Relationship Between Environment and Human Organism: Theory and Applications

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Introduction

Human beings and their environment represent a dynamic relationship between interconnected complex systems. These systems interact through energetic connections and quantum fields based on the principle of the entanglement, some of which are discussed in this presentation. This is presented on several fractal levels – astrophysical, by introducing the manifestations of Earth-Moon-Sun connections through Schumann resonances, local – by examining the relationship between Schumann resonance and human HRV (Heart Rate Variability), and individual – by assessing the relationship between a group of people and one individual using HRV. A mathematical formalism is introduced for the quantitative evaluation of these relationships. A new universal tool for assessing the complexity of phenomena is presented – the 'Complexity Index', which allows comparison of different physical processes with entirely different dimensions.

1. Schumann resonances

The Schumann resonances (SR) are a set of spectrum peaks in the extremely low frequency portion of the Earth's electromagnetic field spectrum. Schumann resonances are global electromagnetic resonances, generated and excited by lightning discharges in the cavity formed by the Earth's surface and the ionosphere.

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The global electromagnetic resonance phenomenon is named after physicist Winfried Otto Schumann who predicted it mathematically in 1952. Schumann resonances are the principal background in the part of the electromagnetic spectrum from 3 Hz through to 60 Hz and appear as distinct peaks at extremely low frequencies around 7.83 Hz (fundamental), 14.3, 20.8, 27.3, and 33.8 Hz.

Schumann resonances occur because the space between the surface of the Earth and the conductive ionosphere acts as a closed, although variable-sized waveguide. The limited dimensions of the Earth cause this waveguide to act as a resonant cavity for electromagnetic waves in the extremely low frequency band. The cavity is naturally excited by electric currents in lightning.

The GCMS (Global Coherence Monitoring System) is a global network of magnetometers measuring changes in the Earth's magnetic field and monitoring Schumann resonances in the Earth–ionosphere cavity. It helps to study the Earth's magnetic field and ionosphere, examining their response to solar activity and other influences.

The Global Coherence Monitoring Network comprises five magnetometers which are continuously collecting data on Schumann resonance amplitudes at five locations around the globe (the numbers of the stations denote latitude and longitude in degrees): Baisiogala, Lithuania, Eastern Europe (55.638929, 23.722195); Boulder Creek, CA, USA (37.4192, −122.057); Alberta, Northern Canada (53.364561, −113.41565), Hofuf, the eastern region of Saudi Arabia (25.383333, 49.583333); and Northland, on the north island of New Zealand (−38.526368, 175.675718). The magnetometer used in this study has two ANT4 magnetic field detectors (Zonge Engineering Inc., Zonge International, 3322 E. Ft. Lowell Road, Tucson, AZ 85716, USA) which are positioned in north–south and east–west orientations. The signals are digitized with a 24-bit data acquisition system at an average rate of 130 Hz. The spectral power is computed on the east–west component. The same applies for each magnetometer. At each location, two magnetometers are positioned in the north–south and east–west orientations to measure the time-varying magnetic field. The magnetometers have a large bandwidth, yielding a flat response in the range 0.01–300 Hz, but the measurement is performed (according to Nyquist's theorem) only for frequencies up to 65 Hz. The Schumann resonance amplitude data are collected by data-collecting equipment, time-stamped using the Global Positioning System, and sent to a central server.

To complement our analysis, we also investigated the tidal effects caused by the moon. The effects of the Moon on Earth are mostly represented by tidal effects. Measurement of seawater height serves multiple purposes across various scientific disciplines, from oceanography to meteorology. It involves instant measurements contributing to the understanding and calculation of sea level changes, mean, lowest, and highest sea levels, tide amplitude, and phase. Various sensors, including tide gauges, GNSS (Global Navigation Satellite System), and satellite radar altimeters, contribute to global coverage and complement fixed point observations. The international organization The Global Sea Level Observing System (GLOSS), established in 1985, aims to provide standardized sea level data globally. GLOSS comprises around 300 sea level stations from 80 countries, observing large-scale sea level variations with global implications.

As a result of the research presented in this article (Orinaite et al., 2024), we introduced the Schumann Resonance Complexity Index (SRCI). This is a new complexity measure, designed for

the measurement of algebraic complexity in magnetometers within the Global Coherence Network. This result is particularly interesting, as it fundamentally differs from all other measures of magnetic field complexity, such as the Kp index and other indices that globally represent the properties of the Earth's magnetic field.

On further analysis, we observed that the elimination of diel cycles from the SRCI data yields interesting results. It appears that the correlations between different magnetometers are strongly related to the meridian angles: the smaller the difference in absolute values between the meridian angles, the larger the correlation between different magnetometers. No such similarities would be noticed when analyzing the raw magnetic field signals alone. This is the second result of this article, allowing the exploration of connections between different magnetometers.

This similarity immediately gives rise to a series of hypotheses. The first hypothesis suggests that if meridians play a significant role in the similarity between different magnetometers, it should be related to the influence of the Moon. However, since the magnetic field is measured locally at specific geographic locations, our intention was to evaluate the local tidal effects caused by the Moon. Fortunately, the existence of the global network of tidal waves (significantly larger than the global network of magnetometers) makes this task possible. The selection of the tidal wave monitoring station for each individual magnetometer was based on proximity. However, the geographical proximity was not the only important factor - the meridian proximity was taken into consideration because of the raised hypothesis.

Note that we did not directly measure correlations between the SRCI data and the tidal wave data. In principle, the signals are entirely different: the sampling rate of the magnetic field is 130 Hz, whereas tidal waves constitute one measurement per hour. Despite this, we introduce an identical complexity measure for tidal waves: the Tidal Wave Complexity Index (TWCI).

Having two indices, the Schumann Resonance Complexity Index (SRCI) and the Tidal Wave Complexity Index (TWCI), makes it possible to statistically and reliably explore possible connections. The statistical analysis yields truly intriguing results. And though the New Zealand magnetometer falls out of the rule, all the remaining magnetometers appear to be significantly correlated to the tidal effects. Thus, the main result of this article is the demonstration of the fact that the influence of the Moon (usually observed through tidal waves) affects the readings of the local magnetic field data recorded by the global network of magnetometers. Although this is the first demonstration of such an effect, in principle it is not astonishing. It is well known that tidal effects induced by the Moon affect not only water tides but also crustal displacements and the magnetosphere of the Earth. Naturally, one could expect that the same effects will also manifest in the local magnetic field. This study confirms this fact (Orinaite et al., 2024) (Alabdulgader et al., 2018).

2. Physiological synchronization with Schumann resonances

A new analysis technique for the evaluation of the degree of synchronization between the physiological state of a group of people and changes in the Earth's magnetic field based on their cardiac inter-beat intervals was developed and validated. The new analysis method was then used

to identify clusters of similar synchronization patterns in a group of 20 individuals over a two-week period. The algorithm for the identification of slow wave dynamics for every person was constructed in order to determine meaningful interrelationships between the participants and the local magnetic field data. The results support the hypothesis that the slow wave rhythms in heart rate variability can synchronize with changes in local magnetic field data, and that the degree of synchronization is affected by the quality of interpersonal relationships (Timofejeva et al., 2021).

This study developed and validated a novel computational approach using near-optimal chaotic attractor embedding techniques for the identification of physiological synchronization among individual group members' slow wave rhythms in heart rate variability and the degree of synchronization with changes in the local geomagnetic field. This approach allowed us to identify and quantify the degree of geometrical synchronization in time. This new analysis method was utilized to determine the degree of synchronization between locally obtained geomagnetic fields and to identify clusters of similar synchronization patterns in a group of 20 people whose HRV was continuously monitored over a two-week period as they went about their normal day-to-day lives (Timofejeva et al., 2017).

Through comparing the two-day and two-week clusterization results, it can be seen that the two-week data provided better separation of the clusters of participants, i.e., the distances between the constructed clusters are greater. This demonstrates that the longer duration of the experiment positively impacts the ability to identify meaningful clusters of individuals. However, the comparison of the two-day dendrogram with the survey data showcased that a shorter time span of data provides a clearer detection of the changes in the participants' condition. This is because the changes in the participant's condition can average out over a long period of time. Thus, such investigations should be performed over both short and long time periods in order to obtain more complete results.

To the best of our knowledge, this is the first study to incorporate psychological data gathered throughout the experiment in the context of physiological synchronization to other group members and with the Earth's time-varying magnetic fields.

Interestingly, the synchronization between the groups' slow wave dynamics of RR intervals and the variation of the local magnetic field were consistent with the psychological data gathered throughout the experiment. When individual pairs reported more stress in their interpersonal relationships, they were less synchronized. This could imply that both the physiological and psychological variables were influenced by the time-varying magnetic fields in the environment. On the other hand, it may indicate that one's level of stress and emotional state modulates the capacity to synchronize to other group members and the Earth's magnetic field. Either way, this finding suggests that psychological states may be a factor in mediating the level of physiological synchronization between people and with the rhythms in the Earth's magnetic field.

Although the specific details for how geomagnetic fields influence human psychophysiology are not yet fully understood, a potential explanation is through a resonant coupling between the nervous system and field line resonances (Alfvén waves) or standing waves in the Earth-ionosphere resonant cavity (Schumann resonances) that overlap with physiological rhythms. However, a growing body of research strongly suggests that solar and magnetic influences affect

a wide range of human health and behavioral processes with the cardiovascular and nervous systems being the most clearly affected.

Overall, the study demonstrated that the slow wave rhythms in heart rate variability can synchronize with local magnetic field data, and that the degree of synchronization is affected by the quality of interpersonal relationships. When two or more persons respond to some changing environmental factor in a similar way and are emotionally close as measured by an independent metric (such as the survey or a direct comparison of their HRV attractors over time), then their response patterns to the environmental factor are less likely to result from chance (McCraty et al., 2017) (Qammar et al., 2023).

3. Complex synchronization in the healers group

Another aspect of this study is the development of mathematical algorithms capable to register subtle processes of the complexity matching in a group of persons. The aim of the study is to evaluate the complexity matching between the HRV measures of the group of Healers and the Healed during the various stages of the meditation protocol by employing a novel mathematical approach. The complexity matching of heart rate variability is assessed before and during a heart-focused meditation in a close non-contact healing exercise. The experiment was conducted on a group of individuals (eight Healers and one Healee) throughout the various phases of the protocol over a 75-minute period. The HRV signal for the cohort of individuals was recorded using high-resolution HRV recorders with internal clocks for time synchronization. The Hankel transform (H-rank) approach was employed to reconstruct the real-world complex time series in order to measure the algebraic complexity of the heart rate variability and to assess the complexity matching between the reconstructed H-rank of the Healers and healed during the different phases of the protocol. The integration of the embedding attractor technique was used to aid in the visualization of reconstructed H-rank in state space across the various phases. The findings demonstrate the changes in the degree of reconstructed H-rank (between the Healers and the Healed) during the heart-focused meditation healing phase by employing mathematically anticipated and validated algorithms. It is natural and thought-provoking to contemplate the mechanisms causing the complexity of the reconstructed H-rank to come closer to each other; in support of our argument, it can be explicitly stated that the purpose of the study is to communicate a clear idea that the H-rank algorithm is capable of registering subtle changes in the healing process, and that there was no intention of delving deep to uncover the mechanisms involved in the HRV matching.

This experiment revealed complex findings, and further research will be required to better understand the many complex and subtle factors hinted at in the results. The fact that the Healers' and the Healed HRV began portraying similar patterns during the phases of the protocol in which heart-focused healing intentions were being sent to the Healed, which confirms the complexity matching that occurs in interpersonal communication and is capable to reflect the subtle effects of the interaction. This phenomenon, however, raises additional questions about the factors that mediate such effects to occur. For instance, this study cannot establish the processes involved in modulating the closeness of the Healers and Healed reconstructed H-ranks during the healing process. For example, as shown by the attractor figures, the HRV of the Healers and the Healed becomes closer during the phases of the meditation. The question here is what mechanism

generated this closeness; is it happening because of interaction (coming into the same place for both Healers and Healed)? Another question to consider is what happens if the meditation exercise is both guided and controlled. Will the result be the same or different?

These and similar questions serve as definite targets for future research and are beyond the scope of the current study. As previously stated, this study demonstrates and mathematically confirms the fact that complexity matching happens for a group of individuals during a heart-coherence healing exercise. This research study may pave the way for future research on healing methods by providing a validated mathematical approach for assessing HRV which could be employed in a variety of experiments.

Perceiving the subtle, emotional processes involved in human interactions can often be challenging, however, these findings undoubtedly show that relationships are complex, dynamic, and have great potential for better understanding the coordinated activity that occurs in various contexts involving human interactions (Qammar, 2023a).

4. Conclusions

Rhythms of Schumann resonances, heart rate variability, and different physiological parameters are intertwined in complex patterns. Novel computational and algebraic techniques based on the concept of geometric and generalized synchronization enable some insight into those complex processes.

The results presented in the talk (given at the Biological Physics and Meaning Mini Conference 2) show just a small portion of efforts spent in this interesting and fascinating area of complex pattern formation. We are sure that a large number of unexpected discoveries are still waiting to be uncovered by researchers around the world.

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