

# The Science of Interconnectivity



Exploring the Human-Earth Connection

Rollin McCraty, Ph.D.  
and Annette Deyhle, Ph.D.

HeartMath Research Center – Global Coherence Initiative

# The Science of Interconnectivity

Exploring the Human-Earth Connection

Authored by Rollin McCraty, Ph.D.

Director of Research, HeartMath Research Center

and Annette Deyhle, Ph.D.

Phone: (831) 338-8500

Email: [info@heartmath.org](mailto:info@heartmath.org)

Visit our website at <https://www.heartmath.org>

HeartMath Institute

14700 West Park Ave., P.O. Box 1463, Boulder Creek, CA 95006

Copyright © 2016 by HeartMath Institute

Global Coherence Initiative is a special project of HeartMath Institute

# The Science of Interconnectivity

## Exploring the Human-Earth Connection

Rollin McCraty, Ph.D. and Annette Deyhle, Ph.D.

### **Abstract**

We launched The Global Coherence Initiative (GCI) as a science-based, international effort that seeks to help activate the heart of humanity and promote peace, harmony and a shift in global consciousness. All across the planet, increasing numbers of people, groups and communities are undertaking activities that support positive change and finding creative solutions for manifesting a more peaceful and coherent world.

We are working in concert with other initiatives to help realize the increased power of collective intention and increase consciousness using a scientific approach that conducts groundbreaking research on the interconnections between humanity and Earth's magnetic field environment. An important aspect of that research is the Global Coherence Monitoring System, a global network of magnetometers. Unlike other magnetic monitoring networks, this is designed specifically to measure resonant frequencies in Earth's magnetic fields, such as Schumann resonances, field-line resonances and Alfvén waves.

In this document, we discuss research that demonstrates how global collective behaviors and numerous physiological rhythms in humans are synchronized with solar and geomagnetic activity. Additionally, we examine the fact that the majority of research conducted thus far has focused on how disruptions in the earth's magnetic fields are associated with adverse effects on health and behaviors.

Although understanding how these disruptions affect people's health and well-being is clearly important, we believe there is an even more fundamental and important aspect of the earth's magnetic fields that, once understood, can be utilized to help transform human consciousness. We are suggesting that the earth's magnetic fields provide a plausible mechanism that interconnects and nonlocally distributes information to all living beings on our planet. In this context, we will review several independent lines of research that support the hypothesis that the earth's magnetic fields can be a carrier of and encoded by physiologically patterned and relevant information from a large number of people who are in a heart-coherent state. We further suggest that people can work together in a co-creative relationship to consciously increase coherence in the global field environment, which in turn distributes this information to all living systems within the field.

## INTRODUCTION

Worldwide, an increasing number of people are experiencing mounting concerns about climate change, natural disasters, extreme weather, terrorism, energy and water shortages, food and product safety, and economic instability. These concerns are creating a growing sense of urgency that we must change old structures that do not serve humanity and the environment. People sense that we are on the threshold of a new stage of social, spiritual and cultural evolution.<sup>1</sup>

We believe we are at a point in the evolutionary history of consciousness in which we have an opportunity to evolve to more interconnected, inclusive and cooperative social, economic and cultural systems around the planet. This is precisely why the Global Coherence Initiative (GCI) was formed. GCI is a science-based, co-creative initiative that was established to help facilitate the shift in global consciousness from instability and discord to balance, cooperation and enduring peace by uniting people globally in heart-focused care and intention. The initiative was launched in 2008 by the HeartMath Institute, a nonprofit research and education organization. Currently, over 200,000 people in 154 countries are involved in the initiative.

By pursuing the science of interconnectivity, GCI researches the dynamic relationship between human consciousness and Earth's energetic systems. In addition to conducting research, GCI employs several strategies to help increase personal, social and global coherence. We have an internet-based network that connects people globally who want to participate in helping to shift global consciousness. GCI members receive regular updates that inform them where to direct their energetic contributions of heart-focused care

and intention, often to places of unrest or natural disasters.

GCI is helping to educate the global community by providing tools and technologies for increasing individual, social and global coherence. In this e-book, we will discuss the four primary hypotheses that shape the framework and focus for our research on interconnectivity as well as existing theoretical and experimental support for each hypothesis.

### The Rise of the Field View of Reality

Classical physics conceived of reality as elementary building blocks made up of solid objects, separated by empty space. This view continues to be most people's view of reality, including scientists. With the discovery of radioactivity and electromagnetic fields and the development of modern quantum physics, whose validity in the understanding of elementary particles, atoms and molecules was fully established in the last century, a new view of reality has emerged.

In this new reality, especially in light of the experimental confirmation of "entanglement," physical objects cannot be understood, or observed in isolation, but rather must be viewed as part of a holistic web of interconnectedness in which fields and relationships are pivotal.<sup>2</sup>

From this new perspective, the worldview shifts away from seeing the world only from the outside and interacting mechanistically to a participative, field-connected worldview in which there are no clear boundaries between nonmaterial fields and the physical world.

Early 20<sup>th</sup> century biologists like Paul Weiss and Alexander Gurwitsch proposed that "biological fields" play a crucial role in the development of organisms and that human beings have, in addi-

tion to a solid physical body, a field component reaching out beyond the body's boundaries. This is a view that most pre-scientific cultures embraced.<sup>3</sup> More recently, biophysics has shown that all living organisms are indeed permeated and surrounded by a weak electromagnetic field, composed of optical photons and radio, microwave and extremely low frequencies.<sup>3,4</sup>

Based on experimental evidence indicating the existence of bioelectromagnetic fields, or "biofields," new biophysical models have been developed that view human existence as multidimensional. The models include one of several levels of non-material "field organisms" that include the field-related aspects of our thoughts, emotions and intuitions.<sup>2,5,6</sup>

## Magnetic Fields

Magnetic fields are created either by materials that are magnetic or by the movement of charged particles. Life on Earth ultimately owes its existence to the sun, which has a very large and very complex magnetic field that affects us in many unseen ways. Like a bar magnet, the sun's magnetic field has two poles that flip and reverse their polarity at the peak of the solar activity cycle, approximately every 11 years. The complexity of the sun's magnetic field waxes and wanes over the course of each solar cycle.

Locations on the sun where the magnetic field is especially strong are called active regions, and these often produce sunspots. The local magnetic field in the neighborhood of a large sunspot can be much greater than the sun's average magnetic field.<sup>7</sup> Disruptions in the sun's magnetic fields near these active regions can produce energetic explosions, known as solar flares, and coronal mass ejections.

The sun's magnetic field, called the interplanetary magnetic field (IMF), extends far out into space, beyond the farthest planet. The region of space the IMF extends into is called the heliosphere, and it acts as a magnetic shield for our entire solar system against cosmic rays, which are charged particles from deep space.

The solar wind, which is the stream of charged particles that flows outward from the sun, travels at an average speed of around 1 million miles per hour. Solar wind interacts with planetary magnetic fields in complex ways. Later we will discuss how this interaction leads to "field-line resonances" in the earth's magnetic fields. For now, it should be noted that during solar storms the solar wind speed can increase dramatically and cause disruptions in the earth's magnetic field.<sup>8</sup>

Earth's magnetic field, also known as the geomagnetic field, is the field that extends from the earth's interior to where it meets the solar wind. This region is called the magnetosphere. Earth's magnetic field has been essential for the evolution of life. As we will discuss in a later section, some consider its magnetic field to be a biofield that connects and organizes all living systems on Earth. At the most basic level, the earth's magnetic field provides a protective "shield" against cosmic rays and prevents our atmosphere from being blown away by the solar wind.

The precision in measuring Earth's magnetic field strength, which has been continuously measured since the mid-1830's, was greatly improved by Carl Gauss. Its strength is measured in units called gauss or larger units called tesla (1 tesla = 10,000 gauss). At the earth's surface, the strength of the field currently ranges from 25 to 65 microteslas (0.25 to 0.65 gauss).<sup>9</sup> The earth's magnetic field has decreased in strength by about 10% over the last 150 years.<sup>10</sup>

Governments typically operate geomagnetic observatories such as the International Real-time Magnetic Observatory Network, which has more than 100 interlinked geomagnetic observatories around the world. This network, which has been recording the earth's magnetic field since 1991, obtains a measure of the strength of the earth's magnetic field once per minute.

Frequently, Earth's magnetosphere is hit by solar flares causing geomagnetic storms, provoking more intense displays of aurorae. The short-term instability of the magnetic field, because of solar storms, is measured with the K-index.<sup>9</sup> The ability to accurately measure Earth's magnetic field activity is important because magnetic storms can affect communications equipment, electric power grids and other human activities.

Because every cell in every biological system on Earth is bathed in an external and internal environment of fluctuating invisible magnetic fields of a wide range of frequencies, these fields can affect virtually every cell and circuit in biological systems.<sup>1,2</sup>

The branch of science that studies how solar and geomagnetic activity affect living organisms, especially humans, is called heliobiology. The majority of research in this field to date has focused on how magnetic field disturbances affect physiological health and, to a lesser degree, mental health and behavior.<sup>11</sup>

Data from solar and geomagnetic field detectors and human nervous system activity as reflected in brain waves and heart rate variability (HRV) show that human physiological rhythms and collective behaviors are synchronized with solar and geomagnetic activity. Disruptions in these fields can create adverse effects while other solar and magnetic indices are correlated with improved HRV

and mental and emotional states. This likely is the result of a coupling between the human brain, cardiovascular and nervous systems and resonating geomagnetic frequencies called Schumann resonances that occur in the earth-ionosphere resonant cavity, Alfvén waves and other ultralow frequencies called field-line resonances.<sup>1</sup> These will be discussed in more detail in a later section.

There is growing evidence suggesting that magnetic fields, in addition to serving as a protective shield, also help to synchronize, energize and non-locally interconnect living systems. The evidence suggests these fields act as carriers of biologically relevant and patterned information, which is embedded in the same field and is distributed to all other living system.<sup>12-14</sup> This implies that our attitudes, emotions and intentions are not limited to the space inside our bodies, but that they also can affect the mental and emotional states (consciousness) of others. This broadens our view of what interconnectedness means and how coherent, cooperative intent can be intentionally utilized to shape the future of the world in which we live.

GCI is hearing from an increasing number of people from all walks of life and cultures that they are developing new sensitivities that are enabling them to perceive the subtle energy fields around their bodies, especially the perception of an "energy" (like a subtle wind) flowing in and out of their heart area and hands and interacting and flowing between people, trees and plants. If we can successfully cultivate people's competence in perceiving their own biofields and the "frequency pitch" of the fields they are radiating, as well as the biofields of other people and establish this as a value accepted by society, it would be an enormous advancement in collective consciousness. It could certainly have a positive effect on the quality of human relationships and society once

people truly know that we are not fully isolated from each other, but rather interconnected and entangled with one another. We not only would have to accept responsibility for how our thoughts and emotions affect us, but also for what we are “feeding the field” and how that affects others.

## CENTRAL GCI HYPOTHESES

The following GCI hypotheses guide our ongoing collaborative research:

1. Human and animal health, cognitive functions, emotions and behavior are affected by solar activity and planetary geomagnetic fields.
2. The earth’s magnetic fields are carriers of biologically relevant information that connect all living systems.
3. Each individual affects the global information field.
4. A large number of people creating heart-centered states of care, love and compassion will generate a more coherent field environment – and information – that can benefit others and help offset the current planetary wide discord and incoherence. This more coherent information can be encoded within the earth’s geomagnetic fields, which act as carrier waves of this physiologically patterned and relevant information.

Embedded within the above hypotheses is a related hypothesis: *Human emotions and consciousness interact with and encode information in the geomagnetic field.* Within this field, information can be communicated nonlocally between people at a subconscious level, which, in effect, links all living systems and influences collective consciousness.<sup>1</sup>

Thus, we suggest a feedback loop exists between all human beings and Earth’s energetic systems. It is further proposed that when coherently aligned

individuals intentionally create physiologically coherent magnetic fields, they’re able to more effectively resonate with and encode information in the planetary magnetic fields. This information can positively affect all living systems within the field environment and help increase collective consciousness.

## GLOBAL COHERENCE MONITORING SYSTEM

A global network of 12 ultrasensitive magnetic field detectors is being installed strategically around the planet (Figure 1). These sensors will advance our investigation of the interactions between solar activity and the earth’s geomagnetic field environment and human interconnectivity, health and behaviors. As of March 2016, seven Global Coherence Monitoring System (GCMS) sites had been funded and six had been installed. These are located in the American state of California, Canada, New Zealand, Saudi Arabia, Lithuania, and South Africa.

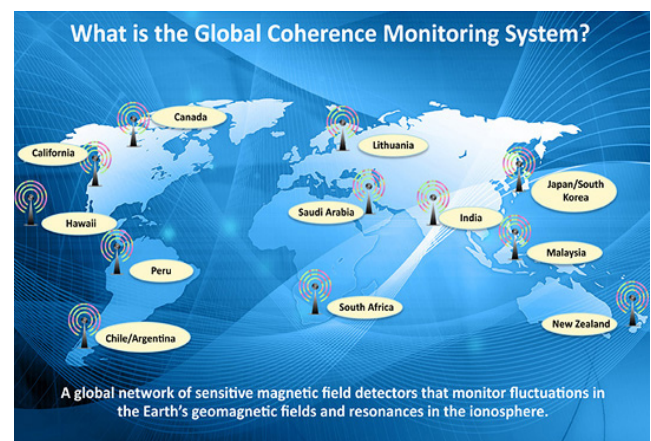


Figure. 1: A map showing the six operating and six proposed locations for the global network of monitoring sites. The magnetometers at each site are specifically designed to measure the magnetic resonances in the earth-ionosphere cavity, resonances that are generated by the vibrations of the earth’s geomagnetic field lines, and ultralow frequencies that occur in the earth’s magnetic field.

The GCMS system is a global network of GPS time-stamped detectors designed to continuously measure magnetic signals that occur in the same range as human physiological frequencies such as those of the human brain and cardiovascular systems. Each site includes ultrasensitive magnetic field detectors specifically designed to measure the magnetic resonances in the earth-ionosphere cavity, as well as resonances that are generated by the vibrations of the earth's geomagnetic field lines and ultralow frequencies that occur in the earth's magnetic field.

Each monitoring site detects the local time-varying magnetic-field strengths (sensitivity  $10^{-12}$  T) over a relatively wide frequency range (0.01-300 hertz) while maintaining a flat frequency response.



Figure 2: The monitoring site at the HeartMath Research Center in Boulder Creek, Calif., USA.

The data acquisition infrastructure captures, stamps with time and global positioning data, and transmits the data to a common server. Each magnetometer is sampled at a rate of 130 hertz (130 times each second) which allows resolution of frequencies up to 65 Hz. In addition, each site has a random number generator

(RNG) that is part of the Global Consciousness Project (GCP) network, which is described later. The monitoring system tracks changes in geomagnetic activity caused by solar storms, changes in solar wind speed, disruption of Schumann resonances (SR) and, potentially, the signatures of major global events that have a strong emotional response component. A growing body of data suggests that changes in ionospheric activity can occur before large earthquakes; GCMS can detect these changes.<sup>15</sup>

There are several networks of ground-based flux-gate and other types of magnetometers around the world that measure the strength of the earth's magnetic field and geomagnetic disturbances as well as several space weather satellites. The data from those, however, is typically only sampled at hourly or one-minute intervals and cannot measure the resonant frequencies occurring in the earth's magnetic fields. The GCMS adds the capacity to measure the resonant frequencies globally, a component that has been missing and is required if we are to better understand how people and animals are affected by the rhythms and resonant frequencies in earth's magnetic fields. This enables us and other researchers to better understand the interconnections between solar and other external forces on the planetary magnetic field environment.

The network is providing a significant research tool to explore not only the effects of solar and geomagnetic disturbances on human health and consciousness, but also the interconnectivity of human beings with each other and with the earth's magnetic field environment. We make our data freely available to other research groups who wish to explore how it may be utilized to study interconnectedness, solar and geomagnetic interactions and other events and to predict earthquakes.

## EARTH'S ENERGETIC SYSTEMS AND HUMAN HEALTH AND BEHAVIOR

In this section we will discuss data that support the first hypothesis: *Human and animal health, cognitive functions, emotions and behavior are affected by solar activity and planetary geomagnetic fields.*

Historically, many cultures believed their collective behavior could be influenced by the sun and other external cycles and influences. This belief has proven to be true. On a larger societal scale, increased violence, crime rates, social unrest, revolutions and frequency of terrorist attacks have been linked to the solar cycle and the resulting disturbances in the geomagnetic field.<sup>16-22</sup>

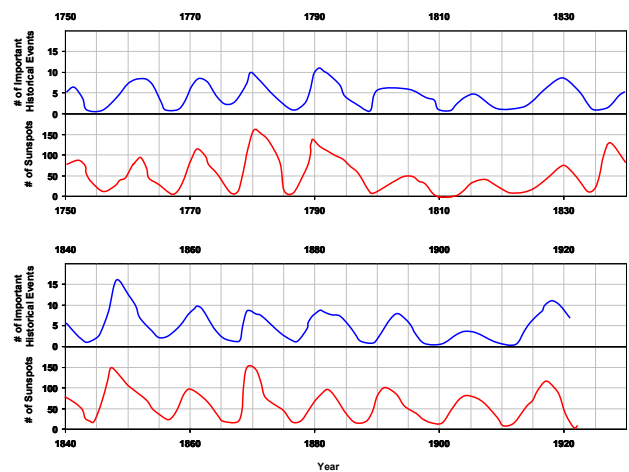
The first scientific evidence of this belief was provided by Russian scientist Alexander Tchijevsky, who noticed that more severe battles in World War I occurred during peak sunspot periods.<sup>21</sup> He then conducted a thorough study of global human history dating back to 1749, which he compared to the solar cycles over the same time period until 1926.

Figure 3, reconstructed from Tchijevsky's original data, plots the number of significant human events occurring each year compared to the solar cycle from 1749 to 1926.<sup>21</sup>

Importantly, solar activity not only has been associated with social unrest, but also with the periods of greatest human flourishing, including clear spurts of innovation and creativity in architecture, arts and science as well as periods of positive social change.<sup>23</sup>

During periods of increased solar activity, which peaks every 10.5 to 11 years, the sun emits increased ultraviolet (UV) energy and solar radio flux, which is measured by the 2.8 GHz signal (F10.7) radiated by the sun.<sup>24,25</sup> Although the de-

tails of the physiological mechanisms in humans and animals are not fully understood yet, it is apparent that increases in these solar and magnetic energy influxes are utilized as a source of energy. This is important because when we do not have the maturity and ability to self-regulate ourselves in day-to-day life to use the energy influxes wisely they lead to increased violence, war, accidents and social unrest.



**Figure 3:** Tchijevsky's original data. The blue line (top) plots the yearly number of important political and social events such as the start of a war, social revolutions, etc. The red line (bottom) plots solar activity, as indicated by the number of sunspots from 1749 to 1926. The histories of 72 countries were compiled, and it was found that 80% of the most significant events occurred during the solar maximum, which correlates with the highest periods of geomagnetic activity.

We can learn from past responses, however, and consciously choose new ways of navigating these energy influxes, including during peak solar activity periods, to create periods of human flourishing and humanitarian advances. This suggests that when outdated structures not serving humanity collapse an opportunity arises for them to be replaced with more suitable and sustainable models. At times of such pertinent energy influx, we have the greatest opportunity to instate positive change in our world by more consciously becoming

ing self-responsible in navigating energy influxes and using this additional energy to create periods of human flourishing. Positive change can affect political, economic, medical and educational systems as well as relationships of people at home, work and in their communities.

## Geomagnetic Disturbances

Not only are human physiological rhythms and global human behavior synchronized with solar and geomagnetic activity, but disruptions in these fields can create adverse effects on human health and behavior.<sup>18,22,26-32</sup>

The human body is designed to adapt to daily and seasonal climatic and geomagnetic variations, but environmental factors like geomagnetic storms can alter the hormone balance of the body, such as the melatonin/serotonin balance.<sup>33-35</sup> These factors affect many physiological functions, including blood pressure, breathing, immune system, reproductive, cardiac and neurological processes.<sup>36-39</sup> Geomagnetic disturbances are associated with significant increases in hospital admissions for depression, mental disorders, psychiatric issues, suicide attempts, homicides and traffic accidents.<sup>27,31,40-44(33)</sup> Birthrates tend to drop, mortality rates increase and migraine attacks can be triggered during periods of increased solar and geomagnetic activity.<sup>45</sup>

Disturbances in geomagnetic activity can exacerbate existing diseases and are correlated with significant increases in the incidence of myocardial infarction and death, cardiovascular disease and death in epileptics.<sup>46-51</sup> In addition, significant changes in blood pressure, blood flow, aggregation and coagulation, cardiac arrhythmia and heart rate variability (HRV) have been found.<sup>22,26,38,49,52,53</sup>

It is noteworthy that a large number of studies have

found significant associations between magnetic storms and decreased HRV, the measurement of beat-to-beat changes in heart rate,<sup>54</sup> indicating a possible mechanism linking geomagnetic activity with increased incidents of coronary disease and myocardial infarction.<sup>36,46,55-61</sup>

Several studies that analyzed weeklong recordings found a ~25% reduction in the very-low-frequency (VLF) rhythm during magnetically disturbed days compared to quiet days. The low-frequency (LF) rhythms also were significantly reduced, but the high frequency (HF) rhythms were not.<sup>58,62</sup> Lower activity or power in the VLF rhythm is strongly associated with increased health risk while the vagally mediated HF rhythm is not as predictive, although lower activity in HF rhythm is associated with decreased capacity to self-regulate thoughts, emotions and behaviors.<sup>54</sup>

In order to further investigate the potential correlations between solar and magnetic factors and HRV, we undertook a collaborative study spanning a five-month period with Dr. Abdullah Al Alabdulgader, director of research for Eastern Province, Saudi Arabia.<sup>1,63</sup> A total of 960 24-hour HRV recordings were obtained from a group of 16 women. HRV data was collected 24 hours per day, three consecutive days each week over a five-month period using ambulatory HRV recorders between March and August of 2012. The HRV measures assessed were the interbeat-interval (IBI), SDNN, RMSSD, total power, VLF, LF and HF power, and the LF/HF ratio. The solar activity and magnetic variables were solar wind speed, Kp and Ap index, PC(N), sunspot number, solar radio flux (F10.7), cosmic rays, Schumann resonance power and the ULF power (2mHz to 3.5 hertz) of the time-varying magnetic-field data collected at the GCI sensor sites in Boulder Creek, Calif., (GCI 1) and Saudi Arabia (GCI 2). The mean and standard deviations

of the geomagnetic activity were computed hourly. Figure 4 shows an example of the mean and SD of the magnetic-field variation. Note the large increase in the SD that occurred on July 14<sup>th</sup>, which resulted from a coronal mass ejection that hit the earth's magnetic field at approximately 1800 UT that day.

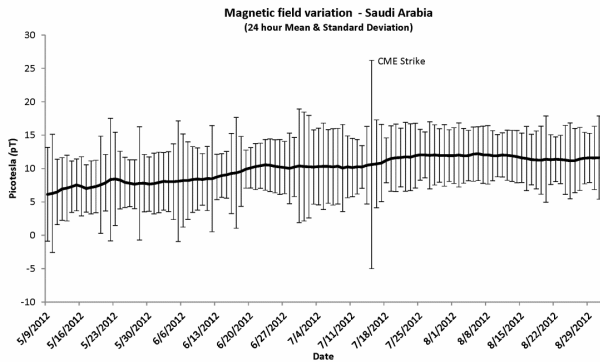


Figure 4. Shows an example of the mean and standard deviation of the magnetic field data recorded from the Saudi Arabia monitoring site.

Circadian effects were removed from both environmental and HRV variables. For each of the 16 study participants, a correlation matrix was calculated between each environmental and HRV variable. Overall, the study strongly confirms that daily autonomic nervous system activity, as reflected by HRV measures, is affected generally by changes in solar and geomagnetic activity, rather than only periods of magnetic disturbances. All of the HRV measures, except IBIs, were negatively correlated with solar wind speed, and the LF and HF power were negatively correlated with the magnetic field mean data from the Saudi Arabia sensor site, but not the California sensor site, suggesting that local measurements are important.

There were a number of positive correlations. The F10.7 (solar radio flux) was correlated with increased HRV in all measures, except the SD of the HRV and IBIs. The SD of the magnetic-field

variation from both the Saudi Arabia and California sites was positive when correlated with RMSSD and HF power, both of which reflect parasympathetic activity. Also, Schumann resonance power was positively correlated with the IBIs (heart rate). In other words, when there were higher levels of solar radio flux energy and higher power in the earth's time-varying magnetic fields (the rhythms that are the same as human rhythms) participants had higher levels of HRV, which indicated they had more energy available. Although there were a number of global correlations, at the individual level, the HRV responses varied and, in some cases, different individuals showed different responses to the same environmental variable.<sup>63</sup>

In a review of the research literature on health effects of geomagnetic disturbances, Palmer, Rycroft and Cermack observed these “definite conclusions”: 1) Geomagnetic disturbances have a greater effect on humans at higher geomagnetic latitudes. 2) Unusually high values of geomagnetic activity have an effect on human cardiovascular health. 3) Unusually low values of geomagnetic activity seem to have an effect on human health. 4) Only 10% to 15% of people in areas studied are significantly affected by geomagnetic activity. 5) HRV is negatively correlated with geomagnetic activity.<sup>11</sup>

## Interconnectedness Study

In our 2010 Interconnectedness Study, 1,643 GCI members from 51 countries completed a survey twice weekly that was given at random times and was organized so data was collected from subgroupings of participants six days each week over a six-month period. The survey contained six scales: positive affect, well-being, anxiety, confusion, fatigue and physical symptoms.

Survey data were subjected to correlation analysis

with a number of planetary and solar activity variables such as solar wind speed and magnetic field and plasma data, measures of energetic protons, solar flux and geomagnetic activity indices.

When solar wind speed, Kp, and Ap, magnetic indices were designed to describe disturbances in the geomagnetic field – and polar-cap magnetic activity increased, positive affect among the participants decreased. Well-being scores were negatively correlated with solar wind speed, Kp-index, Ap-index and polar cap magnetic activity. When solar wind speed increased and the geomagnetic field was disturbed, the levels of fatigue, anxiety and mental confusion increased.

The study produced some unexpected findings. Among them, the solar radio flux index was positively correlated with reduced fatigue and improved positive affect, indicating there are mechanisms that improve human well-being that are not yet fully understood.

When looking at the data from the Interconnectedness Study and HRV data from the study in Saudi Arabia mentioned earlier, it is clear that when the earth's magnetic field was calmer, study participants felt better, were more mentally and emotionally stable and had higher levels of HRV. The same observation was made for increased activity in the resonant frequencies and the solar radio flux. Conversely, when the magnetic field was disturbed (because of solar flares), or had lower power in the resonant frequencies, the participants' HRV was lower and their emotional well-being and mental clarity were adversely affected.

## Interactions Between the Human Brain and Schumann Resonances

The most common tool employed to study brain waves (consciousness) is the electroencepha-

logram (EEG). Measurements are obtained from electrodes located over the surface of the scalp to measure the variations in the electrical currents generated by the 20 billion to 25 billion neurons in the human brain. Voltages measured with the EEG are within the microvolt range while the corresponding magnetic fields produced by the brain are measured in the 1- to 2-picotesla range.

In the mid-1950s, Winfried Otto Schumann and Herbert Koenig first measured frequencies that were consistent with a mathematical model that predicted an Earth-ionospheric resonance.<sup>64</sup> The lowest frequency Schumann resonances (SR), as they are now called, is approximately 7.83 hertz, with a daily (day/night) variation of about  $\pm 0.5$  hertz. The other frequencies are  $\sim 14, 20, 26, 33, 39$  and  $45$  hertz. Figure 5 shows the frequencies of the SR, which are closely overlapping with alpha (8-12 hertz), beta (12-30 hertz) and gamma (30-100 hertz) brain waves. The similarity of the electrical components of the time-varying voltages produced by the brain (EEG) with the SRs was recognized early on, and the ability for the EEG rhythm to become synchronous with SR activity was observed by Koenig.<sup>65</sup> Because the brain is a very sensitive electromagnetic organ, changes in geomagnetic activity and SR intensities appear to alter brainwave and neurohormone responses.

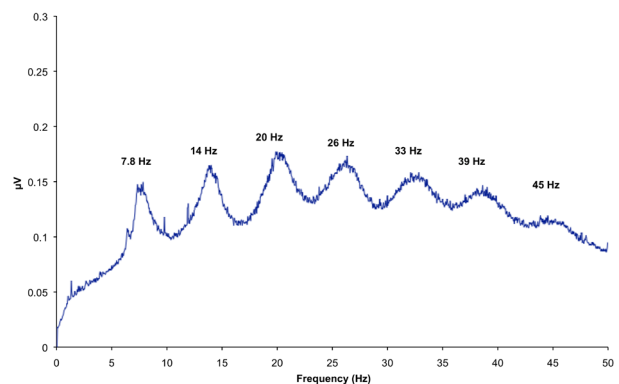


Figure 5: Schuman resonance data recorded from the GCI sensor site in Boulder Creek, California.

A study by Pobachenko et al.<sup>66</sup> monitored the Schumann resonances and the EEGs in a frequency range between 6-16 hertz simultaneously over a six-week period. During a daily cycle, individuals studied showed variations in the EEG similar to changes in the SR and the highest the correlations between the brain rhythms and the SRs were during the periods of higher solar and magnetic activity.

Michael Persinger, a cognitive neuroscience researcher and professor at Laurentian University in Sudbury, Ontario and his colleagues extensively studied EEG activity and the Schumann resonances in real time. Their data suggests that a transfer of information can take place between the magnetic fields of Earth and human brains. They have shown that many of the SR frequencies can be seen clearly in the spectral profiles of most human brain activity,<sup>14,67</sup> which demonstrates that amplitudes of the electric and magnetic fields in human EEG activity are similar to those of the SR (1 to 2 picotesla).

Saroka and Persinger have shown that the spectral power within the quantitative electroencephalographic profiles of men and women displayed repeated transient periods of coherence (synchronization) with the first three resonant frequencies of the SR (7 to 8 hertz, 13 to 14 hertz, and 19 to 20 hertz) in real time.

Their data indicates that the maximum coherence with the SR takes place within the right hemisphere, near the temporal-parietal region, during periods of approximately 300 milliseconds that occur about every 30 seconds. This suggests that under certain conditions, interactive information processing can occur between human brains and the earth's magnetic fields and that variables affecting the Schumann parameters, such as solar wind, could affect brain activity, including modi-

fications of cognition and dream-related memory consolidation.<sup>14</sup>

Altered EEG rhythms in response to changing magnetic fields have been observed by Belov et al., with low-frequency magnetic oscillations (around 3 hertz) having a sedative effect.<sup>68</sup>

## Interactions Between the Cardiovascular System and Field-line Resonances

There are a wide variety of magnetic waves occurring in Earth's magnetosphere that are excited by different processes inside the magnetosphere and by the solar wind. The occurrence of these magnetic waves depends on conditions in the solar wind and in the magnetosphere. Field-line resonances are the most common source of ultralow-frequency wave energy measured on the ground and exhibit the largest wave amplitudes compared to other waves occurring in the magnetosphere (Figures 6 and 7).<sup>69</sup>

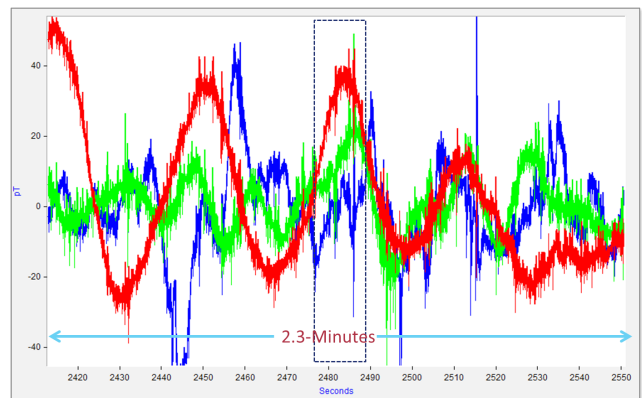


Figure 6: Shows the ultralow frequency field-line resonance magnetic waves recorded from the north-south channels at the GCMS sites in California (Blue), New Zealand (Green) and Canada (Red) on Feb 28<sup>th</sup>, 2015 at 1:00 UTC. The Y axis is picoteslas and X axis is time in seconds. The higher frequency Schumann Resonances can be seen riding on the low frequency waves. The box with dotted lines shows the time segment for the Schumann Resonance waves shown in Figure 7.

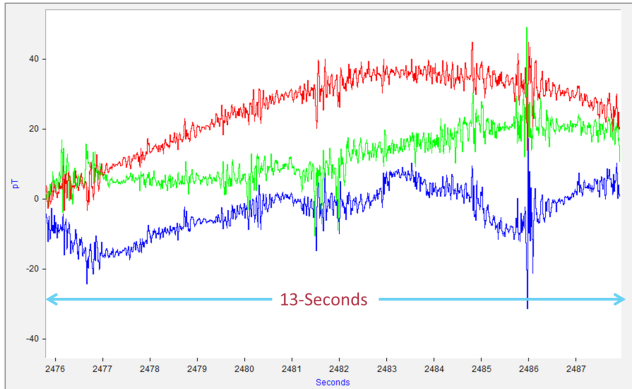


Figure 7: Shows the Schumann Resonances magnetic waves recorded from the north/south channels at the GCMS sites in California (Blue), New Zealand (Green) and Canada (Red) during period shown by the box with dotted lines in Figure 6. The Y axis is picoteslas and X axis is time in seconds.

The frequency of these oscillations depends on the length of the magnetic field line, field strength and the plasma density (number of charged ions) spinning around the field line. Waves in the frequency range below 1 hertz are classified with respect to their waveform and frequency, where quasisinusoidal oscillations are called “Pc” (pulsation continue) and oscillations with irregular waveforms are called “Pi” (pulsation impulsive). Each major type is subdivided into frequency bands roughly corresponding to distinct phenomena. Standing field-line oscillations are associated with Pc3 to Pc5 waves corresponding to a frequency range between 1 mHz and 100 mHz. Oscillations classified as Pc12 are traveling waves, with frequencies up to 5 hertz, which are typically excited by geomagnetic substorms.<sup>70</sup>

Plasma is the name given to highly ionized gases threaded by a magnetic field, and the ionosphere is a layer of plasma surrounding the earth. The charged particles in a plasma can gyrate and spiral around the magnetic field line and travel along it. This is the process involved in creating the auroras, as high-energy particles from the solar wind and ionosphere flow along the field lines to the

earth’s magnetic poles. Any force that moves the particles also moves the magnetic field and vice versa. This concept was first described by Hannes Alfvén to explain a process that creates low-frequency waves that propagate along a magnetic field line.<sup>71</sup> He received the Nobel Prize in 1970 for this discovery, and the wave he described is now called the Alfvén wave.

A standing wave in the magnetosphere implies that many magnetic field lines with a combined length equivalent to several times the earth’s radius ARE excited and oscillate similarly to a plucked guitar string. Longer field lines have lower resonant frequencies and shorter ones have higher resonant frequencies, similar to a guitar string that is depressed in different frets up and down the guitar neck. Field lines with more or heavier particles around them also will have lower frequencies. Changes in orientation and polarity of the interplanetary magnetic field or an increase in solar wind velocity can have dramatic effects on the waves as seen on Earth.<sup>72</sup>

Studies have shown that an increase in magnetic field-line resonances can affect the human cardiovascular system because the Pc frequencies are in a comparable range with the rhythms of the cardiovascular and autonomic nervous systems (Figure 8).<sup>73</sup> EEG patterns, heart rate, blood pressure and reaction times were measured in a group of people by Doronin et al. and compared with the low-frequency rhythms in geomagnetic activity.<sup>26</sup> The authors found that the oscillations in the Kp index had identical periods in the monitored EEG alpha rhythm, suggesting that whole-body changes occur in conjunction with geomagnetic activity by changing both heart and brain patterns.

Experiments were conducted by Zenchenko et al. in Russia that monitored heart rate at rest in

healthy individuals in comparison with variations in the lower-frequency components (0.5 to 3.0 mHz) of the geomagnetic field. They found that two-thirds of the experiments revealed a synchronization between rhythms in heart rate and the ultralow-frequency components of the geomagnetic field over periods of 4 to 30 minutes.<sup>74</sup>

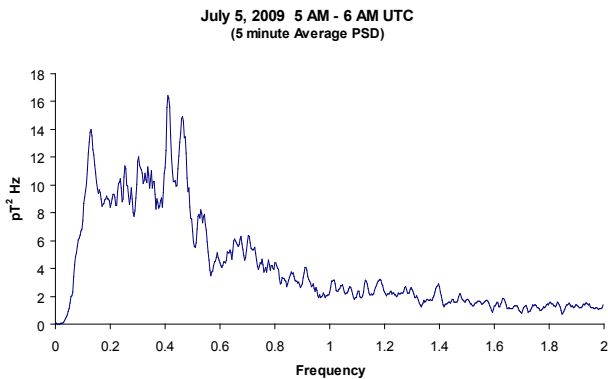


Figure 8: Geomagnetic field-line resonance data recorded from the GCMS site in Boulder Creek, Calif. Note that all the resonant frequencies directly overlap human cardiovascular system frequencies and there is a clear standing wave frequency at 0.1 hertz, which is the same resonant frequency of the cardiovascular systems and thus coherent heart rhythms in humans and many animals.

A study conducted in India demonstrated that Pc frequencies can affect humans and animals.<sup>75</sup> The subjects experienced uneasiness, confusion, restlessness and a lack of sense of well-being when subjected to the simulated pulsating fields, and some complained of headaches.<sup>75</sup>

In a study HeartMath Institute conducted with 10 participants in the American state of California, nonstop HRV recordings were carried out for 30 consecutive days. The study confirmed that autonomic nervous system activity was correlated with solar and geomagnetic influences and there were similar findings to those discussed earlier in the study conducted in Saudi Arabia.

Figure 9 shows an example of healthy participants'

HRV-HF power (parasympathetic activity) plotted with the total magnetic power spectrum of the time-varying aspects of the earth's magnetic field at the Boulder Creek magnetometer site over the same 30-day period. The magnetic field data in the plot has been inverted to help illustrate the visual correlation, which can be seen clearly in the Figure 9.

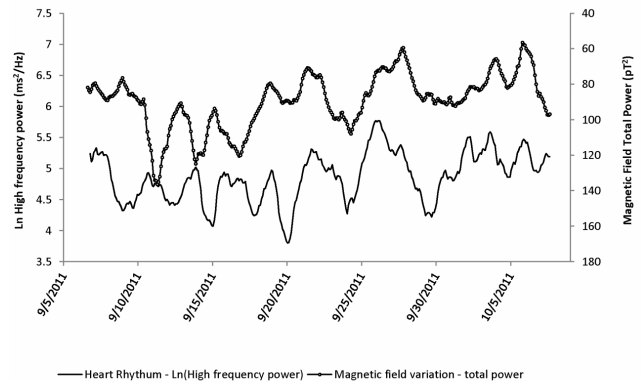


Figure 9: Example of one participant's high-frequency power derived from the person's HRV and the total power of the time-varying magnetic field at the site California over a 30-day period.

As discussed above, it is well established that the earth and ionosphere generate a symphony of resonant frequencies that directly overlap with those of the human brain, cardiovascular and autonomic nervous systems and that of all the bodily systems studied thus far, changes in geomagnetic conditions appear to most strongly affect the rhythms of the heart and the brain.<sup>34,39,43,46,66,76-78</sup>

The evidence that human health, cognitive functions, emotions and behaviors are affected by solar activity and planetary magnetic fields is quite strong and convincing. The data suggests that changes in the resonances in Earth's magnetic field environment can influence the function of the human autonomic nervous system, brain and cardiovascular system. We are of the perspective that many of the negative effects on health and behaviors associated with disturbances or

changes in solar and geomagnetic activity can be significantly reduced by learning to better self-regulate our physiology and emotions.

## INTERCONNECTIVITY BETWEEN LIVING SYSTEMS: THE ROLE OF EARTH'S MAGNETIC FIELDS

### Magnetic Fields Carry Biologically Relevant Information

The second GCI hypotheses states: *The earth's magnetic fields are carriers of biologically relevant information that connects all living systems.*

The first biomagnetic signal was demonstrated in 1863 by Gerhard Baule and Richard McFee in a magnetocardiogram (MCG) that used magnetic induction coils to detect the fields generated by the human heart outside of the body.<sup>79</sup> A remarkable increase in the sensitivity of biomagnetic measurements was achieved with the introduction of the Superconducting Quantum Interference Device (SQUID) in the early 1970s.<sup>80</sup>

Of all the organs, the heart generates the largest rhythmic electromagnetic field, one that is approximately 100 times stronger than that produced by the brain. This field is measured in the nanotesla ranges and can be detected several feet from the body with SQUID-based magnetometers.<sup>81</sup> We have found that the rhythmic patterns in beat-to-beat heart rate variability reflect emotional states and thus encode and transmit biologically relevant information patterns via the electromagnetic field radiated into the environment (Figure 10).

The heart generates a series of electromagnetic pulses in which the time interval between each beat varies in a complex manner. These pulsing waves of electromagnetic energy give rise to interference patterns when they interact with magneti-

cally polarizable tissues and substances.<sup>82</sup>

We have shown in our laboratory that the heart's electromagnetic field can be detected by nearby animals or the nervous systems of other people and can mediate several types of physiological synchronization between individuals.<sup>83,84</sup> These findings have been confirmed by a number of other investigators.

For example, in a study on interpersonal effects of nonverbal compassionate communication in which physiological effects were measured, Kemper and Shaltout found significant changes in the receiver's autonomic nervous system.<sup>85</sup>

Russek and Schwartz found that cardiac energy and information exchange can occur between individuals and that the degree of physiological synchronization between pairs was greater in people who reported being raised in a loving environment. They showed that the EEGs of one person could synchronize to another person's heartbeats (ECG) who was sitting across from the person at a table. They found that participants who rated themselves 40 years before the study as having been raised by loving parents had significantly more synchronization between the pairs than those that reported not being raised in a loving environment.<sup>86</sup>

Although there are too many studies showing physiological synchronization to discuss here, one other interesting study that examined physiological synchronization was conducted during a Spanish fire-walking ritual that looked at synchronized cardiac activity between fire-walkers and spectators.<sup>87</sup> It found a high degree of synchronized activity during a 30-minute ritual between the fire-walkers and related spectators, but not in spectators who were unrelated and did not have an emotional connection with the firewalkers. The

study concluded that the mediating mechanism must be informational.

HeartMath Institute has found that when individuals are in a state of heart coherence, the heart radiates a more coherent electromagnetic signal into the environment and they are more sensitive to detecting the information in the fields radiated by others.<sup>83,84</sup> The magnetic field generated by the heart provides a plausible mechanism for how we can “feel” or sense another person’s presence and emotional state independent of body language or other factors.

We have found there is a direct relationship between the heart-rhythm patterns in the HRV waveforms and the spectral information encoded in the frequency spectra of the magnetic field radiated by the heart (Figure 10). Thus, information about a person’s emotional state is encoded in the heart’s magnetic field, and this information is communicated throughout the body and radiated out into the external environment.<sup>83</sup>

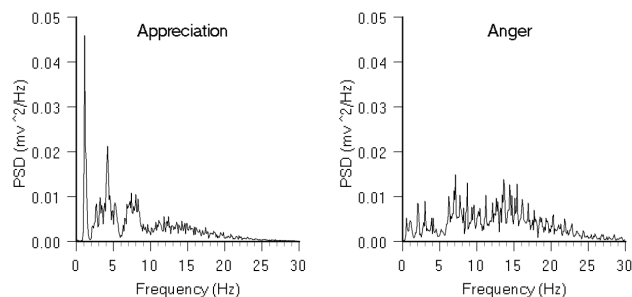


Figure 10. ECG spectra during different emotional states. The above graphs show the average power spectra of 12 individual 10-second epochs of ECG data, which reflect information patterns contained in the electromagnetic field radiated by the heart. The graph on the left is an example of a spectrum obtained during a period of high heart-rhythm coherence generated during a sustained heartfelt experience of appreciation. The graph on the right depicts a spectrum associated with a disordered heart rhythm generated during feelings of anger.

A good analogy for this is how cellphones work. In

this example, we routinely encode information (our voice, text message, etc.) into an electromagnetic field that can carry the information across great distances.

The ability of electromagnetic fields to induce long-range organization in living systems has been proposed by a number of researchers.<sup>88-94</sup> Additionally, it has been suggested electromagnetic fields are responsible for the self-organization of entire ecosystems.<sup>95</sup> Giorgio Piccardi, the first to show that environmental electromagnetic fields could affect chemical reactions, stated the following in the 1930s:

*“Living organisms of necessity take part in the events of the environment in which they exist. Very often they participate by means of specialized organs in accordance with their degree of evolution and complexity. But it is not important for us to know whether the beings in question possess them, whether in greater or lesser number. ... All of this is of no use to us, so we will concern ourselves with the possibilities offered to living beings directly aware of particular environmental phenomena. The events which take place in space act upon living organisms either by ‘contact’ or at a ‘distance’... But the study of action by contact, which is accessible to direct experimental investigation, is, as I see it, related more to physiology than to medical climatology. ... On the other hand, certain phenomena which take place in geophysical space and all the phenomena which take place in solar space and astrophysical space act at a distance. No matter what the nature of far-off special phenomena, their action is exercised by means of radiations of an electromagnetic or corpuscular nature, or by means of variations in the general field, electrical, magnetic, electromagnetic or gravitational. All of this may today be listed as being distant actions.”*<sup>96</sup> (pp. 120–121)

A few pages later (p.126) Piccardi states: "Definitely, all living matter reacts to far-off special actions, both electromagnetic and field."

Larissa Brizhika and Emilio Del Giudice, both of whom are professors of theoretical physics and received the prestigious Prigogine award for their research on ecological systems, state:

*"The electromagnetic field acts as a messenger able to involve simultaneously a large number of molecular components, affecting therefore a macroscopic being; electromagnetic fields interact with all the molecules present within its own wavelength. Moreover, liquid water, which accounts for the huge majority of molecular components of living organisms, should play an essential role in this process, as realized by Piccardi. It has been shown that biological dynamics works only when water exceeds a threshold."*<sup>97</sup>

Brizhika and Del Giudice suggested that the magnetic vector potential could be the physical agent acting as messenger in coherent structures, such as living systems, that provides a continuous exchange of information between living system within the larger ecosystem. They suggest that magnetic potential provides the mechanism for the establishment of the coherence, complexity, nonlocality and self-consistency of living systems and ecosystems.<sup>2,95</sup>

*"The messengers should be the electromagnetic fields produced by all the coherent parts of the organism. We recall that a coherent system is one where the phase (namely the rhythm of oscillation of the coupled matter and electromagnetic field) is sharply defined. Here we generalize this approach to a larger scale and show that according to quantum field theory, the electromagnetic field is the messenger that, via its electromagnetic potential, governs the dynamics of not only individuals, but of the whole ecosystem to*

*which the individuals belong. This generalization is based on the fact that the field causes the emergence of the coherent structures, which, in view of their coherence, openness and nonlinearity, are able to self-organize and form a chain of hierarchical levels of ecosystems."*<sup>95 (p 1856)</sup>

Support for the hypothesis that magnetic fields are carriers of biologically relevant information has been provided by studies conducted by Luc Montagnier, who was awarded the Nobel Prize for physiology or medicine in 2008 for his discovery of HIV.<sup>98,99</sup> He and his co-researchers discovered that epigenetic information related to DNA could be detected as electromagnetic signals radiated from solutions containing DNA. They demonstrated that this information could be transferred to and instruct the re-creation of DNA in a remote test tube of water containing the appropriate basic constituents of DNA by electromagnetic frequency fields of 7.8 hertz, which is, of course, the first Schumann resonance frequency. They showed that the presence of the magnetic field was critical for the information transfer to occur between the test tubes.<sup>99</sup> Furthermore, the authors state that the electromagnetic fields that transfer DNA information could be provided from natural sources such as Schuman resonances.

Persinger has conducted numerous studies examining the effects of magnetic fields, with the same magnitude as the geomagnetic field, on brain functions and information transfer.<sup>14,67</sup> He too suggests that the earth's magnetic field can act as a carrier of information between individuals' neural networks.<sup>100</sup>

Support for experiments on this was provided by Rouleau et al., using two spring water samples separated by large distances that were surrounded by toroidal-wound coils driven with the same magnetic field that has an accelerating and decelerating

phase-modulation pattern. After injecting acetic acid (adding protons) into one water sample, the alkalinity of the other water sample increased.<sup>101</sup> In other words, dynamic changes in the water sample that did not have its pH changed by adding the protons also occurred because of the shared phase-modulated electromagnetic field. Similar experiments were shown to produce the same type of nonlocal excess correlations for photon emissions of cell cultures and the electrical activity of human brains.<sup>102</sup>

### Global Information Field

As an extension to the hypothesis above, we suggest that we not only are receivers of biologically relevant information, but additionally, we can feed information into a “global field environment.”

This leads to our third hypothesis: *We each affect the global information field.*

In this section, we will discuss studies and theories supporting the suggestion that bioelectromagnetic fields such as the ones radiated by human hearts and brains can affect other individuals and potentially couple to a type of “global information field.” Note that the studies discussed in the previous section support the first part of this statement, namely bioelectromagnetic fields such as those radiated by human hearts and brains can affect other individuals.

The concept of a noosphere was introduced by Vladimir Vernadsky,<sup>103</sup> founder of the National Academy of Sciences of Ukraine, although credit for coining the term noosphere is given to Pierre Teilhard de Chardin, a French philosopher, paleontologist and geologist.<sup>104</sup> The noosphere is the third phase, or evolutionary step of Earth, after the geosphere (rocks, water, atmosphere, etc.) and the biosphere (biological life).

Teilhard perceived a continuous growth in the evolution of increasing complexity and consciousness that expands in space and time. For him, the noosphere is a sphere of thought and spiritual energy encircling the earth where interaction between human minds occurs and embraces the social domain and evolution of our legal, educational, religious and technological systems.

The noosphere evolves in steps with the mass consciousness of the human population. and Teilhard believed consciousness could expand beyond the earth and out into the universe. His focus was to “connect the two energies of the body and the soul in a coherent manner.” He believed love was the principal driver of what he called “noogenesis” and that evolution would reach an omega point: an apex of thought and consciousness, which he identified with the return of a Christ consciousness.

Coherent with Teilhard’s concept of the noosphere is “morphic resonance,” a term coined by Rupert Sheldrake who defined it as a type of interconnection between all similar organisms across time and space.<sup>105</sup> Sheldrake’s morphogenic field theory states that once one member of a group that shares the same biological structure acquires a new skill in performing a task, the same skill can be acquired more quickly by other members of the group in successive order.<sup>106</sup> He states that our minds extend into time and space and that members of social groups are linked together through an invisible morphic field even when they are far away.<sup>105</sup>

There is evidence to suggest an energetic field connection is formed among individuals in groups through which communication among all the group members can occur simultaneously. In other words, there may well be a “group field” that connects all the members.<sup>107</sup>

Sociologist Raymond Bradley, in collaboration with neuroscientist Karl Pribram, developed a theory of social communication to explain the patterns of social organization common to most groups, independent of size, culture, degree of formal organization, length of existence or member characteristics.<sup>108</sup> They found that most groups have a coherent network of energetic connections that link virtually all members into a single multilevel hierarchy. By mapping all possible relationships between each pair of members in a group, they found a direct relationship between the number and structure of reciprocated positive emotional bonds and control or power relations among the members that predicted group stability and performance two years later.<sup>109</sup>

The model that best fits the data was one based on a field concept in which information about the group as a whole was distributed to all members in such a way that information about the group's global organization could be obtained from any member within the field – a type of collective consciousness referred to as “social hologram.”<sup>108</sup>

Ervin László, a Hungarian philosopher of science and systems theorist suggests, that a field of information is the substance of the cosmos. Using the Sanskrit term for “space,” akasha, he calls this information field the “akashic field” or “A-field.”<sup>110</sup> He suggests that the “quantum vacuum” is the fundamental energy and information-carrying field similar to that of Brizhika, and Del Giudice.

László believes that such an information field can explain why our universe appears to be fine-tuned so as to form conscious life forms and why evolution is an informed process, rather than a random one. He believes the hypothesis solves several problems that emerge from quantum physics, especially nonlocality and quantum entanglement.

László asserts that consciousness is generated not only by human brains, but by all living organisms, which are interconnected by a field similar to the global information field HeartMath posits. Furthermore, he states, there is mounting evidence that consciousness is not confined to the brain, but rather is “nonlocal,” embracing minds and events beyond the brain and the body.<sup>111</sup> Many other well-known and respected physicists have made similar suggestions.<sup>112-115</sup>

As discussed in the sections above, Saroka and Persinger point out the similarities of basic frequencies, harmonics, magnetic field intensities, voltages, and bandwidths of the Schumann resonances (SR) and human brains, which suggest the capacity for direct interaction and resonant coupling between them.<sup>116</sup> They suggest that dynamics in the magnetosphere that affect the SR stability and amplitudes might be reflected in human brain activity, including modifications of cognition and dream-related memory consolidation.<sup>116</sup>

In a recent experiment, pairs of individuals separated by more than 6,000 km exhibited a significantly increased correlation in EEG activity primarily between the right hemispheres of the pairs of participants.<sup>117,118</sup> In this experiment, the participant pairs had used the same toroidal coils that were used in the experiments that demonstrated an excessive correlation (nonlocal connection) in changes of pH in spring water and photon emissions of cell cultures. The coils were placed around their heads and the pairs were simultaneously exposed to the same magnetic sequences, while using separate devices in the two locations that were time synchronized. In addition, the pairs' subjective experiences, as measured by the Profile of Mood States indicated significantly increased excess correlation for scales reflecting anger and vigor.

Not only has Persinger shown that applying external fields similar to the SRs can induce altered states of consciousness, he also published a detailed theory of how the geomagnetic field can store information related to brain activity and this information can be accessed by other human brains.<sup>13</sup>

Saroka and Persinger recently suggested that the number of people asleep may affect the activity in the Schumann resonance values in the 12- to 14-hertz range (second harmonic) with peak-to-peak changes of ~0.1 hertz and 0.1 pT in the SR. They found that after potential artifacts were removed and as the number of people sleeping increased, the frequency within the 12- to 14-hertz range increased while the intensity decreased by about 1 pT.<sup>119</sup>

### Collective Effects on the Global Field Environment

Our fourth hypothesis states: *Large numbers of people creating heart-centered states of care, love and compassion will generate a more coherent field environment that can benefit others and help offset the current planetary wide discord and incoherence.*

There is experimental evidence that human bio-emotional energy can have a subtle, but significant (scientifically measurable) nonlocal effect on people, events and organic matter.<sup>12,120-124</sup> For example, Steve Morris studied the effect of heart coherence in a group setting with people trained in maintaining states of heart coherence for several minutes and found that they could promote an increase in the coherence of untrained participants, who were unaware of the experiment's goal.<sup>125</sup>

There is evidence to indicate interactions occur between human emotions and a global field when large numbers of people have similar emotional

responses to events such as organized global peace meditations. A study conducted in 1993 in Washington, D.C., showed a 25% drop in crime rate when 2,500 people mediated over specific periods of time,<sup>126</sup> indicating that a relatively small group was able to influence a much larger group.

A similar experiment was done during the peak of the 1982-85 war between Israel and Lebanon to see if a group of meditators could reduce social conflicts and wars. Drs. Charles Alexander and John Davies at Harvard University organized groups of experienced meditators in Jerusalem, Yugoslavia and the United States to mediate and focus their attention on Israel and Lebanon at various intervals over a 27-month period.

After controlling for weather changes, Lebanese, Muslim, Christian and Jewish holidays, police activity, fluctuation in group sizes and other potential influences during the course of the study, the levels of violence in Lebanon decreased 40% to 80% each time a group meditated, with the largest reductions occurring when the number of meditators was largest. During these periods, the average number of people killed during the war per day dropped from 12 to 3, a decrease of more than 70%. War-related injuries fell by 68% and the intensity level of conflict decreased by 48%.<sup>127,128</sup>

### The Global Consciousness Project

Further evidence that there is an interconnecting field linking collective consciousness and human emotionality has been provided by professor Roger Nelson, chief scientist of the Global Consciousness Project (GCP). GCP maintains a worldwide network of random number generators (RNGs) and the results suggest events that evoke mass human emotionality affect the randomness of these electronic devices in a globally correlated manner. According to Nelson:

*“The GCP is a long-term experiment that asks fundamental questions about human consciousness. It provides evidence for effects of synchronized collective attention – operationally defined global consciousness – on a world-spanning network of physical devices. There are multiple indicators of anomalous data structure, which are correlated specifically with moments of importance to humans. The findings suggest that some aspect of consciousness may directly create effects in the material world. This is a provocative notion, but it is the most viable of several alternative explanations.”<sup>122</sup>*

Dr. Nelson has found clear evidence that large events, defined by the number of people engaged and their level of emotional “importance,” can produce larger effects on the global network than smaller events and numbers of people.

One interesting finding in his research is that there is a significant correlation between global events that elicit a high level of emotionality from a large part of the world’s population and periods of nonrandom order generated by the RNGs.<sup>129</sup> For example, multiple independent analyses of the network during the World Trade Center terrorist attacks on the morning of Sept. 11, 2001 (Figure 11), correlate with a large and significant shift in the output of the global network of RNGs.<sup>12</sup>

Although the mechanisms for how human emotions create more coherence in the randomness of this global network are not yet understood, the data clearly shows that such effects are real with an odds-against-chance ratio of over a 1 billion to 1.<sup>12</sup> When an event is characterized by deep and widespread compassion, the GCP effects are stronger,<sup>122</sup> which could be explained because compassion is related to interconnection and positive emotional engagement.

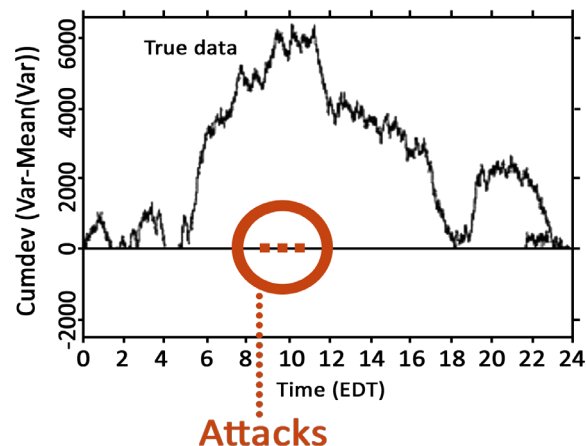


Figure 11: Evidence of collective intuition: Correlated random-number-generator data from the Global Consciousness Project network before, during and after the 9/11/01 terrorist attacks on the World Trade Center.

When we experience true feelings of compassion, we tend to shift into a more coherent physiological state<sup>82</sup> and are thus radiating more coherent cardiac-related magnetic waves into the environment.<sup>84</sup> Compassion is an emotional state that brings us together and makes us coherent; we invest a small part of our individual being to connect with others and, as the GCP data indicate, with the global field environment.

A study that examined GCP data from 1998 to 2008 matched satellite-based interplanetary magnetic field (IMF) polarity with GCP-defined world events such as meditations, celebrations, natural catastrophes and violence. The results suggested that RNG deviations may depend on a positive interplanetary magnetic field polarity coinciding with emotionally significant conditions.<sup>130</sup>

Another study that suggests magnetic fields can affect RNGs was conducted by Lyndon Juden-Kelly.<sup>131</sup> It found that when individual RNGs were exposed to the same patterned rotating magnetic field that produced excess correlation and entanglement in photon emissions, pH alterations

in spring water and EEG activity in pairs of people separated by great distances, as discussed earlier, the random numbers deviated significantly and in opposite directions to each other.

This suggests the result is consistent with entanglement, such as when two particles are “connected” and one of the particles changes its polarity and the other particle responds in the opposite direction. The study points out that because of the extensive shielding and calibration testing of the RNG devices, classical physical interactions can be ruled out as the source of deviation from statistical randomness.

The GCP group has investigated a number of theoretical models that could potentially explain the global effect they are detecting with the network. In summary, here is an excerpt from the study's analysis:

*“Finally, a nonlinear dynamic field model proposes that individual minds are mutually interactive, and that the interactions are responsible for an emergent field which depends on individual consciousness but is not reducible to it. The model implies that the dynamic and interactive qualities of consciousness also involve subtle interactions with the physical world and that these are responsible for certain anomalous phenomena such as are found in the GCP experiment.”<sup>122 (p12)</sup>*

## Human and Earth Magnetic Field Interactions

The studies and theories discussed in this section further support the fourth hypothesis.

A potential indicator of human bioemotional energy interacting with Earth's magnetic field was provided from measures of the earth's geomagnetic field during the 9/11 terrorist attacks. Figure 12 shows data recorded from two separate space

weather satellites in geosynchronous orbit in the days before and after the attacks. The data from the magnetometers on these two satellites, which are positioned over the U.S. east and west coasts, reveal that a large shift occurred in the earth's geomagnetic field at the same time as the attacks. Note the difference in the fields in the days before and after the attacks. The instability in the fields during the days after the attacks may reflect the mass emotional turmoil that occurred as news of the attacks spread around the globe. The same patterns were observed in ground-based magnetometers.

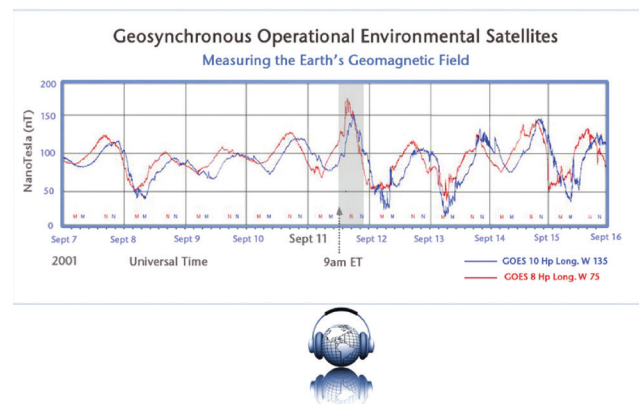


Figure 12: The data recorded from the Geostationary Operational Environmental Satellite 8 and 10 which are in geosynchronous orbit over the east and west coasts of the United States in the days before, during, and after the September 11, 2001, terrorist attacks.

Although the data shown in Figure 12 does not prove that human emotions somehow modulated the earth's geomagnetic field, combining this data with GCP and other data supports the hypothesis that the earth's energetic systems are coupled with and exchange information in a bidirectional manor with the collective emotional energy of humanity. Interestingly, a study of terrorist attacks between the years of 1994 and 2008 found that geomagnetic activity increased significantly both on the day and day after the attacks.<sup>17</sup>

Relative to this discussion is the HeartMath study mentioned earlier, in which continuous HRV recordings were taken with 10 participants for 30 consecutive days. It yielded some surprising and unexpected results, which emerged after time synchronizing and normalizing and removing all circadian rhythms from the HRV time series data. We found that participants' HRV rhythms synchronized with each other across the 30-day period even though all participants simply went about their days normally and were in separate locations across California. (Figure 13).

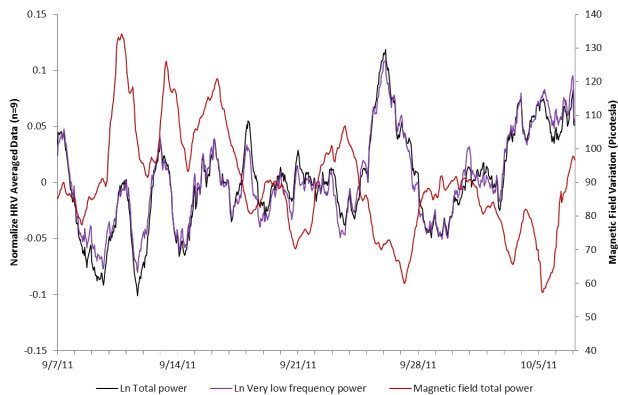


Figure 13: Shows the averaged time-synchronized HRV data from participants located in separate locations across California over a 30-day period. The rhythms for the HRV total and very-low-frequency power and the time-varying magnetic-field-strength power (red) are shown for the 30-day period.

This suggested that the participants were synchronizing to an external signal, and a significant correlation was found between the group's HRV indices and the measures of the earth's time-varying magnetic-field data across the 30-day period.

To follow up and confirm these profound findings, an international study with 104 participants in five countries was conducted. The preliminary findings have confirmed and extended the results of the first study and they indicate humanity's heart rhythms are synchronized on a global scale. We are synchronized not only with each other, but also

with the earth's energetic systems (A manuscript on these findings is in preparation).

## Future Research Directions

We will be conducting further research related to the fourth hypothesis and studies that examine the potential effects of events in which large numbers of people in a heart-coherent state and who hold a shared intention may be able to encode information on the earth's energetic and geomagnetic fields.

We will conduct more specific studies to test the hypothesis that magnetic fields act as carrier waves of physiologically patterned and relevant information. Persinger's series of experiments producing nonlocal connections (entanglement) in various systems, including in pairs of people separated by great distances are noteworthy here: Excess correlations only occur when the systems are exposed to the same patterned rotating magnetic field that uses phase shifting of fields by a series of pulses that move progressively closer, followed by a series of pulses that progressively move farther apart. This clearly somehow creates a coupling of information from the biological systems (cell cultures and brains) to the magnetic field, which then carries this biologically relevant information to a remote location, where it is coupled into a separate biological system.

These findings are of great interest because the heart rhythms of humans and animals are basically a series of repeating ascending and descending magnetic pulses, very similar to what Persinger has shown is involved in coupling the magnetic field with biological information.

Brizhika and Del Giudice and Persinger have developed different theoretical models in this area that are supported by some experimentation. Brizhika

and Del Giudice use a quantum field theory approach that suggests electromagnetic fields act as messengers from the components of living organisms to establish a coherent whole.<sup>97</sup> They suggested that the magnetic vector potential can be the physical agent acting as messenger that provides a continuous exchange of information between living systems *and* the larger ecosystem.

Persinger focuses more on the levels of energy exchange between the fields and structures in a biological system. We are currently in the process of setting up the same procedure Persinger's group used. If we are able to replicate that group's findings, we will try using coherent heartbeats at the magnetic field source to test whether this creates an excess correlation and transfers biological information to the magnetic field.

## PERSONAL, SOCIAL AND GLOBAL COHERENCE

### Personal Coherence

Our previous research identified a psychophysiological state that is the underpinning of optimal function, termed *heart coherence*.<sup>82,107</sup> Practical techniques, tools and technologies, frequently referred to as the HeartMath System, have been developed by the HeartMath Institute that help people shift into and maintain a state of heart coherence. This empowers them to better manage stress, increase performance and connect with a deeper self-awareness and intuitive intelligence.<sup>82,107,132</sup> Improvements in cognitive performance, focus, effectiveness, self-responsibility and social cohesion through use of the HeartMath System have been shown in youth and adult populations.<sup>82,107,133-136</sup>

At the individual level, a person's level of heart coherence can be assessed by monitoring the

rhythmic patterns that are reflected in the individual's heart rate variability (HRV), the beat-to-beat changes in heart rate. Positive emotions such as love, appreciation and compassion tend to generate a heart-rhythm pattern that is more ordered and coherent, whereas negative emotions such as anxiety, anger and fear generate a disordered, incoherent heart-rhythm pattern. Ongoing feelings of impatience, frustration, irritation, worry or blame are associated with incoherent HRV rhythms, indicating that inner rhythms are out of sync.<sup>82</sup>

Studies have found that the combination of using HeartMath's heart-rhythm coherence monitoring technology (emWave® and Inner Balance™) to promote skill acquisition and its mental and emotion self-regulation techniques are highly successful at reducing stress, anxiety, anger, chronic pain, fatigue and burnout as well as many other stress-related conditions.<sup>82,107,133-136</sup>

As more and more people increase their personal coherence and ability to self-regulate, they benefit themselves and others because their hearts' magnetic fields, which are radiated out into the local environment, become more coherent (Figure 10).

Moreover, we suggest that being in a heart-coherent state strengthens and stabilizes the coupling and transfer of bidirectional information to the planetary magnetic fields. We believe that as greater numbers of people in any social group (family, team and community) increase their overall personal coherence they help to establish a more coherent standing wave at the group level and this wave is reinforced and amplified through collective coherent intention and actions. This "group field" then makes it easier for people in the group to sustain their coherence and self-regulatory capacity and lift their consciousness, which over time is reflected in increased and sustained social coherence (Figure 14).

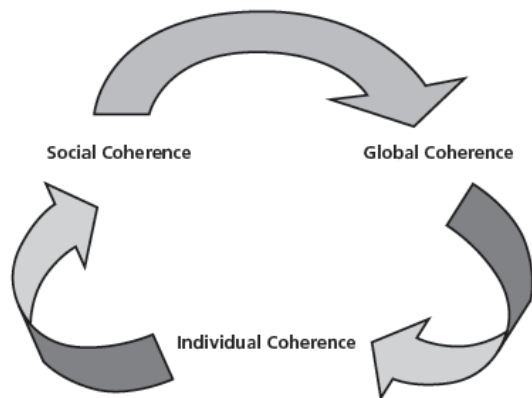


Figure 14: Global Coherence Initiative theory of change.

## Social Coherence

When members of any work group, sports team, family or social organization get along well, there is a natural tendency for good communication, cooperation and efficiency. Social or group coherence refers to the alignment and harmonious order in the network of relationships among individuals who share common interests and objectives.

In a coherent team, there is freedom for the individual members to do their part and thrive while maintaining cohesion and resonance within the larger group's intentions and goals. Social coherence is therefore reflected as a stable, harmonious alignment of relationships that allows for the efficient flow and utilization of energy and communication required for optimal collective cohesion and action.<sup>107</sup>

When individuals are not well self-regulated or are acting in their own self-interests without regard to others, it generates social incoherence. It has become apparent that social incoherence not only influences the way we feel, relate and communicate with one another, it also affects physiological processes that directly affect health.

Numerous studies have found that people undergoing social and cultural changes or who are living

in situations characterized by social disorganization, instability, isolation or disconnectedness are at increased risk of acquiring many types of disease.<sup>137</sup> James Lynch provides a sobering statistic on the effects of social isolation on one's health. His research shows that social isolation and the resulting loneliness produces a greater risk for heart disease than smoking, obesity, lack of exercise and excessive alcohol consumption *combined*.<sup>138</sup>

In contrast, there is an abundance of research that shows close relationships and coherent social networks are highly protective. Numerous studies of diverse populations, cultures, age groups and social strata have shown individuals who are involved in close and meaningful relationships have significantly reduced mortality, reduced susceptibility to infectious and chronic disease, improved recovery from post-myocardial infarction and improved outcomes in pregnancy and childbirth.<sup>139-142</sup>

There are practical steps and practices that can be taken to build and stabilize social coherence and health. A growing number of hospitals, corporations, schools, athletic teams and communities are actively working toward increasing their team, group and organizational coherence. Attention and energy are required to shift a social system into a more coherent mode, and the key to creating stable, coherent groups is related to establishing positive emotions and dissipating negative emotional tensions, interpersonal conflicts and other stressors among the individuals in a group.

We have found that collective coherence is built by first working at the individual level. As individuals become more capable of self-management, a group increases its collective coherence and can achieve its objectives more effectively.<sup>143</sup>

## Global Coherence

If living systems are indeed interconnected and communicate with each other via biological and electromagnetic fields, it stands to reason that humans can work together in co-creative relationships to consciously increase the coherence in the global field environment, which in turn distributes this information to all living systems within the field. Of course, the idea is not new that shared intentions can influence others at a distance. Such ideas have been the subject of numerous studies that have looked at the effects of prayer, meditations and groups sending intentions in various experimental contexts.<sup>123,144-146</sup>

How can we have such an influence on each other at a distance? There are no clear answers yet, but we hypothesize that a feedback loop exists among all human beings and the earth's energetic systems. Our basic hypothesis is that when enough individuals and social groups increase their collective coherence, a more coherent standing reference wave is created and amplified in the global field environment that will help lift individual, social and global consciousness. In time, as more individuals stabilize the global field and families, workplaces and communities move to increased social coherence, it will lead to increased global coherence.

Global coherence will greatly accelerate cooperation, collaboration, innovative problem-solving and intuitive discernment for addressing society's significant social, environmental and economic problems. This will become increasingly apparent as countries adopt a more coherent and inclusive planetary view. This planetary view will be critical for meaningfully and successfully addressing social and economic oppression, wars, cultural intolerance, crime and disregard for the environment.

## CONCLUSIONS

Every individual contributes to the global field environment, and each person's attitudes, intentions and emotional experiences count. This is empowering for many individuals who often feel overwhelmed by current conflicts on the planet and negative predictions about the future. This helps them realize that their actions can make a difference and that by increasing their own coherence, they can become "coherence builders" and contribute to the shift that many now perceive to be occurring.

The personal benefits of greater emotion self-regulation and self-responsibility, enhanced well-being and improved health and relationships are powerful motivators that reinforce the individual's efforts to achieve the greater planetary good. As more and more individuals become increasingly self-regulated and grow in conscious awareness, their increased individual coherence in turn increases social coherence, which is reflected in increased cooperation and effective co-creative initiatives for the benefit of society and the planet.

## REFERENCES

1. McCraty, R. & Deyhle, A. in *Bioelectromagnetic and Subtle Energy Medicine, Second Edition* (ed Paul J. Rosch) (2015).
2. Bischof, M. & Del Giudice, E. Communication and the emergence of collective behavior in living organisms: a quantum approach. *Molecular biology international* **2013** (2013).
3. Bischof, M. Synchronization and coherence as an organizing principle in the organism, social interaction, and consciousness. *NeuroQuantology* **6** (2008).
4. Hammerschlag, R. *et al.* biofield Physiology: A Framework for an emerging discipline. *Global Advances in Health and Medicine* **4**, 35-41 (2015).
5. Ho, M.-W. *The Rainbow and the Worm: The Physics of Organisms*. (World Scientific Publishing Co., 2005).
6. Persinger, M. A. Electromagnetic bases of the universality of the characteristics of consciousness: quantitative support. *J. Cosmol* **14** (2011).
7. Sun, X. *et al.* Evolution of magnetic field and energy in a major eruptive active region based on SDO/HMI observation. *The Astrophysical Journal* **748**, 77 (2012).
8. Hasegawa, H. *et al.* Transport of solar wind into Earth's magnetosphere through rolled-up Kelvin–Helmholtz vortices. *Nature* **430**, 755-758 (2004).
9. Finlay, C. *et al.* International geomagnetic reference field: the eleventh generation. *Geophysical Journal International* **183**, 1216-1230 (2010).
10. Courtillot, V. & Le Mouel, J. L. Time variations of the earth's magnetic field-From daily to secular. *Annual Review of Earth and Planetary Sciences* **16**, 389-476 (1988).
11. Palmer, S. J., Rycroft, M.J., Cermack, M. Solar and geomagnetic activity, extremely low frequency magnetic and electric fields and human health at the Earth's surface. *Surv Geophys* **27**, 557–595 (2006).
12. Nelson, R. Effects of Globally Shared Attention and Emotion. *Journal of Cosmology* **14** (2011).
13. Persinger, M. On the possible representation of the electromagnetic equivalents of all human memory within the earth's magnetic field: Implications of theoretical biology. *Theoretical Biology Insights* **1**, 3-11 (2008).
14. Persinger, M. A. & Saroka, K. S. Human quantitative electroencephalographic and Schumann Resonance exhibit real-time coherence of spectral power densities: implications for interactive information processing. *Journal of Signal and Information Processing* **6**, 153 (2015).
15. Uyeda, S., Nagao, T., Orihara, Y., Yamaguchi, T. & Takahashi, I. Geoelectric potential changes: possible precursors to earthquakes in Japan. *Proc Natl Acad Sci U S A* **97**, 4561-4566 (2000).
16. Ertel, S. Space weather and revolutions: Chizhevsky's heliobiological claim scrutinized. *Studia Psychologica* **39**, 3-22 (1996).
17. Grigoryev, P., Rozanov, V., Vaiserman, A., Vladimirov, B. Heliogeophysical factors as possible triggers of suicide terroristic acts. *Health* **1**, 294-297 (2009).
18. Mikulecký, M. Solar activity, revolutions and cultural prime in the history of mankind. *Neuroendocrinology Letters* **28**, 749-756 (2007).
19. Persinger, M. A. Wars and increased solar-geomagnetic activity: aggression or change in intraspecies dominance? *Percept Mot Skills* **88**, 1351-1355 (1999).
20. Smelyakov, S. V. *Tchijevsky's Disclosure: How the Solar Cycles Modulate the History*, 2006).
21. Tchijevsky, A. L., (de Smitt, V.P. translation). Physical Factors of the Historical Process. *Cycles* **22**, 11-27 (1971).
22. Halberg, F., Cornelissen, G., McCraty, R. & Al-Abdulgader, A. Time Structures (Chronomes) of the Blood Circulation, Populations' Health, Human Affairs and Space Weather. *World Heart Journal* **3**, 1-40 (2011).
23. Ertel, S. Cosmophysical correlations of creative activity in cultural history. *Biophysics* **43**, 696-702 (1998).
24. Lean, J. Evolution of the Sun's spectral irradiance since the Maunder Minimum. *Geophys. Res. Lett* **27**, 2425-2428 (2000).
25. Tapping, K. Recent solar radio astronomy at centimeter wavelengths: The temporal variability of the 10.7 cm flux. *Journal of Geophysical Research: Atmospheres* **92**, 829-838 (1987).
26. Doronin, V. N., Parfentev, V.A., Tleulin, S.Zh., Namvar, R.A., Somsikov, V.M., Drobzhev, V.I. and Chemeris, A.V. Effect of variations of the geomagnetic field and solar activity on human physiological indicators. *Biofizika* **43**, 647-653 (1998).
27. Kay, R. W. Geomagnetic Storms: Association with Incidence of Depression as Measured by Hospital Admission. *British Journal of Psychiatry* **164**, 403-409 (1994).
28. Caswell, J. M., Carniello, T. N. & Murugan, N. J. Annual incidence of mortality related to hypertensive disease in Canada and associations with heliophysical parameters. *International journal of biometeorology* **60**, 9-20 (2016).
29. Vares, M. A. P. Correlations between a New Daily Global Indicator of Human Behavior, Threshold Seismicity, and Solar Activity: Congruence of Energy and Implications. *Global Journal of Human-Social Science Research* **15** (2015).
30. Halberg, F. *et al.* Cross-spectrally coherent ~10.5- and 21-year biological and physical cycles, magnetic storms

- and myocardial infarctions. *Neuroendocrinology* **21**, 233-258 (2000).
31. Halberg, F., Cornelissen, G., Panksepp, J., Otsuka, K. & Johnson, D. Chronomics of autism and suicide. *Biomed Pharmacother* **59 Suppl 1**, S100-108 (2005).
  32. Halberg, F. *et al.* Cycles Tipping the Scale between Death and Survival (=“Life”). *Progress of Theoretical Physics Supplement* **173**, 153-181 (2008).
  33. Burch, J. B., Reif, J.S., Yost, M.G. . Geomagnetic disturbances are associated with reduced nocturnal excretion of a melatonin metabolite in humans. *Neuroscience Letters* **266**, 209-212 (1999).
  34. Rapoport, S. I., Malinovskaia, N.K., Oraevskii, V.N., Komarov, F.I., Nosovskii, A.M. and Vetterberg, L., . Effects of disturbances of natural magnetic field of the Earth on melatonin production in patients with coronary heart disease. *Klin Med (Mosk)* **75**, 24-26 (1997).
  35. Bergiannaki, J.-D., Paparrigopoulos, T.J., Stefanis, C.N. . Seasonal pattern of melatonin excretion in humans: relationship to day length variation rate and geomagnetic field fluctuations. *Experientia* **52**, 253-258 (1996).
  36. Cernouss, S., Vinogradov, A., Vlassova, E. . Geophysical Hazard for Human Health in the Circumpolar Auroral Belt: Evidence of a Relationship between Heart Rate Variation and Electromagnetic Disturbances. *Natural Hazards* **23**, 121–135 (2001).
  37. Cherry, N. Schumann Resonances, a plausible biophysical mechanism for the human health effects of Solar/Geomagnetic Activity. *Natural Hazards* **26**, 279-331 (2002).
  38. Ghione, S., Mazzasalma, L., Del Seppia, C., Papi, F. . Do geomagnetic disturbances of solar origin affect arterial blood pressure? . *Journal of Human Hypertension* **12**, 749-754 (1998).
  39. Hamer, J. R. Biological entrainment of the human brain by low frequency radiation. *Northrop Space Labs*, 65-199 (1965).
  40. Gordon, C., Berk, M. . The effect of geomagnetic storms on suicide. *South African Psychiat Rev* **6**, 24-27 (2003).
  41. Kay, R. W. Schizophrenia and season of birth: relationship to geomagnetic storms. *Schiz Res* **66**, 7-20 (2004).
  42. Nikolaev, Y. S., Rudakov, Y.Y., Mansurov, S.M. and Mansurova, L.G. Interplanetary magnetic field sector structure and disturbances of the central nervous system activity. *Reprint N 17a, Acad. Sci USSR, IZMIRAN, Moscow*, 29 (1976).
  43. Oraevskii, V. N., Breus, T.K., Baevskii, R.M., Rapoport, S.I., Petrov, V.M., Barsukova, Zh.V., Gurfinkel' Iul, and Rogoza, A.T. . Effect of geomagnetic activity on the functional status of the body. *Biofizika* **43**, 819-826 (1998).
  44. Berk, M., Dodd, S., Henry, M. . Do ambient electromagnetic fields affect behaviour? A demonstration of the relationship between geomagnetic storm activity and suicide. *Bioelectromagnetics* **27**, 151-155 (2006).
  45. Zaitseva, S. A. a. P., M. I. Effect of solar and geomagnetic activity on population dynamics among residents of Russia [In Russian]. *Biofizika* **40**, 861-864 (1995).
  46. Cornélissen, G. *et al.* Non-photoc solar associations of heart rate variability and myocardial infarction. *Journal of atmospheric and solar-terrestrial physics* **64**, 707-720 (2002).
  47. Villorosi, G., Ptitsyna, N.G., Tiasto, M.I. and Iucci, N. Myocardial infarct and geomagnetic disturbances: analysis of data on morbidity and mortality [In Russian]. *Biofizika* **43**, 623-632 (1998).
  48. Malin, S. R. C. a. S., B.J. Correlation between heart attacks and magnetic activity. *Nature* **277**, 646-648 (1979).
  49. Stoupel, E. Sudden cardiac deaths and ventricular extrasystoles on days of four levels of geomagnetic activity. *J. Basic Physiol. Pharmacol.* **4**, 357-366 (1993).
  50. Persinger, M. A. Sudden unexpected death in epileptics following sudden, intense, increases in geomagnetic activity: prevalence of effect and potential mechanisms. *Int J Biometeorol* **38**, 180-187 (1995).
  51. Knox, E. G., Armstrong, E., Lancashire, R., Wall, M. and Hayes, R. Heart attacks and geomagnetic activity. *Nature* **281**, 564-565 (1979).
  52. Giannaropoulou, E. *et al.* A study on the various types of arrhythmias in relation to the polarity reversal of the solar magnetic field. *Natural hazards* **70**, 1575-1587 (2014).
  53. Stoupel, E., Wittenberg, C., Zabłudowski, J. & Boner, G. Ambulatory blood pressure monitoring in patients with hypertension on days of high and low geomagnetic activity. *J Hum Hypertens* **9**, 293-294 (1995).
  54. McCraty, R. & Shaffer, F. Heart Rate Variability: New Perspectives on Physiological Mechanisms, Assessment of Self-regulatory Capacity, and Health Risk. *Global advances in health and medicine : improving healthcare outcomes worldwide* **4**, 46-61, doi:10.7453/gahmj.2014.073 (2015).
  55. Watanabe, Y., Cornelissen, G., Halberg, F., Otsuka, K. & Ohkawa, S. I. Associations by signatures and coherences between the human circulation and helio- and geomagnetic activity. *Biomed Pharmacother* **55 Suppl 1**, 76s-83s (2001).
  56. Cernouss, S., Vinogradov, A. & Vlassova, E. Geophysical hazard for Human health in the circumpolar Auroral Belt: evidence of a relationship between heart rate variation and electromagnetic disturbances. *Natural hazards* **23**, 121-135 (2001).
  57. Dimitrova, S., Angelov, I. & Petrova, E. Solar and geomagnetic activity effects on heart rate variability. *Natural hazards* **69**, 25-37 (2013).

58. Otsuka, K. *et al.* Geomagnetic disturbance associated with decrease in heart rate variability in a subarctic area. *Biomed Pharmacother* **55 Suppl 1**, 51s-56s (2001).
59. Otsuka, K. *et al.* in *Computers in Cardiology 2000*. 453-456 (IEEE).
60. Otsuka, K. *et al.* Altered chronome of heart rate variability during span of high magnetic activity. *Scripta Medica (Brno)* **73**, 111-116 (2000).
61. Gmitrov, J. & Ohkubo, C. Geomagnetic field decreases cardiovascular variability. *Electro-and Magnetobiology* **18**, 291-303 (1999).
62. Oinuma, S. *et al.* Graded response of heart rate variability, associated with an alteration of geomagnetic activity in a subarctic area. *Biomedicine & pharmacotherapy* **56**, 284-288 (2002).
63. Alabdulgader, A. *et al.* Human heart rhythm sensitivity to earth local magnetic field fluctuations. *Journal of Vibro-engineering* **17** (2015).
64. Schumann, W. & König, H. Über die beobachtung von "atmosphärischen" bei geringsten frequenzen. *Die Naturwissenschaften* **41**, 183-184 (1954).
65. König, H. L., Krueger, A. P., Lang, S. & Sönning, W. *Biologic effects of environmental electromagnetism*. (Springer Science & Business Media, 2012).
66. Pobachenko, S. V., Kolesnik, A. G., Borodin, A. S., Kalyuzhin, V. V. The Contingency of Parameters of Human Encephalograms and Schumann Resonance Electromagnetic Fields Revealed in Monitoring Studies. *Complex Systems Biophysics* **51**, 480-483 (2006).
67. Saroka, K. S. & Persinger, M. A. Quantitative evidence for direct effects between earth-ionosphere Schumann resonances and human cerebral cortical activity. *International Letters of Chemistry, Physics and Astronomy* **20**, 166 (2014).
68. Belov, D. R., Kanunikov, I. E., and Kiselev, B. V. Dependence of human EEG synchronization on the geomagnetic activity on the day of experiment. *Russ Fiziol. Zh Im I M Sechenova* **84**, 761-774 (1998).
69. Southwood, D. Some features of field line resonances in the magnetosphere. *Planetary and Space Science* **22**, 483-491 (1974).
70. Heacock, R. Two subtypes of type Pi micropulsations. *Journal of Geophysical Research* **72**, 3905-3917 (1967).
71. Alfvén, H. *Cosmicalelectrodynamics*. (РиполКлассик, 1963).
72. McPherron, R. L. Magnetic pulsations: their sources and relation to solar wind and geomagnetic activity. *Surveys in Geophysics* **26**, 545-592 (2005).
73. Kleimenova, N. & Kozyreva, O. Daytime quasiperiodic geomagnetic pulsations during the recovery phase of the strong magnetic storm of May 15, 2005. *Geomagnetism and Aeronomy* **47**, 580-587, doi:10.1134/s0016793207050064 (2007).
74. Zenchenko, T., Medvedeva, A., Khorseva, N. & Breus, T. Synchronization of human heart-rate indicators and geomagnetic field variations in the frequency range of 0.5-3.0 mHz. *Izvestiya, Atmospheric and Oceanic Physics* **50**, 736-744 (2014).
75. Subrahmanyam, S., Narayan, P. & Srinivasan, T. Effect of magnetic micropulsations on the biological systems – A bioenvironmental study. *International Journal of Biometeorology* **29**, 293-305, doi:10.1007/bf02189660 (1985).
76. Otsuka, K., Cornelissen, G., Norboo, T., Takasugi, E. & Halberg, F. Chronomics and "Glocal" (Combined Global and Local) Assessment of Human Life. *Progress of Theoretical Physics Supplement* **173**, 134-152 (2008).
77. Dimitrova, S., Stoilova, I. and Cholakov, I. Influence of Local Geomagnetic Storms on Arterial Blood Pressure. *Bioelectromagnetics* **25**, 408-414 (2004).
78. Cornelissen, G., McCraty, R., Atkinson, M. & Halberg, F. in *1st International Workshop of The TsimTsoom Institute*. 26-27.
79. Baule, G. & McFee, R. Detection of the magnetic field of the heart. *American Heart Journal* **55**, 95-96 (1963).
80. Nakaya, Y. Magnetocardiography: a comparison with electrocardiography. *J Cardiogr Suppl* **3**, 31-40 (1984).
81. Steinhoff, U. *et al.* Spatial distribution of cardiac magnetic vector fields acquired from 3120 SQUID positions. *Neuro Clin Neurophysiol* (2004).
82. McCraty, R., Atkinson, M., Tomasino, D., & Bradley, R. T. The coherent heart: Heart-brain interactions, psychophysiological coherence, and the emergence of system-wide order. *Integral Review* **5**, 10-115 (2009).
83. McCraty, R. in *Bioelectromagnetic and Subtle Energy Medicine, Second Edition* (ed Paul J. Rosch) (2015).
84. McCraty, R. in *Bioelectromagnetic Medicine* (eds P J Rosch & M S Markov) 541-562 (Marcel Dekker, 2004).
85. Kemper, K. J. & Shaltout, H. A. Non-verbal communication of compassion: measuring psychophysiological effects. *BMC Complement Altern Med* **11**, 132, doi:10.1186/1472-6882-11-132 (2011).
86. Russek, L. G. & Schwartz, G. E. Interpersonal heart-brain registration and the perception of parental love: A 42 year follow-up of the Harvard Mastery of Stress Study. *Subtle Energies* **5**, 195-208 (1994).
87. Konvalinka, I. *et al.* Synchronized arousal between performers and related spectators in a fire-walking ritual. *Proc Natl Acad Sci U S A* **108**, 8514-8519, doi:10.1073/pnas.1016955108 (2011).
88. Fröhlich, H. Long-range coherence and energy storage

- in biological systems. *International Journal of Quantum Chemistry* **2**, 641-649 (1968).
89. Del Giudice, E., Doglia, S., Milani, M. & Vitiello, G. Electro-magnetic field and spontaneous symmetry breaking in biological matter. *Nuclear Physics B* **275**, 185-199 (1986).
  90. Giudice, E. D., Spinetti, P. R. & Tedeschi, A. Water dynamics at the root of metamorphosis in living organisms. *Water* **2**, 566-586 (2010).
  91. Freeman, W. & Vitiello, G. Brain dynamics, dissipation and spontaneous breakdown of symmetry. *J. Phys. A: Math. Theor* **41**, 304042 (2008).
  92. Popp, F.-A., Chang, J., Herzog, A., Yan, Z. & Yan, Y. Evidence of non-classical (squeezed) light in biological systems. *Physics letters A* **293**, 98-102 (2002).
  93. Brizhik, L. & Eremko, A. Nonlinear model of the origin of endogenous alternating electromagnetic fields and selfregulation of metabolic processes in biosystems. *Electromagnetic biology and medicine* **22**, 31-39 (2003).
  94. Tedeschi, A. Is the living dynamics able to change the properties of water. *Int. J. Des. Nat. Ecodyn* **5**, 60-67 (2010).
  95. Brizhik, L., Del Giudice, E., Jørgensen, S. E., Marchettini, N. & Tiezzi, E. The role of electromagnetic potentials in the evolutionary dynamics of ecosystems. *Ecological Modelling* **220**, 1865-1869 (2009).
  96. Piccardi, G. *The Chemical Basis of Medical Climatology*. (Charles C. Thomas, 1962).
  97. Brizhik, L. S., Del Giudice, E., Tedeschi, A. & Voeikov, V. L. The role of water in the information exchange between the components of an ecosystem *Ecological Modelling* **222**, 2869-2877 (2011).
  98. Montagnier, L. *et al.* Transduction of DNA information through water and electromagnetic waves. *arXiv preprint arXiv:1501.01620* (2014).
  99. Montagnier L, A., J., Del Giudice, E., Lavallee, C, Tedeschi, A., Vitiello, G. DNA waves and water. *Journal of Physics: Conference Series* **306**, 1-10 (2011).
  100. Persinger, M. A. On the possibility of directly accessing every human brain by electromagnetic induction of the fundamental algorithms *Perceptual and Motor Skills* **80**, 791-799 (1995).
  101. Rouleau, N. C., Trevor N.; Persinger, Michael A. . *Journal of Biophysical Chemistry* **5**, 44-53 (2014).
  102. Dotta, B. T., Buckner, C. A., Lafrenie, R. M. & Persinger, M. A. Photon emissions from human brain and cell culture exposed to distally rotating magnetic fields shared by separate light-stimulated brains and cells. *Brain research* **1388**, 77-88 (2011).
  103. Vernadsky, V. I. *The biosphere*. (Springer Science & Business Media, 2012).
  104. De Chardin, P. T. *The phenomenon of man*. (Lulu Press, Inc, 2015).
  105. Sheldrake, R. Mind, Memory, and Archetype Morphic Resonance and the Collective Unconscious. *Psychological Perspectives Part I*, 12 (1997).
  106. Sheldrake, R. *A New Science of Life*. (Tarcher, 1981).
  107. McCraty, R., Childre, D. Coherence: Bridging Personal, Social and Global Health. *Alternative Therapies in Health and Medicine* **16**, 10-24 (2010).
  108. Bradley, R. T. *Charisma and Social Structure: A Study of Love and Power, Wholeness and Transformation*. (Paragon House, 1987).
  109. Bradley, R. T. & Pribram, K. H. Communication and stability in social collectives. *Journal of Social and Evolutionary Systems* **21**, 29-80 (1998).
  110. Laszlo, E. *Science and the Akashic Field: An Integral Theory of Everything*. Rochester, VT: Inner Traditions. *Psychotherapy*. Washington, DC: American Psychological Association (2004).
  111. Lazlo, E. *Consciousness in the Cosmos: Part I – The Third Concept of Consciousness*. *Watkins Mind Body Spirit* (2014).
  112. Bohm, D. & Hiley, B. J. *The Undivided Universe*. (Routledge, 1993).
  113. Tiller, W. A., W E Dibble, J. & Kohane, M. J. *Conscious Acts of Creation: The Emergence of a New Physics*. (Pavior Publishing, 2001).
  114. Stapp, H. P. Attention, intention, and will in quantum physics. *Journal of Consciousness studies* **6**, 143-143 (1999).
  115. Penrose, R. *The Emperor's New Mind: Concerning Computers, Minds, and the Laws of Physics*. (Oxford University Press, 1989).
  116. Saroka, K. S., Persinger, M. A. Quantitative Evidence for Direct Effects Between Earth-Ionosphere Schumann Resonances and Human Cerebral Cortical Activity *International Letters of Chemistry, Physics and Astronomy* **20**, 166-194 (2014).
  117. Scott, M. A. *et al.* Experimental Production of Excess Correlation across the Atlantic Ocean of Right Hemispheric Theta-Gamma Power between Subject Pairs Sharing Circumcerebral Rotating Magnetic Fields (Part I). *Journal of Consciousness Exploration & Research* **6**, 658-684 (2015).
  118. Scott, M. A. *et al.* Experimental Production of Excess Correlation across the Atlantic Ocean of Right Hemispheric Theta-Gamma Power between Subject Pairs Sharing Circumcerebral Rotating Magnetic Fields (Part II). *Journal of Consciousness Exploration & Research* **6**, 685-707 (2015).
  119. Saroka, K. & Persinger, M. A. Quantitative Shifts in the Second Harmonic (12-14 Hz) of the Schumann Resonance

- Are Commensurate With Estimations Of The Sleeping Population: Implications of a Causal Relationship. *Pre Publication copy* (2016).
120. Radin, D. *The Conscious Universe: The Scientific Truth of Psychic Phenomena*. (HarperEdge, 1997).
  121. Scott, M. A. *et al.* Experimental Production of Excess Correlation across the Atlantic Ocean of Right Hemispheric Theta-Gamma Power between Subject Pairs Sharing Circumcerebral Rotating Magnetic Fields (Part I). *Journal of Consciousness Exploration & Research* **6** (2015).
  122. Nelson, R. in *World Forum of Spiritual Culture*. 1-18.
  123. Jain, S. *et al.* Clinical Studies of Biofield Therapies: Summary, Methodological Challenges, and Recommendations. *Global Advances in Health and Medicine* **4**, 58-66 (2015).
  124. Sheldrake, R., McKenna, T. & Abraham, R. *The Evolutionary Mind: Dialogues at the Edge of the Unthinkable*. (Dialogue Press, 1998).
  125. Morris, S. M. Facilitating collective coherence: Group Effects on Heart Rate Variability Coherence and Heart Rhythm Synchronization. *Alternative Therapies in Health and Medicine* **16**, 62-72 (2010).
  126. Hagelin, J. S., Orme-Johnson, D. W., Rainforth, M., Cavanaugh, K., & Alexander, C. N. . Results of the National Demonstration Project to Reduce Violent Crime and Improve Governmental Effectiveness in Washington, D.C. *Social Indicators Research* **47**, 153-201 (1999).
  127. Davies, J. L. Alleviating political violence through enhancing coherence in collective consciousness: Impact assessment analysis of the Lebanon war. *Dissertation Abstracts International* **49**, 2381A (1988).
  128. Orme-Johnson, D. W., Alexander, C. N., Davies, J. L., Chandler, H. M. & Larimore, W. E. International Peace Project in the Middle East THE EFFECTS OF THE MAHARISHI TECHNOLOGY OF THE UNIFIED FIELD *The Journal of Conflict Resolution* **32**, 776-812 (1988).
  129. Bancel, P., Nelson, R. The GCP Event Experiment: Design, Analytical Methods, Results. *Journal of Scientific Exploration* **22**, 309-333 (2008).
  130. Wendt, H. W. Mass emotions apparently affect nominally random quantum processes: interplanetary magnetic field polarity found critical, but how is causal path? , (Halberg Chronobiology Center, University of Minnesota, St. Paul, 2002).
  131. Juden-Kelly, L. M., Dotta, B. T., Vares, D. A. & Persinger, M. A. Demonstration of Excess Correlation in Non-Local Random Number Generators Sharing Circular, Changing Angular Velocity Magnetic Fields. *Journal of Consciousness Exploration & Research* **6** (2015).
  132. McCraty, R. & Zayas, M. Intuitive Intelligence, Self-regulation, and Lifting Consciousness. *Global advances in health and medicine : improving healthcare outcomes worldwide* **3**, 56-65, doi:10.7453/gahmj.2014.013 (2014).
  133. Bradley, R. T., McCraty, R., Atkinson, M., Tomasino., D. Emotion Self-Regulation, Psychophysiological Coherence, and Test Anxiety: Results from an Experiment Using Electrophysiological Measures. *Applied Psychophysiology and Biofeedback* **35**, 261-283 (2010).
  134. Ginsberg, J. P., Berry, M.E., Powell, D.A. Cardiac Coherence and PTSD in Combat Veterans. *Alternative Therapies in Health and Medicine* **16**, 52-60 (2010).
  135. Lloyd, A., Brett, D., Wesnes, K. Coherence Training Improves Cognitive Functions and Behavior In Children with ADHD. *Alternative Therapies in Health and Medicine* **16**, 34-42 (2010).
  136. McCraty, R., Atkinson, M., Lipsenthal, L. & Arguelles, a. L. New Hope for Correctional Officers: An Innovative Program for Reducing Stress and Health Risks. *Appl Psych and Biofeedback* **34**, 251-272, doi:10.1007/s10484-009-9087-0 (2009).
  137. Berkman, L. F. & Syme, S. L. Social networks, host resistance, and mortality: a nine-year follow-up study of Alameda County residents. *Am J Epidemiol* **109**, 186-204 (1979).
  138. Lynch, J. J. *A Cry Unheard: New Insights into the Medical Consequences of Loneliness*. (Bancroft Press, 2000).
  139. Uchino, B. N., Cacioppo, J. T. & Kiecolt-Glaser, J. K. The relationship between social support and physiological processes: a review with emphasis on underlying mechanisms and implications for health. *Psychol Bull* **119**, 488-531 (1996).
  140. Cohen, S., Doyle, W. J., Skoner, D. P., Rabin, B. S. & Gwaltney, J. M., Jr. Social ties and susceptibility to the common cold. *Jama* **277**, 1940-1944 (1997).
  141. Cohen, S. & Syme, S. (Academic Press, Orlando, 1985).
  142. Ornish, D. *Love and Survival: The Scientific Basis for the Healing Power of Intimacy*. (HarperCollins Publishers, 1998).
  143. McCraty, R. *Science of The Heart Vol.2*. Vol. 2 (HeartMath Institute 2016).
  144. Ameling, A. Prayer: an ancient healing practice becomes new again. *Holist Nurs Pract* **14**, 40-48 (2000).
  145. Gillum, F. & Griffith, D. M. Prayer and spiritual practices for health reasons among American adults: the role of race and ethnicity. *J Relig Health* **49**, 283-295.
  146. Schwartz, S. A. & Dossey, L. Nonlocality, intention, and observer effects in healing studies: laying a foundation for the future. *Explore (NY)* **6**, 295-307.

## About HeartMath Institute

HeartMath Institute (HMI) is an innovative nonprofit research and education organization that provides simple, user-friendly mental and emotion self-regulation tools and techniques that people of all ages and cultures can use in the moment to relieve stress and break through to greater levels of personal balance, stability, creativity, intuitive insight and fulfillment.

HMI research has formed the foundation for training programs conducted around the world in many different types of populations, including major corporations, government and social-service agencies, all branches of the Armed Forces, schools and universities, hospitals and a wide range of health-care professionals. The tools and technologies developed at HMI offer hope for new, effective solutions to the many daunting problems that society currently faces, beginning with restoring balance and maximizing the potential within each of us.

### **HeartMath Institute's Mission (HMI)**

The mission of HeartMath Institute is to help people bring their physical, mental and emotional systems into balanced alignment with their heart's intuitive guidance. This unfolds the path for becoming heart-empowered individuals who choose the way of love, which they demonstrate through compassionate care for the well-being of themselves, others and Planet Earth.

# The Science of Interconnectivity

Exploring the Human-Earth Connection



Rollin McCraty, Ph.D. and Annette Deyhle, Ph.D.

**HeartMath<sup>®</sup> Institute**

expanding heart connections

14700 West Park Avenue, Boulder Creek, California 95006

831-338-8500 • [www.heartmath.org](http://www.heartmath.org)