberbaum *et al.*, 1994; Thaheld, 2005; 2006). And, that if it can arise in a *biological* setting, it should not be ruled out as also being capable of arising in certain specific *inanimate* instances, since the firing of all types of electrical circuits, also results in both electromagnetic fields and gravitational radiation being simultaneously generated.

Since the separated human subjects and the separated human neural stem cells are in Faraday cages, where one can rule out any extraneous electromagnetic influences, the only thing that could be causing these correlated results has to be of a nonlocal nature, just as it is in the case of entangled photon polarization measurements. Since

the neurons are all entangled and are all constantly 'transmitting' and 'receiving' biological quantum nonlocality, which contains information of a quantum nonlocal nature, this could provide the answer to the binding problem (Penrose, 1994; Penrose and Hameroff, 1996; Thaheld, 2003; 2005). Furthermore, these correlations may also provide a solution to the reverse direction problem, if the biological quantum nonlocality can be considered as equivalent to what we refer to as mental events (Thaheld, 2003).

### Conclusion

Once we find out *how* a neuron accomplishes this feat of 'generating' biological quantum nonlocality, and *how* information is carried and exchanged by this nonlocality, we will then be well on our way to developing a new quantum nonlocal communication technology (Thaheld, 2006). It appears that future quantum nonlocal technologies involving computation and/or communication can be built initially around a biophysical hybrid, where there is a merging of biological and physical components. Finally, is Nature trying to reveal something to us regarding new effects in the field of physics, by having the neuron and its action potential, exhibiting simultaneous electromagnetic, gravitational radiation and biological quantum nonlocality effects?

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