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Bioinformation Within the Biofield: Beyond Bioelectromagnetics

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ABSTRACT

This review article extends previous scientific definitions of the biofield (endogenous energy fields of the body) to include nonclassical and quantum energy fields. The biofield is defined further in terms of its functional property to act as a resonance target for external forms of energy used as treatment modalities in energy medicine. The functional role of the biofield in the body's innate self-healing mechanisms is hypothesized, based on the concept of bioinformation which, mediated by consciousness, functions globally at the quantum level to supply coherence, phase, spin, and pattern information to regulate and heal all physiologic processes. This model is used to explain a wide variety of anomalies reported in the scientific literature, which can not be explained by traditional biophysics and bioelectromagnetics.

INTRODUCTION

In the advent of the recent funding of biofield research by the National Institutes of Health (NIH), there is a renewed interest in the scientific investigation of endogenous energy fields generated by and contained within the body and the use of complementary and alternative medicine (CAM) biofield therapies to modulate these endogenous fields. Research goals in the new field of energy medicine, as well as conventional bioelectromagnetics, include the characterization of endogenous energy fields in health and disease, the understanding of how they regulate physiologic processes and the discovery of how externally applied (exogenous) energy fields can normalize abnormal fields associated with disease. Two recent review articles (Hintz, 2003; Rubik, 2003) have been published defining the scientific basis for a biofield, albeit only in terms of this classical form of the electromagnetic (EM) force field.

The purpose of this paper is to utilize contemporary theories in quantum physics to expand the definition of the biofield to include nonclassical and quantum forms of energy (Rodrigues and Lu, 1997; Tiller, 1993). This gives a more complete characterization of the energetic properties of the biofield beyond the limitations imposed by the recent guidelines published by a new (self-appointed) group of experts. In many cases nonclassical forms of energy have also been characterized with respect to their biologic effects. Therefore these nonclassical forms of energy meet the criteria described by Hintz et al. (2003) as "following conventional scientific principles in biology and physics," but do not meet their definition of bioenergy as referring only to "common forms of energy." It is proposed here that these nonclassical fields can be generated by the body and therefore become components of the biofield and can be externally applied to the body to modulate endogenous fields. Therefore unlike bioelectromagnetics, the wider perspective of energy medicine should consider the biofield in terms of its nonclassical and quantum forms of energy.

ENDOGENOUS CLASSICAL ELECTROMAGNETIC FIELDS

The concept of a biologic field, which permeates the whole organism and organizes individual cellular processes during embryonic morphogenesis, was first introduced as a "normating" field (Gurwitsch, 1932) and an electrodynamic field (Burr, 1935). Bioelectromagnetics researchers have established that endogenous direct current (DC) electric fields are involved in wound healing (Becker, 1974) and guide or regulate normal developmental processes such as embryogenesis (McCaig et al., 2000). Furthermore, DC electric fields may also be involved with the Oriental meridian sys-

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tem, because acupoints themselves have altered DC electrical resistance and conductance (Reichmanis et al., 1975). A study recently reported measured the dynamic, real-time fluctuations in DC potentials on acupoints and demonstrated complex, nonlinear behavior during healing and meditative states of consciousness (Syldona and Rein, 1999).

Biomedical researchers routinely measure the manifestation of endogenous EM fields using electroencephalograms (EEGs) and electrocardiograms (ECGs). Brain waves arise from electrochemical oscillations with frequencies in the extremely low frequency (ELF) portion of the EM spectrum. ELF oscillations are involved with neuron synchronization (Lestienne, 2001), wound healing (Chiang et al., 1991), circadian rhythmicity (Cajochen et al., 2002) and coordinate the organization of reaction components in biochemical reactions (Pokorny et al., 2001). Such collective and coordinated biologic behavior is associated with self-organization that is further mediated by endogenous electric fields of the body (Pokorny, 1999). Using methodology other than EEG and ECG, researchers have measured EM fields of higher frequencies (kilohertz to gigahertz) radiating from the body. A recent review article has summarized these various methods (Schwartz, 2001). These studies indicate a role for high-frequency endogenous EM fields in healing states and altered states of consciousness (Hunt, 1995; Schwartz and Russek, 1997). The body also contains classical acoustic energy fields (Barry, 1991), because of macroscopic oscillations of large molecules, membranes, and filaments, unlike EM fields that are generated by microscopic oscillations of electrical charges.

DYNAMIC COHERENT FLUCTUATIONS IN ELECTRODERMAL POTENTIALS

Investigators have also studied dynamic changes in the electrical properties of the body's surface as a method of obtaining information about the intrinsic properties of the underlying endogenous EM fields. Frequency spectrum analysis of human EEG using linear, time averaging algorithms indicates a complex mixture of stationary (fixed) frequencies and complex harmonic relationships among these frequencies. However, when nonlinear time series analysis is applied to human EEG recordings, nonstationary frequencies appear that come and go and shift their fundamental values, and the intensity of a given frequency can exhibit an ultra-low rhythmicity between 0.05 and 0.5 Hz (Lambertz and Langhorst, 1998).

Rhythmicity of individual frequencies is an unusual form of periodicity within the EEG. More typical is the periodicity in the intensity of the millivolt electrical readings of EEG recordings, which can be highly coherent (Robinson, 2003). Such coherence is a property of self-organizing systems (Frohlich, 1988). In the case of self-coherence, time-domain oscillations are extremely regular and appear as a sine wave. In other cases, coherence is observed between two separate brain regions. Either type of coherence can occur weakly over a broad range of frequencies or can manifest as a strong coherence at specific frequencies. Of particular interest here is that external frequencies (associated with an EM field) can increase EEG coherence (Strens et al., 2002). Furthermore, EEG coherence is increased during meditative states of consciousness (Travis et al., 2002). Similarly, coherence has been observed in ECG during meditation (Tiller et al., 1996).

In addition to coherence in the EM fields comprising the biofield, coherence has also been observed with optical radiation emitted from biologic systems. Because light energy can act as a particle or a wave, it is capable of behaving in a nonclassical manner. Using ultrasensitive photomultiplier tubes, ultraweak photon emission (visible and ultraviolet [UV]) was measured from a variety of isolated cells (Popp, 1979) and from the surface of the body (Edward et al., 1990). These biophoton emissions exhibit highly coherent properties (Popp and Ruth, 1981; Popp et al., 1994; Van Wijk et al., 1993). Biophotons are associated with cell growth and differentiation (Popp, 1979) and mediate inter-cellular communication (Kaznacheyev and Mikhailova, 1976).

These results indicate that the frequency information that characterizes the biofield is complex, cooperative, and occassionally coherent. Although this frequency information within the biofield has been used to diagnose disease, relatively few studies use this frequency information to treat diseases. However, the initial steps are being taken. Replicating the natural dynamic frequency patterns within an externally applied EM field carrier could be used to treat the body. As a first step, real-time EEG recordings have been replicated and played back to nerve cells in culture, where an alteration in their electrical activity was observed (Noda et al., 1968). More recently, the author extended this idea to ECG recordings that were taken from an individual in an altered state of healing consciousness characterized by a high degree of coherence (McCraty et al., 1995). When the dynamic coherent frequency information was fed back to cultured fibroblasts, there was a significant increase in DNA synthesis (a measure of growth rates) (Rein, 1994). These two studies, utilizing naturally occurring dynamic frequency information, are examples of engery medicine, which is distinct from bioelectromagnetics research, utilizing synthetic EM fields with static frequency information.

Similar experiments were performed at the clinical level by Valerie Hunt, Ph.D., who played back the unique high-frequency components of electromyographic recordings observed during altered states of consciousness. Individuals in ordinary states of consciousness shifted to altered states when receiving these frequencies (Hunt, 1995). The Biocom (Meritest European Center, Avenida Presidente Lluis Companies Numbers 84 and 203A, Girona, Spain) and Interro (not commercially available) devices, used by electronic

medicine practitioners in Europe, reportedly measure naturally occurring biofield information from a patient, electronically invert the signal and play it back to the body to normalize and "balance" the biofield. This new treatment modality, referred to as bioresonance therapy, is currently being investigated scientifically. Feeding healthy signals back to the body has been demonstrated effective in treating immunodeficiency and mastopathy in mice (Lednyiczky, 1993).

LONG-RANGE COHERENT INTERACTIONS

The ordered and coherent behavior in the electrical and optical properties of the biofield are made even more complex when the interactions between different oscillating systems in the body, like the brain, the heart and respiration are considered (Strogatz and Stewart, 1993). Mathematical modeling of the complex interaction between subsystems comprising the whole body (dynamic systems analysis) has been previously used to characterize the biofield (Rubik, 2002; Schwartz and Russek, 1997). Other mathematical approaches have focused on the underyling dipole oscillators whose normal transverse vibrational modes generate classical electric fields at the surface of the body.

Fröhlich reexamined the properties of these oscillators within a highly polar biologic millieu and developed a new set of equations to describe their behavior in proteins within cell membranes (Fröhlich, 1968). Fröhlich observed that some vibrational modes were far from equilibrium and coherent in nature. In addition, the equations describe energy exchange between the oscillator and the environment. These equations also accurately describe the subsequently measured frequencies of these oscillators (10^{11}–10^{12} Hz). The equations further describe the interaction between two different oscillating systems (not necessarily at the same frequency) as nonlinear, long-range, order-creating, and phase coherent. Fröhlich's calculations predict phase information is involved with such long-range communication and that these effects are mediated by A fields. Therefore, coherent interactions between separate electric dipoles can account for the generation of coherent EM fields, as measured in the electro-optical properties of the body.

ENDOGENOUS NONCLASSICAL ENERGY FIELDS

In addition to describing typical transverse oscillations of a dipole, responsible for generating classical EM fields, Fröhlich 's equations also describe longitudinal oscillations (Fröhlich, 1968). These longitudinal oscillations act as an antennae to generate A fields. Thus, the same oscillator in the body can generate both classical force fields and nonclassical potential fields.

Magnetic vector potentials and electrostatic scalar potentials are mathematical terms in Maxwell's equations required for accurate description of the behavior of classical EM fields. These potentials also have fields associated with them. Although the magnetic vector potential and its corresponding potential field, the A field, is traditionally thought of as a theoretical construct, physicists have now demonstrated that static potential fields, in the absence of classical EM fields, produce physical effects by changing the phase of electrons (Chambers, 1960). Because classical EM fields are derived from these potentials, potential fields can be considered more fundamental than classical EM fields. The potential field is considered here to be one type of nonclassical field because classical fields are force fields. Because A fields appear in both Maxwell's and Schrodinger's equations, they act as a bridge between the ordinary EM level and the quantum level. The implications of this regarding the biofield were first pointed out by Tiller (Tiller, 1993).

Experimental evidence for a direct biologic role for A fields has been obtained by Smith using a novel method that involves measuring muscle contractions (Smith, 1995, 2003). Smith's method is similar to the digital O-ring test, which is a new noninvasive method for diagnosing microbial infections (Shimotsuura et al., 1987) that involves measuring the contraction of the finger flexor muscle under resonance conditions. EM resonance occurs between two substances, one inside the body and the other held by the practitioner as a reference. The O-ring method has also been used to measure the size and location of acupuncture meridians (Omura et al., 1988). Smith used a novel extension of this technique, which involves resonance between two energy fields at specific frequencies, inside and outside of the body. Because Smith uses an A field radiating from a toroid as the external field, resonance will occur with A fields within the body. Using this technique (Smith, 1995, 2003) Smith demonstrated that each meridian has a unique frequency. Under healthy conditions, there is a periodic fluctuation in a meridian's frequency, whereas no fluctuations are observed in illness. Externally applied frequencies can alter these endogenous frequencies by shifting their fundamental value or modulating their fluctuations. Smith further observed characteristic physiologic responses when certain endogenous frequencies were fed back to the body (Choy et al., 1987).

In addition to A fields, the body also contains other types of nonclassical energy fields. The linear propagation of free ions (not bound in a dipole) acts as a source of classical EM fields. The nonlinear movement of these free ions can explain the generation of nonclassical energy fields in the body. In some cases, ions propagate in a self-sustaining oscillatory manner through the extracellular matrix. A mathematical characterization of these oscillations and their corresponding ion displacement waves has been described (Nobili, 1987). Their nonlinear propagation is best described

by the Schrodinger wave equations, and therefore, these ion waves have also been called Schrodinger waves. Ion displacement waves can also be considered information fields. Their interaction and superposition results in complex interference patterns that supply phase information. Ion displacement waves are nonclassical and distinct from classical electric fields in the brain. Their quantum behavior has been used to describe organizational and holographic (Nobelli, 1985) functions of the brain. Valuable insights about the fundamental underlying quantum level in biologic systems can be obtained by studying such quantum fields.

ANOMALIES IN BIOLOGICAL SYSTEMS

Intrinsic properties

Coherence at the electrical and optical levels within the body and biofield are examples of anomalous behavior not explainable by conventional biophysical theories (equations). Additional anomalies have also been observed regarding the intrinsic properties of biomolecules or cells. Under appropriate conditions individual enzyme molecules (Hideshima, 1990) and neurons (Zhu et al., 1999) exhibit nonlinear and coherent oscillatory activity. In addition, several biomolecules and cellular systems exhibit collective, coordinated, self-organizing behavior (Prigogine, 1980). For example, intercellular communication between individual cells occurs as a population-wide coordinated response (biophoton emission) after stimulation with a strong light source (Popp, 1979).

Another experimental anomaly involves the ultrafast propagation of electrons along the central channel of the DNA helix (Paine and Pensinger, 1979). The superconductive propagation is not explainable by the slow conventional electron-hopping mechanism. Superconductive properties have also been reported for enzymes, cholesterol, and organic polymers (Ahmed and Smith, 1978; Cope, 1975) at biologic temperatures. Conventional theory predicts that such behavior only occurs at low temperatures.

Responses to classical EM fields

The extreme sensitivity of biologic systems to ultralow–intensity classical EM fields cannot be explained by traditional biophysics. For example, the eye is sensitive to single photons (single quanta of light). Furthermore, cells in tissue culture are sensitive to ultra-weak fields (Blackman et al., 2001) and even single magnetic flux quanta (Del Giudice et al., 1989).

Treating substrates of biochemical reactions with ultralow doses of light causes a significant increase in enzyme activity that lasts for days after the light source is removed (Comorosan, 1974). Furthermore, under some conditions, the treated substrates induce oscillations in enzyme activity. The same effect was also observed after treatment of an essential amino acid with the same low dose of light, although in this case enhanced growth of *Escherichia coli* cells was observed *in vitro* (Comorosan et al., 1988). Conventional biophysical theories predict that excited states arise only after strong doses of light and last for only a few seconds.

Similar anomalies have been observed by treating intact cells with EM fields. For example, Smith measured the electrical properties (voltages) of *E. coli* cells in response to low-intensity magnetic fields. As a function of increasing magnetic field strength, Smith observed an anomalous oscillatory behavior in electrical activity, instead of a linear increase as conventional theory dictates (Smith, 1989). A second anomaly was also observed when an electrical current was applied to the cells at different frequencies. A sharp voltage jump was observed at specific resonance frequencies, which correspond to Josephson frequencies (Smith, 1995). The results indicate that cells act like Josephson superconductors. In addition to the standard current-voltage measurements, Smith measured the dynamic behavior of the voltage peaks on an oscilloscope. During critical times in the growth cycles, a momentary narrowing of the peaks was observed (Smith, 1998). Conventional theories predict that such voltage peaks should be broad. Sharply defined peaks are consistent with the presence of coherent radiation within the cells. These results were later confirmed using a specially designed sensor attached to a spectrum analyzer (Pokorny et al., 2001).

Responses to nonclassical fields

In an attempt to understand and validate CAM biofield therapies such as *Reiki*, *qigong* and Therapeutic Touch, investigators have been measuring classical EM fields emitted by the body in near-field conditions (near the body) using both physical (Jahn and Dunne, 1986; Lounasmaa et al., 1996; Schwartz, 2001; Tiller, 1972) and biologic (Benor, 1990) detectors. Because the intensity of these fields rapidly fades with distance, they cannot explain anomalous healing (Schlitz et al., 2003) and prayer (Dossey, 1998) at a distance. Such anomalous effects are likely to be mediated by nonclassical energy fields.

A variety of nonclassical fields have been described in the physics literature. The properties of these fields cannot be accurately described by Maxwell's equations but are described by other mathematical equations. The existence of nonclassical fields (Barrett, 1993; Rodrigues and Lu, 1997; Tiller, 1993) is predicted by mathematical theory and in many cases they have been generated (launched) in the real world. Although a detailed description of these fields is beyond the scope of this paper, it is important to realize that nonclassical energy fields have properties that are quite distinct from classical EM fields. The propagation of these fields is nonclassical because they can travel at superlumi-

nal (faster than light) velocities (Rodrigues and Lu, 1997) and can transmit energy over long distances without losses (Tesla, 1904). Tesla used the term non-Hertzian to describe the new energy field because it did not behave according to standard EM field theory described by Hertz and Maxwell. Today physicists use the terms non-Maxwellian, non-Abelian, and nondispersive for similar reasons. Other terms used to describe these nonclassical fields include longitudinal waves (classical fields are transverse), scalar waves (classical fields are vectors), divergent fields (classical fields are convergent), standing waves (classical fields propagate) and force-free fields (classical fields have force).

With the exception of A fields, little is known about their interaction with matter (physical or biologic). Nonetheless, traditional biophysical theories do not explain the interaction of nonclassical fields with biologic systems, because they do not appear to be mediated by electric dipoles or electron transitions.

Biologic effects of plasma waves. In the 1930s and 1940s a French and an American scientist independently experimented with a novel method of modulating the properties of classical EM field by passing them through gaseous plasma environments containing charged ions and electrons. Because such environments have large electrical conductivities, nonlinear oscillations of charged plasma particles create anomalous dielectric properties. Of interest here is the fact that plasmas emit plasma waves (i.e., electron cyclotron waves and backward echo waves) that exhibit nonclassical behavior (Stix, 1990). With government funding, Priore and Riviere (1964) developed a sophisticated treatment device utilizing a complex mixture of EM signal passing through a rotating plasma. Using diseased animals, some remissions, including cancer, were observed and shown to be mediated by disease-specific antibodies (Riviere and Priore, 1964). However, double-blinded clinical trials were never conducted and this work was largely ignored because of the inability of the scientific community to explain their results. The plasma technology of Rife was less sophisticated than that of Priore and Riviere (1964) and was based on tuning the device to a specific resonance frequency in the audio frequency range (20 Hz to 20 kHz). Rife's device was clinically tested at the University of Southern California's Scripps Ranch and his preliminary evidence (Rife, 1953) was also ignored by biomedical researchers.

Although several contemporary devices are available that pass EM signals through plasmas, randomized double-blinded clinical trials have not been conducted. However, case reports from various practitioners are now available and in some cases before/after differences have been documented using standard medical diagnostic equipment (Bare, 1997). The most common reported benefit from these devices is a rapid analgesic effect, similar to that produced by transcutaneous electrical nerve stimulation (TENS) devices. In nearly all cases, nutritional supplements are given in parallel with energetic treatments and it is unclear to what extent dietary mechanisms may be involved with these effects.

In some cases remissions of pathologic conditions have been reported. In addition, immune enhancement has been measured with respect to increased white blood cell counts. In several cases, enhanced wound healing has been observed with a notable case of cervical brachial syndrome showing a significantly reduced post surgical recovery time. One commercial device appears to be effective at clearing physical blockages in the lymphatic system as demonstrated using real-time microscopy (Reeves, 1995).

Cellular studies with plasma devices have also been conducted, but they have not been published in peer-reviewed journals. The plasma technology of Rife was developed to kill pathologic microorganisms by finding their resonant frequency. Using a specially designed, high-power microscope to visualize living microorganisms in real time, Rife scanned through the audio frequency range (20 Hz to 20 kHz) and eventually found specific frequencies to devitalize microorganisms after a 30–60-second treatment. Reduced mobility, inhibition of growth and membrane lysis effects were observed *in vitro* and shown to be strain- and frequency-specific (Rife, 1953). Antimicrobial activity *in vitro* has been confirmed by contemporary researchers and used to demonstrate that plasma fields, unlike classical EM fields, are not blocked by a Faraday cage or by a steel barrier (Bare, 1997). Furthermore, this approach has been used to demonstrate that classical fields of the same frequency, generated in the absence of a plasma tube, were ineffective at inhibiting bacterial growth (Bare, 1997).

Biologic effects of potential fields. In the absence of classical force fields, static potential fields have macroscopic effects on the phase of electrons (Chambers, 1960). Of particular interest is the use of time varying vector potentials that has mostly been studied from a theoretical perspective by physicists (Lee et al., 1992). The first practical application of time-varying potential fields was accomplished by Tesla who used two spiral coils in a self-canceling (opposing) configuration to phase cancel classical EM fields (Sector, 1916).

Several commercial devices have appeared that utilize self-canceling Mobius and caduceus coils and some scientific studies have begun to investigate their biologic and clinical effects. At this point in time, there are no double-blinded clinical trials investigating this technology. A preliminary report appeared in 1979 that used a Mobius coil to produce a change in the electrical conductivity of skin (Flannigan, 1979). Using an 8-Hz sine wave, the time-varying potential fields emitted from the coil normalized electrodermal readings of acupuncture points as measured using the electroacupuncture according to Voll (EAV) technique. Shortly afterwards two patents appeared for the use of potential fields to transfer information with some preliminary clinical effects used to support the patent claims (Gelinas, 1984).

In the mid-1980s a commercial device became available that was based on a patent (Puharich, 1984) utilizing a Mobius strip in a crystal oscillator circuit. Anecdotal case reports from electromagnetic sensitive individuals suggested the device might block adverse effects of power lines. Case reports from practitioners indicate pain reduction in migraine and arthritis patients and reduced anxiety and depression.

A series of *in vitro* experiments was conducted by the author using standard biochemical measurement techniques in an attempt to verify these findings. The Mobius oscillator was used with and without the Mobius coil. In the absence of the coil, the control device generates only a classical electric field, whereas the experimental device with the Mobius coil generates a potential field in the presence of the electric field. The classical electric field was measured using a specially designed electrometer and shown to contain a wide spectrum of low frequencies peaking at approixmately 260 Hz. The electric fields were identical in amplitude and frequency in the two devices.

The biologic effects of these devices were studied using nerve cells where an inhibition of neurotransmitter uptake was observed using both experimental and control Mobius devices (Rein, 1993). These effects were similar to those previously obtained with classical EM fields using the same methodology (Rein and Korins, 1987). However, the potential field, in the presence of the electric field, produced a 20% larger effect than the electric field by itself. To determine whether potential fields generated from the Mobius device might also influence other cell types, the experiments were repeated using human lymphocytes from healthy individuals. In the presence of the control device, lymphocyte growth was stimulated by 34% (Rein, 1989). This effect is similar to that obtained from other studies using classical EM fields. Proliferation was increased by an additional 76% when the lymphocytes were grown in the presence of the experimental Mobius device.

Additional experiments were conducted using a specially designed caduceus coil (Dynamic Engineering, Sacramento, CA) that was driven by a complex square waveform generating a broad spectrum of frequencies peaking at approximately 4 kHz. Human lymphocytes treated with the caduceus coil showed a 20-fold stimulation of cell growth in the absence of chemical growth factors (Rein, 1991). Using the same experimental protocol, classical EM fields were previously shown to stimulate lymphocyte growth (Conti and Gigante, 1983), although the magnitude of this response is substantially less.

The biologic effects of potential fields have been confirmed by Ho, who used a toroid coil to contain classical EM fields inside. Using a well-established biologic system, know to respond to classical EM fields, Ho demonstrated that potential fields increase abnormalities in drosophila embryos (Ho, 1994). Additional confirmation has more recently been obtained using a multipolar electrode configuration which cancels classical electric fields in the center of symmetry. In this region, growth of *E. coli* cells was stimulated by nearly 200% (Zavalin et al., 2002).

NOVEL BIOPHYSICAL MECHANISMS TO EXPLAIN ANOMALIES

Most of the anomalies described above involve the response of biologic systems to nonclassical energy fields. Because these effects do not appear to be mediated by electron excitation or electric dipole oscillations such as classical EM fields, alternative mechanisms are being sought. Such mechanisms mediating the biologic response to externally applied or endogenous nonclassical fields are considered below.

Ionic mechanisms

Transverse oscillations of electrical charges in a dipole are capable of absorbing the energy of classical EM fields. Longitudinal oscillations of such dipoles (Fröhlich, 1968), however, may be responsible for the receptivity of biologic systems to nonclassical fields. The linear propagation of free ions (not bound in a dipole) is a known antenna for classical EM fields, whereas their nonlinear movements are likely to mediate biologic responds to nonclassical fields. Ion propagation in excitable media in biologic systems has been mathematically described (Pertsov and Vinson, 1994) to be complex and nonlinear in nature. The self-sustaining oscillatory propagation of ions in biologic systems offers another mechanism whereby nonclassical energy fields might influence the body. Such oscillatory behavior is distinct from the more typical fluctuations in ion concentrations, which are highly sensitive to entrainment by external EM fields (Loschinger et al., 1999). These ion displacement oscillations are of particular interest because they exhibit nonlinear and quantum behavior (Nobili, 1987). They may therefore offer a mechanism for the sensitivity of biologic systems to quantum fields. As previously proposed (Smith, 1998; Tiller, 1993) such effects may be mediated by A fields.

Electronic mechanisms

In addition to the nonlinear movement of ions, nonclassical fields may be generated and detected in biologic systems by moving electrons. Traditional electron conduction and electron hopping within the oxidation-reduction enzyme pathways is well known to mediate locally acting, classical EM fields. Nonconventional semiconduction pathways (Becker, 1974) have also been described and may mediate the biologic effects of nonclassical fields. Electron oscillatory behavior in microtubules (Hameroff et al., 2002) may offer a similar mechanism. Because anesthetic drugs, which modify states of consciousness, also alter microtubules, Hameroff et al. have proposed that such electron oscillations offer biologic systems a new molecular quantum information processing system.

Modulation of endogenous fields

In addition to the physical mechanisms described above, an energetic mechanism has also been proposed. This hy-

pothesis states that the action of exogenous EM fields (classical or nonclassical) on biologic systems is mediated by endogenous energy fields that resonate with and are modulated by the external fields. In support of this hypothesis are experimental data demonstrating that exogenous EM fields can either induce or perturb endogenous fields. Somewhat indirect evidence was obtained by Nucetelli who observed that exogenous DC electric fields produce the same effects as physical stimuli known to activate endogenous fields and wound healing (Nucetelli, 1992). Direct evidence indicates that classical EM fields can alter endogenous fields associated with the heart (Hart and Gandhi, 1998). Exogenous fields can also modulate nonclassical fields, because electric fields can modulate the propagation of endogenous spiral waves (Perstov and Vinson, 1994) in cardiac tissue (Pumir et al., 1994). Future energy treatment modalities can readily be envisioned that utilize a combination of classical and nonclassical energy fields to target and regulate endogenous fields involved with the natural healing processes. Such an approach can be considered a fundamental distinction between bioelectromagnetics and energy medicine. As previously mentioned bioresonance therapy is a first attempt to achieve this goal.

THE BODY QUANTUM

Considering the anomalies described above, several investigators have concluded that the body functions as a macroscopic quantum system (Del Giudice et al., 1989; Nobili, 1985; Popp, 1979; Smith, 1998). This notion, however, was first popularized by Bohm (1952) when describing quantum information associated with quantum potentials. The scientific basis for quantum biology is based in contemporary quantum electrodynamics and quantum chromodynamics (Feynman, 1949). A fundamental property of quantum systems is that they contain quantum domains (Preparata, 1995) that contain nonclassical oscillators that allow them to generate (internally) and respond (externally) to potential fields and other nonclassical fields. Some nonclassical energy fields propagate at superluminal velocities thereby allowing for instantaneous quantum information transfer. Using this model, the bioenergy within the biofield can now be readily defined as the global and holographic distribution of quantum domains and their interacting quantum networks throughout the body. Individual quantum domains store quantum bioinformation that consists of phase, coherence, spin, and pattern information about the entire body. This is in sharp contrast to information supplied by classical EM fields that is primarily frequency information. Quantum domains within the body are mathematically described at the atomic and molecular level, although manifest at the cellular and systemic levels as spatial/dynamic ordered patterning and macroscopic quantum coherence (Garg, 1985). Coherent EEG and ECG patterns are examples of this that have been previously discussed. Furthermore, Smith's data (Smith, 1995, 2003) suggests that the acupuncture meridian system is composed of quantum domains and networks.

Nonclassical energy fields mediate resonant information transfer between two quantum domains, whether they exist within the body or between bodies (individuals). By considering the interactions between two quantum systems contained within a CAM healing arts practitioner and a client, many anomalies within the field of energy medicine can be explained. A fundamental property of interacting quantum systems is that information transfer is independent of time (instantaneous) and distance (nonlocal) (Julsgaard et al., 2001). Therefore, quantum information transfer (Bennett and DiVicenzo, 2000) can readily explain the ability of healers and prayer to influence biological systems at a distance. Because classical EM fields fade rapidly with distance from the source, they cannot explain these anomalous CAM modalities.

In addition to explaining the transfer of healing energy between two people, the current model can also be used to define mechanisms involved with the natural self-healing process within people. The current perspective provides a mechanism for a previously proposed energetic model of self-healing (Rein, 1998). Simply stated the biofield is described in terms of three fundamental energetic levels (infolded within each other according to Bohm [1980]) that can be listed in order of increasing density: quantum fields > potential fields > classical EM fields. Healing information originates in quantum domains at the most fundamental inner spiritual level and cascades outward into the denser EM layer, eventually reaching the physical body. Thus healing information "imprints" all layers of the biofield. Under healing conditions there is a resonance information transfer between the different layers of the biofield, whereas in disease information flow is impeded. Healing bioinformation resonates with and neutralizes disease information. In this model, the interface between the underlying quantum level and the physical body is the potential and the classical EM field. In other models, the interface is the meridian and nadi systems. Thus each meridian/nadi can be seen as an energetic infrastructure composed of similar quantum domains and networks with a coordinated activity reflecting its physiologic function. Smith's experimental data indeed support such a contention.

Still other models utilize consciousness or some aspect of it as the interface between the quantum level and the body. For example, thoughts and intentions could comprise a unique mixture of quantum domains and networks. The information content of each quantum domain would correspond to the content of the thought or intention. The energetic nature of various aspects of consciousness has been considered by other investigators (Jahn and Dunne, 1986). Conscious intentionality is now an area of scientific investigation of relevance here when considering the intention of practitioners. A variety of sensors have been used to mea-

sure macroscopic effects of conscious intentions. These include electronic sensors (Jahn and Dunne, 1986; Tiller, 1972), clinical measures (Benor, 1990; Schlitz et al., 2003; Schwartz, 2001), cellular systems (Chien et al., 1991; Hintz et al., 2003; Rein, 1992), biomolecules (Hameroff et al., 2002; Rein, 1995) and water molecules (Dibble and Tiller, 1999; Schwartz and DeMattei, 1991). In some cases a correlation was observed between the direction of the biologic response and opposite intentions. Intentionality is also being studied by traditional neuroscientists and in the emerging field of consciousness research. From a neurologic perspective, specific intentions are associated with patterns of nerve firing within specific brain regions. Consciousness researchers are now acknowledging a role for the local EM fields, global nonclassical fields and quantum fields associated with such nerve firing (Beck and Eccles, 1992; Hameroff et al., 2002; Lounasmaa et al., 1996; Rein, 1993).

CONCLUSIONS

Theoretical and experimental evidence has been presented for the existence of electric, magnetic, optical, and acoustic classical and nonclassical energy fields emitted from and contained within the body. Some nonclassical fields are most accurately described by the equations of quantum physics. These individual fields comprise a global collective biofield. The anomalous behavior of biologic systems is consistent with the presence of nonclassical fields in the body and in the biofield. The incorporation of quantum physics and nonclassical energy fields into our description of the human biofield can enhance our understanding of many fundamental principles in energy medicine.

Within this framework a quantum biologic model is proposed as a possible mechanism for the natural self-healing processes in the body. Furthermore, this model gives insight into the contribution of energy medicine to facilitate this natural healing process by supplying bioinformation at the quantum and potential levels to neutralize disease information within the body and the biofield contained within. Although bioelectromagnetics can achieve this goal by supplying frequency information at the EM level, energy medicine can supply more subtle bioinformation stored at deeper psychologic, emotional, and spiritual levels within the biofield. Such insights should be helpful in designing the next generation of energetic treatment modalities with relevant bioinformation.

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