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Possible negentropic effects observed during energy medicine sessions

Loren Carpenter[a], Helané Wahbeh[a], Garret Yount[a], Arnaud Delorme[a,b], Dean Radin[a,*]

[a] Institute of Noetic Sciences, United States
[b] University of California, San Diego, United States

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ABSTRACT

Introduction: Previously reported experiments suggest that aspects of the physical environment, in particular measures of negentropy (i.e., order) associated with the statistical outputs of truly random number generators, may be affected during periods of focused mental attention. The present study was designed to conceptually replicate those reports during energy medicine sessions.
Method: A custom-built "quantum noise generator" (QNG) was used to continuously record and digitize (at 1 KHz) 16 independent channels of random samples (i.e., noise) produced by electron tunneling and avalanche effects in Zener diodes. One metric was developed to quantify temporal dependencies in the noise samples aggregated across the 16 channels, and a second metric was formed that measured spatial dependencies among the 16 channels. The two metrics were combined into a single "spacetime" variable used to measure fluctuations in entropy during 110 half-hour energy medicine sessions. As a control, the same measure was examined in data recorded eight hours after each energy medicine session took place, when no one was in the laboratory.
Results: QNG data recorded during the half-hour sessions showed significant deviations from chance expectation, with a peak deviation observed at 24 minutes into the half-hour ($z = 4.24$, $p < 0.00003$, two-tail), and with deviations associated with $p < 0.05$ from 20 to 29 min, after correction for multiple comparisons. By comparison, data recorded eight hours after each session showed uniformly null results. This outcome is consistent with previously reported studies, suggesting that during periods of focused attention negentropic deviations emerge in random physical systems. Counterarguments to this interpretation are discussed, as well as recommendations for future studies.

Introduction

The word "energy" in the term *energy medicine* does not refer to energy as it is commonly used by physicists, but rather to a felt sense that therapists describe as energetic-like, magnetic-like, or tingling-like sensations in or around the body. There are experimental and anecdotal reports of physical measures that appear to correlate with these feelings, e.g. electromagnetic and magnetic fields,[1,2] mechanical vibrations,[3] and other less conventional approaches,[4] but so far there is no way to reliably detect when the presumed "energy" is present or absent. In addition, many energy medicine modalities have non-contact variants, where the distance between practitioner and client is considered to be irrelevant.[5–7] These puzzling features of energy medicine are among the principle reasons that it is not considered a mainstream medical therapy, despite clinical evidence suggesting that some of the techniques are efficacious.[8,9] While the full range of possible energetic processes have yet to be explored, there is reason to suspect that the underlying mechanisms may not involve energetic processes at all, at least not those understood at the present time.

As a result of the challenges in understanding energy medicine, it may be fruitful to entertain other concepts by reexamining the assumptions underlying the prevailing scientific worldview, especially the relationship between mind and matter. Science today is based on the doctrine of reductive materialism, which assumes that everything, including mind, emerges from matter (and after Einstein, energy). From that perspective, energy medicine therapies are regarded as dubious partially because of confusions over the meaning of the term "energy," but also because many energy medicine modalities emphasize the importance of the practitioner's focused attention. From a conventional perspective, it is not clear why a practitioner's mind should have any effect on a client's body, especially if that body is remote from the practitioner.

Therefore, it may be worthwhile to entertain a broader perspective that regards materialism as a special case of a more comprehensive worldview, whereby mind and matter are both considered to be fundamental aspects of reality. Within this larger worldview, akin to that of Spinoza's neutral monism, mind and matter are metaphorically like two sides of the same coin. When a mind becomes

* Corresponding author.
E-mail address: deanradin@noetic.org (D. Radin).

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coherently focused, then because of the tight correlation between mind and matter, matter must also move into a more coherent state. While mind-matter correlations can be observed in mundane ways by the effects of meditation on the body, caffeine on the mind, or in general by the neural correlates of consciousness, here we are proposing a connection that transcends the body and extends out to the physical environment.

This idea of an intimate, extended relationship between mind and matter, gives rise to a testable method that may provide clues about the underlying mechanisms of energy medicine. That is, we may ask if periods of focused or coherent mind give rise to corresponding periods of coherence in the physical environment. To detect physical coherence, it is convenient to use a system designed to produce maximum physical entropy (i.e. maximum randomness). The hypothesis then tested is that when mind becomes coherent, order should also emerge in the physical system. Order in this context is the opposite of entropy, thus sometimes referred to as negative entropy, or negentropy for short.

Dozens of previously reported experiments involving small and large groups have investigated this idea. They used electronic devices called random number generators (RNGs) to continuously generate truly random data during healing sessions, meditations, choral groups, global media events, theatrical presentations, group therapies, and so on.[10–17] Overall, these studies provide evidence supporting the mind-matter hypothesis.

RNGs are designed to generate sequences of truly random bits (0 s and 1 s), where the randomness is often based on noise produced by electron tunneling (a quantum process) and/or avalanche effects (a classical process) in Zener diodes. RNGs are designed to ensure that the bit sequences are independent of each other and identically distributed (*iid*). To accomplish *iid*, the bit stream produced by an RNG is often "whitened" by comparing the output against an alternating sequence of 0 s and 1 s through an exclusive-or (XOR) logical gate. The XOR procedure ensures that if there are biases in the distribution or sequence of random bits, or even if the device completely fails, that the mean of the RNG's output will trend toward chance expectation.

The present experiment was conducted during an energy medicine clinical trial consisting of 17 practitioners and 190 participants, as described in more detail in an article in this issue of the journal. A purpose-built RNG was used for this study to see if the act of administering energy medicine would be correlated with negentropic deviations in the output of the RNG.

Hypothesis

The hypothesis was that periods of healing intention applied during energy medicine sessions would correlate with periods of negentropy in the outputs of a random physical system.

Method

Instrumentation

The device built for this experiment was called a QNG, for "quantum noise generator" (see Fig. 1). Instead of converting electronic noise into random bits, like a commercial RNG, the QNG recorded the analog noise produced by a Zener diode. The noise was digitized with 16-bit resolution, sampled at 1 KHz, and stored on a microSD card. Sixteen independent circuits in the device were used to form 16 parallel sources of random data.

The Zener diodes used in each of these circuits were first screened to identify those with measurable levels of each of four types of noise that can appear in these components: (1) Johnson-Nyquist noise, due to thermal effects in electronic components, (2) shot noise, due to fluctuations in electrical current caused by the discreteness of the charge on the electron, (3) avalanche noise, due to the unpredictable movements of a large number of electrons, analogous to how a snow avalanche can be sparked by a single snowflake if it increases the weight of the snow mass beyond a critical threshold, and (4) tunneling noise, a quantum effect due to the wave nature of electrons passing through energy barriers that would block the passage of classical particles. All four sources of noise can be simultaneously present in a Zener diode. To check that this was the case used for the diodes used in the QNG, many diodes were tested and approximately 10% were deemed suitable.

The QNG provided two new features beyond what is available in commercial RNGs. First, because the random output was not turned into bits, nor conditioned or whitened with XOR logic, this allowed for a more detailed analysis of what happened to the noise itself. This kind of analysis is not possible if the only data one has is in the form of a random bit stream, because with such data the underlying source of randomness is hidden. Second, having simultaneous random data from 16 parallel data streams made it possible to develop a "space-time" metric, whereby possible negentropic deviations in space and time could be investigated.

Protocol

The QNG was placed on a lower shelf of a table next to a side wall located inside an $8 \times 8 \times 7.5$ foot electromagnetically shielded chamber (ETS-Lindgren, Series 83, Cedar Park, TX), located in the laboratory of the Institute of Noetic Sciences. This chamber is where all of the energy medicine sessions in this study took place. The QNG was designed to run continuously for one week, saving the generated data from all 16 channels onto a microSD card. The segment of data analyzed for this study was from one hour prior to the start of each half-hour healing session, to one hour afterwards. To provide control data, two-hour segments were similarly extracted from the continuous data stream, but starting eight hours after each healing session. This placed the control data in the evening to early morning hours, when no one was in the laboratory.

Analysis

Two key measures were determined from the QNG data: an autocorrelation metric and a mutual information metric. The former characterized the temporal nature of the noise, and the latter characterized the spatial nature of the noise. Combined, these two measures were used as a metric for assessing hypothesized fluctuations in what might called "entropic space-time." This previously unpublished method was originally developed for use in evaluating QNG data collected informally at the Burning Man festivals in 2014, 2015, and 2016, and during the 2016 Presidential election. The latter result was described briefly in a popular book;[19] the other studies were posted in a report on the website of the Institute of Noetic Sciences.

To determine the autocorrelation metric, first each sample of noise was averaged across the 16 QNG channels, providing a single array of 1,000 average samples (per second). Then that array was linearly detrended, and the Matlab (version R2020b) *xcorr* function was used to form the autocorrelation of the array, ranging from lags 20 to 40 (msec). The resulting autocorrelations were then averaged, and the resulting per-second mean autocorrelation was averaged over 60 seconds to produce a minute-by-minute measure of "temporal coherence" for the QNG output. Under chance expectation, after detrending each noise sample generated by the QNGs, the resulting data should be temporally independent, in which case the autocorrelation metric should be null.

To determine the mutual information metric, all possible pairs of unique correlations among the 16 QNG channels were determined per second (i.e., among arrays of 1000 samples each). Then all of

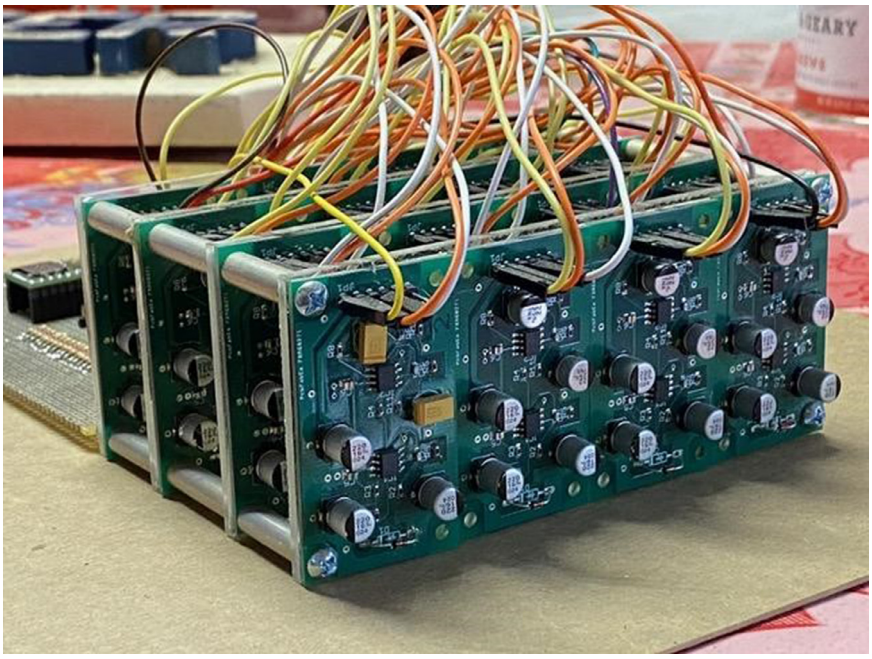

Fig. 1. Sixteen channel Quantum Noise Generator, showing four stacks of four circuits.

those correlations were averaged over 60 s. This formed a minute-by-minute measure of the "spatial coherence" among the 16 channels. Under chance expectation, this measure should also be null.

These temporal and spatial arrays were extracted from the entire database by selecting two-hour segments starting from one hour before the energy medicine session began, to one hour afterwards. The temporal and spatial metrics were uncorrelated (as will be shown), allowing them to be combined into a single, composite measure that metaphorically provided a way to detect a "disturbance in the force," i.e., entropic distortions in time and space. To create this combined value, the space and time arrays associated with each energy medicine healing period were first separately normalized into standard normal deviates (z scores), and then the two measures were combined as a Stouffer Z, i.e., by summing each minute of the two normalized metrics and dividing by $\sqrt{2}$. The final step formed an ensemble Stouffer Z across all of the two-hour segments, where each segment corresponded to a healing session, centered on the moment when each energy medicine session period began.

Results

A total of 17 datafiles of QNG data were recorded, one for each energy medicine practitioner. The microSD card for practitioner #2 did not record properly for unknown reasons, and due to a programming oversight the data for the first 14 practitioners only recorded 1.5 days of data, where the intended design was to record for 7 days. After that deficit was detected and the software revised, the data records for the last three practitioners were complete.

This provided data for 110 of the 190 energy medicine sessions. The results of the ensemble temporal and spatial arrays are shown in Fig. 2 (top), and the combined result for both metrics is shown in Fig. 2 (bottom). Time "0" in Fig. 2 represents the moment when each energy medicine session began. The dotted vertical line at 1800 s indicates the end of the 30-min energy medicine session. The curves range from one hour before each energy medicine session (shown as −3600 s) to one hour afterwards (+3600 s), while the curve itself consists of one point per minute. The peak deviation was observed at 24 min into the half-hour ($z = 4.24$, $p < 0.00003$, two-tail), and deviations associated with $p < 0.05$ (after adjustment for multiple comparisons) were observed from minutes 20 to 29 of the half-hour sessions.

Fig. 3 shows the minute-by-minute correlation between the temporal and spatial arrays (recall that each element in these arrays consisted of 110 samples, with one sample from each healing session), graphed in terms of odds against chance. The figure indicates that none of the correlations were statistically significant, which justifies the combined result shown in Fig. 2 (bottom).

To provide control data for comparison, Figs. 4 and 5 show the same analyses applied to data recorded 8 hours after the start of each energy medicine session. These results indicate that there was nothing inherently biased in the analytical method.

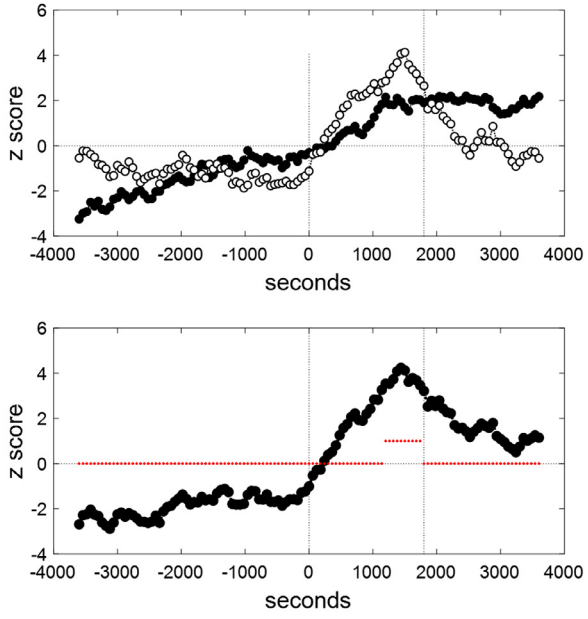

Fig. 2. (Top) Normalized ensemble Stouffer *Z* scores for temporal (white dots) and spatial (black dots) data one hour before to one hour after the start of each of 110 energy medicine sessions. (Bottom). Combined temporal and spatial metrics. The red line notch at $z = 1$ indicates the portion of the array that is statistically significant at $p < 0.05$ (two tailed) after correction for multiple testing using the False Discovery Rate algorithm.[18]

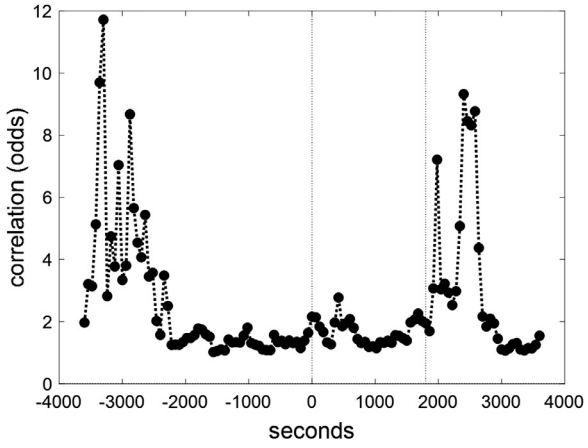

Fig. 3. Odds against chance associated with correlations between the elements of the temporal and spatial arrays. It indicates that there were no statistically significant correlations between these two metrics, supporting the validity of combining the two measures into a single space-time metric, as shown in Fig. 1 (bottom).

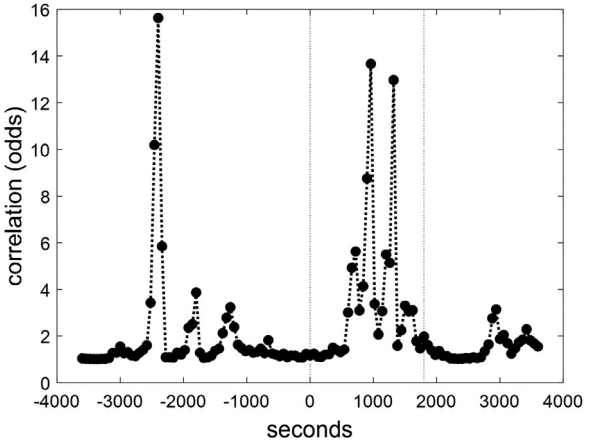

Fig. 5. Odds against chance associated with correlations between the elements of the temporal and spatial arrays shifted 8 h after each energy medicine session. Similar to results shown in Fig. 3, this justifies combining the two measures into a single space-time metric, as shown in Fig. 3 (bottom).

Discussion

The results of this exploratory analysis support the hypothesis that focused intention during energy medicine sessions seems to give rise to negentropic physical effects in the local environment. In the present case, a metric formed from data produced by a QNG indicated the presence of significant deviations from chance in both space and time. The peak deviation occurred 24 min into the 30-min energy medicine session, and deviations significant at $p < 0.05$ (after adjustment for multiple testing) persisted from 20 to 29 min into the session. Results of the same analysis applied to data generated by the same device but collected 8 hours later when no one was in the laboratory, provided uniformly null results.

While the outcome of this experiment seems clear, it should be regarded with caution because by design the noise recorded by the QNG device was not conditioned or whitened to strictly exclude possible environmental influences. This design feature made the QNG output potentially more susceptible to mundane environmental effects than one would expect in an RNG that was designed to exclusively generate random bits. Components in electronic circuits are sensitive to changes in temperature, electromagnetic, and magnetic fields, so it is conceivable that the deviations observed in the present test were actually caused by the body heat of the individuals involved in the healing intention sessions, or by distortions in electromagnetic or magnetic fields within the chamber due to movements of those individuals.

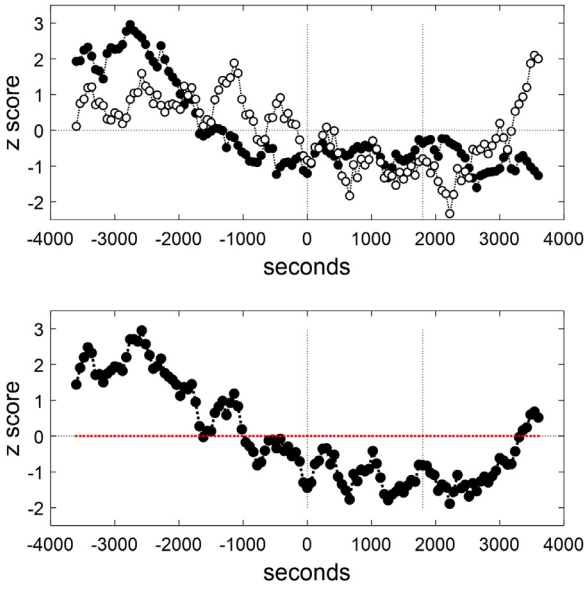

Fig. 4. (Top) Normalized ensemble Stouffer *Z* scores for temporal (white dots) and spatial (black dots) data recorded eight hours after the beginning of each of 110 half-hour energy medicine sessions. (Bottom) Combined temporal and spatial metrics. The red dotted line at $z = 0$ indicates that no portion of the array was statistically significant after correction for multiple testing.

There are two main counterarguments to such mundane explanations. First, if the results were due to rising ambient temperature, then that would not explain why the statistical deviation began to decline after 24 min. That is, the temperature in the chamber would have continued to rise for the full 30 min of the healing intention period, so one might expect the deviation to have continued to rise as well. Second, the results of the present study are in alignment with previously reported experiments that used RNGs specifically designed to be immune from mundane environmental influences.

For future studies using QNG-like devices, to help resolve these questions it would be useful to provide additional channels that generated random bits using the same methods employed in commercial RNGs, or to run separate RNG devices in parallel to QNGs. Having both sources of data available would allow for a closer examination of possible environmental influences. Continuous temperature recordings would also make it possible to quantitatively assess if the space-time metric was influenced by variations in temperature, and if that were the case then temperature could be used as a covariate. In addition, it would be useful to run control sessions that more closely mimicked the energy medicine sessions, with the same number of individuals in the chamber as during healing treatments, but engaged in other tasks that did not require coherently focused attention.

One way to interpret the observed outcome, assuming it represents a genuine mind-matter interaction phenomenon, is by analogy with a well-known feature of Einstein's General Relativity, in which the force of gravity warps spacetime itself. If we speculated that mind resides in a kind of "informational space," then perhaps focused attention acts like a gravitational force that distorts the space it is embedded in. Whether this analogy has any explanatory merit at all will, of course, require much further study. But it might be useful in designing future ways to analyze data generated in these experiments.

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Data repository

Open Science Framework. The raw database is a total of 59 GB, so the data provided in the OSF repository are pre-processed results used to prepare the graphs shown in this article. For further details, please contact the first author.

Declaration of Competing Interest

The authors declare no conflict of interest.

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