

CONSCIOUSNESS, INFORMATION, AND LIVING SYSTEMS

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Abstract - The possibility of a proactive role for consciousness in the establishment of physical reality has been addressed via an extensive 26-year program investigating physical anomalies in human/machine interactions and non-sensory acquisition of information about remote geographical locations. Empirical databases comprising many hundreds of millions of random events confirm that information can be introduced into, or extracted from, otherwise random physical processes solely through the agencies of human intention and subjective resonance. Much of the evidence mitigates the likelihood that the anomalies are manifestations of neo-cortical cognitive activity. Rather, they may be expressions of a deeper information organizing capacity of biological origin that emerges from the uncertainty inherent in the complexity of all living systems.

Key words: Anomalies, biological complexity, complementarity, consciousness, human/machine interactions, intention, PEAR, random event generators (REGs), remote perception, resonance, subjectivity, uncertainty

"THE WIND BLOWETH WHERE IT LISTETH"

The voice of the wind is the whisper of the spirit, the breath of life. It sings to the heart, in a language that the scientific mind is not trained to comprehend. It murmurs in inscrutable enigmas and archetypal symbols, arousing a sense of wonder and a longing for understanding. Science may attempt to measure the physical magnitude and regularity of the wind's velocity, to determine its direction, or to ascertain its implications for tomorrow's weather, but usually fails to hear its sublime harmony or grasp its profound message. On rare occasions, when the analytical mind is still, the heart of the scientist may vaguely sense the wind's mystery, but the challenges of its translation and response seem insurmountable, and so the mind typically dismisses it as unworthy of scholarly attention. Yet, throughout human history, it is this whisper of the spirit that has moved many who have heard it to deep contemplation of their role in the creation of reality.

Although artists have always applied their respective tools to expression of the subjective dimensions of human experience, there is good evidence that long before the establishment of formal scientific methodology, analytical scholars also recognized the essential interplay between the human mind and the mystical basis of mathematics. Socrates' Academy postulated that the road to

understanding the physical world proceeded via self-knowledge, and the early alchemists embraced the *pneuma*, or breath, as the mediating agent between "that which is above" and "that which is below". But over the past several hundred years, as science has become increasingly committed to its objectification of nature, inner experience has been progressively excluded from its purview. Those drawn to explore the role of consciousness in the physical world have been derided as "mystics" and essentially disqualified from membership in the scientific community, and despite the extensive evidence that many of the greatest scientific minds maintained a deep interest in such matters, even their writings on this subject have often been ridiculed or dismissed as eccentric flights of fancy.

Before the dawn of the Information Age in the latter half of the 20th century, there seemed little practical reason for science to concern itself with the function of consciousness in the establishment of physical reality. For several centuries its monumental achievements in comprehending and applying the principles and mechanics of matter and energy had proceeded productively under the premise that subjective experience was at best irrelevant and frequently an obstruction to the practice of rigorous objective quantification. But the emergence of information as a third major scientific currency, along with the development of increasingly sensitive and complex tools for its clarification and deployment, have now introduced questions of how to

accommodate issues of context and meaning, both of which are inherently subjective yet critical aspects of pragmatic information. To complicate matters further, the prospect that information might be subject to the same fungibility that Einstein's famous $E = mc^2$ equivalence captured in the relationship between matter and energy has raised the possibility that such subjective factors not only might be relevant to the perception of physical reality, but actually might be critical components of its essential nature. In particular, the observation of consciousness-related anomalies emerging in the behavior of complex physical or biological systems has provided evidence that the prevailing models of these regimes are inherently incomplete, and must be expanded to accommodate a participatory role for the observing mind.

This paper is an attempt to relate the saga of a small group of unconventional researchers who, from diverse perspectives, have heard the wind's song and accepted its daunting challenge to identify and interpret some of its chords and harmonies, and to render them into conventional scientific parlance. Over the past quarter century, their program has amassed empirical data and assembled coordinated conceptual frameworks in an attempt to create a contemporary "science of the subjective". The platform for this effort has been a modern engineering science laboratory that utilizes equipment and analytical methodologies drawn from conventional information processing technology, wherein increasingly sensitive and delicately poised devices and systems have become the core of its research and practice, and painstaking effort has routinely been deployed to insulate them from environmental artifacts.

Despite the extensive precautions usually taken to protect contemporary information processing equipment from electromagnetic, thermal, acoustical, or cosmic disturbances, very little concern has been given to possible influences associated with the states of mind of its human operators. Late in the 1970s, an undergraduate independent research project brought this possibility to the attention of one of the authors (RJ), an aerospace engineer and applied physicist who at the time was serving as Dean of the School of Engineering and Applied Science of Princeton University. This project had been stimulated by the earlier work of physicist Helmut Schmidt, who had conducted experiments suggesting that devices involving random physical processes could be influenced solely by the subjective intentions of their human operators (34). Recognizing the potential implications of such anomalous effects for the integrity of the burgeoning information technology, the Dean established a modest research program to probe such anomalous human/machine interactions more systematically. Shortly thereafter, the first author (BD), a developmental psychologist with degrees in psychology and the humanities, joined this program as

Laboratory Manager, bringing with her a background in remote perception research (2). The Princeton Engineering Anomalies Research (PEAR) laboratory then found a home in a small suite of basement rooms in the engineering school complex that previously had served as a storage area, where it resides to the present day.

From its inception, the PEAR program has faced an array of pragmatic obstacles that have challenged its implementation and subsequent operations. These have included obtaining the requisite financial and administrative support, confronting the rejection and ridicule of academic colleagues, developing adequate methodological protocols, and determining appropriate analytical strategies for representing and interpreting the anomalous phenomena. Surmounting each of these hurdles has contributed a critical chapter to PEAR's history, but comprehensive depiction of any one of them would require a narrative well beyond the scope of this paper (19). Thus, we will simply pass over the first two issues by noting that all of the program's funding has been derived through generous gifts from visionary philanthropists and foundations; that ongoing administrative and collegial objections have been overcome by periodic invocation of academia's sacred tenet of freedom of inquiry; and that continuing attacks from skeptical colleagues have been deflected by assiduous attention to high scholarly standards, a focus on learning rather than proving, a thick skin, and a sense of humor. More germane to our purpose here is an attempt to summarize the evolution of PEAR's empirical and theoretical progress over the course of its 26-year dialogue with the wind.

CONCEPTS, CONTEXTS, AND CAVEATS

Any investigation of the role of human consciousness in physical reality needs first to define what is meant by the term "consciousness". It is worth recalling that at the time the PEAR program was undertaken, consciousness was rarely recognized as a valid topic for scientific study, even in the field of psychology. Although it has subsequently become more accepted, materialistic premises have led to assumptions that it is merely an epiphenomenon of the human brain function and its associated neurophysiology, and that eventual understanding of these physiological processes will ultimately reveal the mind's structure and function. Consequently, most recent studies of consciousness have been limited to those domains of cognition, sensory perception, language, or other spheres where relatively well-understood relationships between these processes and their associated brain functions prevail. In so doing, the less tangible subjective aspects of experience, such as intuition, emotion, or instinct, have tended to be neglected.

In contrast, PEAR has defined consciousness in a much

broader sense, to subsume all categories of personal experience without presumptions of specific psychological or physiological mechanisms. In this view, it encompasses all dimensions of personal identity, or "self", that can be distinguished from external circumstances and influences that consciousness perceives to be "not-self", with the separation between the two regarded as subjective and situation specific. While this definition is admittedly imprecise, it is also relatively unencumbered by mechanistic assumptions, and leaves room for the self to reveal its experiences on its own terms. Regardless of how one may choose to characterize it, it is generally accepted that what is commonly referred to as "intention" or "volition" is a property of consciousness rather than of the physical world, and PEAR's basic experimental protocols treat this as a primary variable, while objectively specifiable physical parameters are held as constant as possible.

It is also pertinent to clarify our position on scientific methodology. Here, too, we need to soften some of the rigid tenets of contemporary science, such as pure objectivity, deterministic causality, and strict replicability. Rather, we return to the most fundamental premise of the scientific process as originally postulated by Francis Bacon, which we have re-termed, somewhat whimsically, the "scientific two-step" (16). It enjoins that scholarly advancement must move forward on the two feet of "experiment" – an observation or measurement performed under controlled conditions to acquire information about a natural effect or process; and "theory" – a stated model, principle, or formalism to explain, correlate, or predict the observational experience, each constructively informing the other in a productive forward march toward new knowledge. This two-step dynamic of science is, of course, simply a particularly disciplined form of the more common, albeit less deliberate process employed by the conscious human mind in establishing, ordering, and interpreting its personal experiences and forming models thereof.

What is at issue for our PEAR program and similar scholarly enterprises is how broadly one construes the designs of the experiments and theories. In our case, the former comprises two complementary domains of empirical investigation. One is an ensemble of experiments investigating anomalies arising in human/machine interactions, wherein human operators address an array of well-calibrated random physical devices or systems capable of rapidly producing substantial statistical output distributions. The primary variable under study here is the effect of human intention, whereby the operators attempt to shift the means of the output distributions to higher or lower values, or to produce undisturbed baselines, in accordance with pre-stated, pre-recorded, objectives. The second is investigation of a phenomenon we call "remote perception", sometimes referred to as "remote viewing", wherein individuals attempt to acquire information about locations

remote in distance and time that are inaccessible by any known sensory mechanism. Beyond the acquisition of trustworthy bodies of data, the principal goal of these studies is the development of analytical techniques capable of quantifying the amount of information so acquired.

Over the years, both of these categories of empirical investigation have produced huge databases yielding statistically robust evidence of anomalous consciousness-related physical effects that are clearly correlated with subjective factors, and hence cannot be accommodated within any currently recognized model of physical reality. Therefore, the theoretical component of the PEAR program has been an attempt to propose new conceptual frameworks, capable of explicating the anomalous phenomena on fundamental grounds, by accommodating not only the quantitative empirical evidence, but also the more subtle subjective features that appear to prompt their manifestation in the objective domain.

Since our first human/machine and remote perception experiments were essentially replications of prior work by others, e.g. Schmidt's ongoing studies of human/machine anomalies (35), and Puthoff and Targ's investigations of remote viewing (32), they employed protocols that had already been extensively implemented and tested elsewhere. Our program's goals and operational style, however, have evolved to differ sufficiently from those previous studies to require some fundamental changes in their implementation. For example, most former explorations of human/machine anomalies had followed in the tradition of parapsychological research, wherein the variables of interest were dictated by attempts to identify "gifted" individuals or to ascertain the psychological characteristics of successful human participants. Hence, these studies focused either on the ability of a few selected operators to produce large anomalous effects, or required each of a large number of contributing operators to generate small databases. In contrast, PEAR's engineering orientation has addressed itself to the responses of the physical devices when operated by ordinary individuals, all of whom have been anonymous and uncompensated volunteers, and none of whom have claimed extraordinary abilities in this regard. Recognizing that the major factors involved in producing these anomalies are subjective in nature, we have made no assumption that any one operator's experience is likely to be identical to any other's and evidence for "replication" has been sought mainly in the repeated efforts of given individuals. Also, since the "subject" of these experiments has been the behavior of the physical devices, rather than their human operators, no systematic attempts have been made to characterize participants' personalities, belief systems, or subjective strategies, or to monitor their physiological functions. Instead, they have been regarded as colleagues and co-experimenters, whose comments, suggestions, and

anecdotal reports have been respected as valuable contributions to the evolution of the research protocols. Indeed, all members of the PEAR staff have themselves served as operators, thus acquiring first-hand familiarity with the subjective dimensions of the experience. Consistent with this strategy, every effort has been made to create a relaxed and comfortable environment where sessions are scheduled at the convenience of the operators, and are carried out without direct supervision by laboratory staff. This obviously has required strict precautions to preclude any deliberate or inadvertent interference with the integrity of the data, and therefore all experimental hardware, software, and protocols have been implemented with stringent redundant controls and failsafes, and all equipment has been extensively calibrated on an ongoing basis to assure its accurate performance and conformance to theoretical expectations.

In the remote perception experiments as well, modifications have been made to the original protocols. Here again, as in the human/machine experiments, only volunteer participants have been involved, rather than individuals claiming special talents, and no psychological or physiological measurements have been conducted. Participants have been free to select their own subjective strategies with no direct staff supervision, and no training methods have been deployed. At the same time, scrupulous care has been taken to assure that no information exchange has taken place via known sensory channels.

INDICATIONS AND ENIGMAS

The detailed results of these various experiments have been reported in numerous publications and technical reports, most of which are available on-line on the PEAR website <www.princeton.edu/~pear>. Here we shall attempt only rudimentary descriptions and summaries of the most salient findings, emphasizing those aspects that hold some promise of illuminating the ambiguities of the self/non-self dialogue.

Human/machine anomalies

PEAR's most extensive studies have utilized microelectronic random event generators (REGs) (23), wherein operators attempt to shift the means of the output streams of binary samples derived from an electron tunneling noise source. Consistent with the caveats of the previous section, these devices incorporate mechanisms that monitor all essential functions and abort the experiment in the event of any change from their standard operation. Redundant data records are maintained in encrypted computer files, real-time hardcopy printouts, and systematic logbook entries. Device outputs are typically generated in "trials" of 200 binary samples, whose counts are determined by comparison with a regular alternation of 1s and 0s, rather

than by simple counts of all the 1s or all the 0s, thus precluding distortion of the output data by drift of the zero-crossing of the noise pattern due to any environmental disturbances.

The standard protocol requires operators to generate equal numbers of trials under conditions that are identical in every respect save for their pre-stated intentions to produce higher, lower, or baseline mean values of the output count distributions. These intentions may be selected either by operator choice or assigned by a random sequence of computer-generated instructions, but in all cases the number of trials per intention in a given series (the basic experimental unit) is pre-determined, thus precluding any optional stopping. In order to maintain operators' continued interest, participants have been encouraged to explore a number of other secondary parameters, such as the feedback display, manual vs automatic generation of the trial sequences, or the number of trials in a run produced by a single button push. In all cases, however, the selected parameters are recorded before any data are generated and remain constant throughout any given series, and results are evaluated solely on the basis of correlations between operator intention and the terminal scores. The immense databases collected, consisting of many millions of trials, have contained several evident indicators of subtle informational patterns embedded within ostensibly random background noise.

The primary question addressed in the early human/machine experiments was whether anomalous effects could be produced and detected under controlled laboratory conditions, and if so, whether they would display consistent characteristics. Results from our "benchmark" database, comprising some 750,000 trials per intention generated by 91 operators, displayed positive correlations with operator intention that were statistically significant at a level of chance probability less than 10^{-4} , even though the observed effect sizes were quite small, of the order of 10^{-4} bits deviation per bit processed (22). These results were confirmed by a variety of other statistical tests, including a Bayesian evaluation (3) and a multi-factorial analysis of variance (ANOVA) (29). In the latter, none of the secondary experimental parameters made significant overall contributions to the variance, although some proved to be important, but idiosyncratic, determinants in a few of the larger individual operator databases. Thus, the response to our initial question was positive: i.e. the anomalies could indeed be detected quantitatively on a systematic statistical basis in the form of correlations with operator intention, although their small scale would require huge amounts of data to distinguish the subtle signals from the background random noise.

Given the evident need for large individual databases, sustaining operator interest and enthusiasm over such extended periods became an enduring challenge, along with

identification of factors that might enhance the small effect sizes. Considerable effort has been expended over the years to implement more engaging modifications of the standard REG protocol and to construct other experimental systems that could indicate the dependence of the effect sizes on the nature of the random source. Many such devices have been explored, some of which ultimately were discarded because of major difficulties in maintaining adequate environmental controls or the complexities of implementing operator-friendly protocols. One categorically different machine that did achieve full implementation and produced viable databases is a ten-foot high \times six-foot wide random mechanical cascade (RMC) (9). This apparatus drops some 9000 $\frac{3}{4}$ " spheres through a quincunx array of 330 nylon pegs into an array of 19 collecting bins monitored by photoelectric counters, while operators seated on a sofa some six feet away attempt to shift the means of the essentially Gaussian distributions of balls to the right, to the left, or to allow the device to run in an undisturbed baseline condition. Another experiment has employed an attractive linear pendulum with a crystal bob that changes color in accordance with the pendulum's damping rate, while operators alternatively attempt to increase or decrease the damping relative to baseline operation (28). Both of these have yielded statistically significant results of comparable scale to those observed in the REG data. In fact, when the results of thirteen distinct experiments encompassing a variety of random and pseudorandom noise sources, comprising a total of nearly six million trials, are combined in a meta-analysis the overall correlation with operator intention exceeds 7 sigma ($p = 6.5 \times 10^{-11}$) (23). Most of these experiments present strong indications of operator-specific patterns of achievement, particularly for those operators who have produced large individual databases. Several who generated data on more than one experiment frequently produced patterns of effects that were sufficiently consistent across the various devices to be referred to as operator "signatures". In short, these explorations generally confirm the earlier indications of statistically consistent small effects of an operator-specific character that appear to be independent of the nature of the physical source, or indeed of any other objectively specifiable parameters.

A reasonable subsequent question was whether the human/machine anomalies also might appear in remote operation. Accordingly, a protocol was designed whereby operators situated at distant locations could attempt to interact remotely with the REG, RMC, and Pendulum devices, which were programmed to run at pre-arranged times, not necessarily coincident with the operator's effort. These studies have produced results comparable with those generated in the laboratory, including the operator-specific patterns of achievement, indicating that the human/machine anomalies are also space- and time-independent and suggesting that attractive proximate feedback does not

necessarily contribute to the yield (7).

The role of operator feedback also has been explored in another REG-based experiment, termed ArtREG, which utilizes attractive works of art, rather than numerical or graphical displays, as both target and feedback. Operators select two pictures from a library of 24 images, which are then displayed on the computer screen in a superimposed state, with half the pixels initially assigned to each picture. Output from an REG drives the relative proportion of assigned pixels, as operators attempt to make their chosen picture dominate the screen. While most participants have described this experiment as highly enjoyable, the overall results have shown no significant correlations with their pre-stated intentions. The results for the individual pictures, however, have revealed an unanticipated effect of potential relevance. While one or two of the 24 available images might have been expected to produce significant yields simply by chance, six pictures displayed extra-chance results, all of which shared the common feature of religious or archetypal imagery, in contrast to the other pictures of more mundane content (21). One specific variant of this experiment presented operators with a target image based on a specific religious theme, Giotto's painting of "Saint Francis Receiving the Stigmata", competing with a computer-generated graphic. This exploration produced composite results that were well beyond chance, although virtually all of the anomalous effect was attributable to those operators with a Catholic background, to whom the target picture had more deep personal significance (1). Thus, while quantitative cognitive feedback has been shown to be of little consequence in most other REG studies, it appears that feedback having a deeper, more profound level of meaning for the operator potentially could enhance the anomalous results.

Another indication that such anomalies are not driven by superficial cognitive processes has been reported by René Peoc'h, who arranged for newly hatched chicks to imprint on a randomly driven robot (31). When the chicks were separated from their "mother" by being confined in a cage at one end of the robot's range of activity, the robot was observed to spend a significantly disproportionate time in the vicinity of the cage. PEAR's version of this experiment, still in progress, utilizes human operators and an engaging mobile robot with a toy frog "driver". The robot's stochastic trajectory is controlled by an on-board micro-REG, and is monitored by a video recorder that transmits the details of this pattern directly into a computer while operators alternately attempt to induce the device to venture to one side of a circular table or the other, or to affect the length of time it takes to reach the edge of the table. Initial analyses have indicated significant correlations between operator intentions and these performance aspects.

-a) *Replicability.* Traditionally, one of the major obstacles confronted in anomalies research has been the

recalcitrance of the phenomena to systematic replication. The PEAR program has faced its share of this frustration in several of its own studies, and most notably in the course of an attempted large-scale replication of our earlier REG results undertaken in collaboration with research colleagues at the Institut für Grenzgebiete der Psychologie und Psychohygiene (IGPP) in Freiburg, Germany, and the Giessen Anomalies Research Project (GARP) at Justus-Liebig-Universität, Giessen, Germany (20). Each of the three participating laboratories agreed in advance to produce 250 series, each of 3000 trials per intention, using essentially identical REG equipment, protocols, and data analysis procedures. While a number of secondary correlates were also explored, such as feedback type or experimental run length, the agreed-upon primary criterion for an anomalous effect was the magnitude of the high-minus-low data separation. Although these mean separations proceeded in the intended directions at all three laboratories, the scale of the deviations, both individually and collectively, failed by an order of magnitude to attain that of the prior PEAR experiments or to achieve any persuasive level of statistical significance. However, these same data displayed a number of unanticipated interior structural anomalies in such features as a reduction in trial-level standard deviations; irregular series-position patterns; and differential dependencies on the various secondary parameters, to a composite extent well beyond chance expectation, though no such patterns were evident in the calibration data. Such evidence of internal structure in otherwise unpersuasive primary data raises the possibility that the lack of replicability may actually be an inherent characteristic of the phenomena themselves, rather than evidence of failed experimentation, in the sense that the operator influence may express itself in forms of anomalous outputs other than those directly intended. (It is perhaps worth noting that, to varying degrees, experimenters in all three of the participating laboratories expressed a sense of constraint by the standardized protocol that precluded their attention to aspects of more avid personal or professional interest.)

Another failed attempt at inter-laboratory replication involved a double-slit photon detector as a target. In this instance, the initial experiment was conducted by an optical physicist with a somewhat skeptical view of such anomalous phenomena, and produced only chance results. When his device was installed at the PEAR laboratory, however, significant extra-chance results were obtained following the same operational protocol (12). Thus, in both of these investigations it appears that the experimenters' intentions and expectations may have played as important a role in the outcomes as those of the operators. This correlate, usually labeled "experimenter effect", frequently has been noted in conventional psychological studies (33) as well as in anomalies research (38), and conceivably may

be related to the so-called "observer effects" in quantum physics. It follows that any attempts to construct theoretical models that can accommodate subjective factors may be further complicated by the need to take into account those of the experimenters as well as of the participants, and by the options for these to express themselves in output data distortions other than those specifically intended.

-b) *Structural indicators.* The presence of any systematic structural pattern in the data output distributions is tantamount to binary information having been introduced in some anomalous manner. Indications of anomalous distortions other than simple mean shifts prompted a number of *post hoc* examinations of existing PEAR databases to ascertain whether other types of consciousness-induced irregularities might exist elsewhere in our reservoir of results. Some of these were suggested by an impressionistic sense of repetitive patterns that were then addressed quantitatively; others by theoretical hypotheses that prompted empirical tests. In one such exploration, we examined the count populations of the data distribution profiles across a variety of experiments to determine whether the anomalous mean shifts were driven by excesses or deficiencies of counts in the tails of the distribution, of those adjacent to the mean, or via some other regularly distributed configuration. The preponderance of the mean shifts were found to be attributable to remarkably similar fractional count alterations across the full spectrum of count populations, which were not present in the baseline or calibration data (14). The most parsimonious interpretation of such interior patterns is a marginal transposition of the normal chance Gaussian distributions, to an extent consistent with specific incremental changes in their elemental binary probabilities. Hence, in a strictly technical sense, the only difference between the chance expectations and the demonstrated anomalous experimental results is the presence of increased information at the binary level, i.e. a decrease in the overall entropy.

Evaluation of the composite yields in our various experiments has always been complicated by the substantial disparities in the sizes of individual operator databases, which predicate varying degrees of statistical outcomes for intrinsic effect sizes of comparable magnitude. When more balanced sets of data were constructed for such analyses, consisting, for example, of the separate results of the first, second, third, fourth, and fifth and higher series generated by the 21 operators who had produced at least five series each in the diode-based REG experiment, an interesting "serial position" structural effect emerged. Namely, these results displayed statistically significant tendencies for operators to produce the strongest effects in their first series, to fall off in performance in their second and third series, and then to recover to some intermediate levels during their fourth, fifth, and subsequent series (6). Such correlations were present in both the high- and low-intention data, in the

local and remote experiments, in the databases of individual operators, and over a sequence of different experimental protocols, but no similar effects appeared in the baseline or calibration data. Like the count population patterns, these physical effects must be subjective in origin, reflecting some characteristic of the operator's evolving experience, expectation, or attitude, rather than some artifact of machine performance, and are consistent with the so-called "decline effects" reported in parapsychological publications (10). They also bear an intriguing resemblance to the ubiquitous patterns of damped periodic oscillations found in many mechanical and electromagnetic physical systems, in numerous forms of free wave propagation, and in various biological functions, all of which feature an initial maximum signal excursion, followed successively by a reverse phase, a lesser recovery to the initial polarity, and eventual stabilization to some intermediate steady-state value.

Another valuable insight into the nature of these anomalous phenomena was derived from a comprehensive re-assessment of possible gender differences in nine existing databases, five local and four remote, acquired from the REG, RMC, and Pendulum devices. Together, these comprise nearly 20 million experimental data points from 270 individual operators databases, produced by a total of 135 human operators. Since the 140 databases produced by the 62 females were much larger on average than the 130 produced by the 73 males, the results were evaluated solely on the basis of each operator's success or failure in achieving results in the desired directions of effort. While both groups achieved greater success in the high-intention efforts than in the low, the average male results displayed significantly stronger correlations with intention than the females'. A substantial majority of the male operators succeeded in both directions of effort and produced intentional results that were relatively symmetrical in comparison with their empirical baselines. In contrast, most of the females' results were strongly asymmetrical, with low-intention results that were opposite to intention, and their data frequently displayed larger score distribution variances than the males'. Furthermore, while the males' baseline data tended to deviate less from the theoretical mean than would be expected by chance, the females' baselines frequently displayed mean shifts that were well beyond chance values. All these gender disparities were more pronounced in local than in remote experiments, which inherently preclude interactive feedback, and no noticeable gender differences were observed in the two experiments that yielded null overall results (5). The potential implications of the distortions of the baselines, i.e. null-intention data, may be worth considering in the context of a "control" condition for any "objective" scientific enterprise.

–c) *The role of resonance.* Throughout the course of all

these studies, one feature that repeatedly emerged from participants' subjective descriptions of their experiences was language suggestive of some form of wave mechanical resonance. For example, they often spoke of "being on the same wavelength", of "flowing", or of being "in tune" with the machines as playing as important a role in their achievements as their conscious intentions. The distinction between a "wave" vs "particle" nature of these anomalies was addressed empirically via a series of "co-operator" human/machine experiments wherein two operators, each of whom had produced a characteristic pattern of achievement in his or her individual database, generated data cooperatively with a shared intention. If the human/machine interactions were fundamentally "particulate" in nature, the concerted effort of the two operators would be expected to combine with one another in an algebraically additive fashion. If they were "wave-like", the results should display non-linear combinations of the operators' individual capacities. The results of these experiments clearly supported the "wave" hypothesis, with co-operator pairs producing distinctively different, albeit statistically repeatable, patterns that were not simply additive. They also revealed unanticipated gender correlations. Namely, while the overall effect size in these data was larger than that of the single operators' results, this was attributable primarily to the efforts of co-operator pairs of opposite sex whose average effect size was more than twice that generated by the same individuals operating alone, while same-sex pairs tended to produce chance outcomes. Moreover, when the opposite-sex pairs were couples who shared a strong resonant bond, their results achieved an average effect size nearly seven times larger than that produced by those same people as individual operators. In the opposite-sex data, the female-driven asymmetries between high- and low-intention results observed in the various composite databases virtually disappeared and both the high and low cumulative deviation traces were quite consistent in magnitude (4). Thus, not only did these experiments support the wave-like essence of the phenomena, they also corroborated the operators' intuitive feelings that a wave-like resonance with the device was pertinent to the anomalous experience.

Earlier experiments like the Pendulum had attempted to invoke resonance, in the physical sense of the term, in the hope of enhancing effect sizes, to no avail. The co-operator experiments suggested that the importance of this factor may lie in its subjective meaning; but how could one conduct systematic scientific study on such an elusive impressionistic variable? Unlike intention, resonance is not an experience that can be summoned on demand, although it can be recognized when present. Another experiment has been developed that treats resonance, rather than intention, as the primary variable, by deploying portable random event generators in field environments outside the

laboratory. We call this FieldREG (27,30), a term that reflects both the nature of the protocol and the results it has produced, which resemble certain types of physical field effects. Small REG devices connected to a laptop or palmtop computer are placed in venues that have the potential to engender group resonance. Here they run passively in the background, generating continuous sequences of 200-bit trials and a time-stamped index, with no stated direction of effort imposed. These systems have been operated in convocations that are likely to include periods of unusually cohesive interpersonal exchange, creative enthusiasm, or other forms of emotional intensity, such as religious rituals, musical or theatrical events, or meditation groups, as well as in several more mundane venues, such as business or professional meetings. An experimenter notes the onset and ending of periods of interest by pressing a computer key, and maintains a written log of events and subjective impressions of the degree of resonance that seems to be present, but receives no feedback while the FieldREG is running. Data are subsequently examined for correlations between these subjectively identified periods of strong interpersonal resonance and protracted data segments displaying corresponding shifts in the output means. The composite results of over 100 such applications to date display significant deviations during charismatic events, while the traces from mundane applications actually deviate less than chance predictions. Control data, on the other hand, are well within expectation. While we are still far from comprehending the mechanisms responsible for such modulations of REG performance, it appears that under circumstances fostering intense or profound subjective resonance among a group of people, the device outputs can reflect this coherence by introducing slight increases of order into the otherwise stochastic activity of the REG device.

Remote perception

The subtle message of the wind appears to speak more directly in the remote perception phenomenon than in the human/machine interactions, but the task of transcribing its message into a form amenable to quantification is correspondingly more problematic. Our efforts to achieve this transcription have encountered a sequence of obstacles, but ultimately have yielded several useful insights. In the course of developing the various analytical scoring algorithms that constituted the main objective of this component of our program, a substantial database has been accumulated, comprising over 650 formal experimental trials that can be divided into four categories. The target and perception transcripts of the earliest experiments, which were conducted before the development of the analytical judging techniques, were encoded *ex post facto* into a list of binary (yes/no) descriptor responses by independent judges; the next segment comprised a subset of trials encoded *ab*

initio by the participants themselves, using the same descriptor queries. In the third phase the binary questions were replaced by an array of ternary (yes/maybe/no), and then quaternary descriptors (yes/somewhat/unsure/no); and the final subset utilized a list of distributive descriptors based on a nine-point rating scale. In all of these methods, the degree of anomalous information was determined by comparing each percipient's descriptor responses with those of the agent, normalizing these scores via various analytical algorithms, and comparing the distributions of "matched" scores with those of large arrays of scores computed from deliberately mismatched percipient/agent responses calculated via the same algorithms (8).

The combined results of all 653 trials have an overall chance probability of 3×10^{-8} , leaving little doubt that substantial components of anomalous information have been accessed. As in the human/machine experiments, the amount of information acquired in any given trial is typically modest relative to the background noise, but accumulates to statistically significant increments over a large number of trials. Again, no statistical correlations with the distance between the percipient and the physical target are evident, up to separations of several thousand miles, or with the amount of time between the perception effort and that of target visitation, up to plus or minus several days. Likewise, there are no notable correlations with any of the secondary parameters explored, e.g. volitional vs random target selection, target categories and characteristics, diurnal or seasonal aspects, single or multiple percipients, etc. However, a form of "series position effect", akin to that found in the human/machine data, is also evident in the remote perception results. The strongest yield appears in the initial *ex post facto* dataset, with the *ab initio*-encoded binary data also highly significant, albeit of somewhat smaller scale. The quaternary-coded data are only marginally significant, and those of the distributive set are indistinguishable from chance. Numerous attempts have been made to ascertain the possible causes of this gradual diminution of the effects, and these eventually implicated the increasing complexity of the descriptor queries, together with increased participant emphasis on this "filtered" information, rather than on the less constrained free-response process upon which the earlier experiments had been based. Indeed, as the program progressed, the early multi-page free-response transcripts had gradually diminished to a few cursory phrases intended primarily to clarify the descriptor responses (8).

The evolution of the various scoring algorithms has been driven, to a substantial degree, by frequent complaints from participants that they felt too "constrained" by the task of encoding their subjective stream-of-consciousness impressions into arrays of coarse-grained descriptor responses. Yet, attempts to alleviate this discomfort by replacing the initial binary questions with ternary,

quaternary, and eventually nine-point distributive scales did little to relieve this impressionistic discomfort and, indeed, seemed even to increase it. It took many years and considerable analytical effort before it became evident that these "constraints" were not so much a consequence of the descriptor questions, *per se*, as of their premature imposition on the free-response process itself.

All of this forces us to confront the dilemma that while all of these consciousness-related anomalies seem to be driven primarily by subjective factors, any effort to demonstrate, record, and quantify them in a systematic fashion necessarily entails the imposition of objectively specifiable criteria and measurements. Unfortunately, the former appear to be obstructed by the latter, and vice versa, to the extent that we may be subject to a kind of "consciousness uncertainty principle" that inherently limits our ability to specify either aspect with complete precision. Whether this uncertainty derives from the psyches of the human participants or is endemic to the physical character of the information itself is unclear, and possibly irresolvable. A more broadly consequential question is whether such uncertainty may itself be essential for the experience and comprehension of the self/not-self dialogue that characterizes all living systems.

"HOW CAN THESE THINGS BE"?

The imposing array of phenomenological characteristics and irregularities that have emerged from these empirical studies are inconsistent with most canonical precedents, indeed with most rational expectations, and pose major obstacles for accommodation within effective theoretical representations. These include:

- Anomalous informational increments riding on stochastic background noise;
- Primary correlations of objective physical evidence with subjective parameters, most notably, intention, resonance, and uncertainty;
- Data distribution structures consistent with slight alterations in the elemental binary probabilities;
- Statistical independence of the magnitude of the effects on intervening distance and time;
- Irregular replicability, including oscillatory sequential patterns of performance.

Clearly, no direct applications or extrapolations of extant physical, biological, psychological, or informational models can hope to encompass all of these features. Rather, it will be necessary to turn to more radical propositions, wherein the revered concepts of deterministic causation, objectification, quantification, and replication are vastly generalized, and consciousness is allowed a proactive role in the construction of physical reality.

Lacking traditional tools for such a task, we have turned instead to metaphor in our initial attempts to elucidate the

ineffable. For example, we have found that many of the principles and formalisms of quantum mechanics, which itself was driven by a host of empirical anomalous physical effects, can provide useful analogies for representing the experience that emerges from the consciousness/environment information exchange. Following Werner Heisenberg's dictum that "Natural science... is part of the interplay between nature and ourselves; it describes nature as exposed to our method of questioning" (11), we have postulated that since any theoretical model is itself a product of the organizational processes of consciousness as it filters and interprets its experiences of the physical world, it may tell us as much about that process of organization as it tells us about that which is being organized. In an article entitled "On the Quantum Mechanics of Consciousness, with Application to Anomalous Phenomena" (15), we described how the intuitively familiar terms of uncertainty, complementarity, and indistinguishability, or the quantum concepts of wave/particle duality, wave mechanical resonance, and the exchange force that is the basis for molecular bonding, can serve as effective two-way metaphors for symbolic representation of this reflective activity. For example, by representing consciousness as a quantum mechanical wave function, and its environment as an appropriate potential profile, Schrödinger wave mechanics yields eigenfunctions and eigenvalues that can be associated with the cognitive and emotional experiences of that consciousness in that environment. To articulate this metaphor it is necessary to associate certain mathematical aspects of the formalism, such as the coordinate system, the quantum numbers, and even the metric itself, with various impressionistic descriptors of consciousness, such as its intensity, perspective, approach/avoidance reactions, and active/passive dispositions. But with these in hand, certain computational applications display instructive metaphoric relevance to individual and collective experience and, in particular, to our experimental situations and observations. Intangible as these associations may be, they do allow conceptual representation of mind/matter interactions wherein the "anomalous" effects become quite normal expectations of quantum-bonded human/machine and human/human systems.

Another conceptual framework has been described in a publication entitled "A Modular Model of Mind/Matter Manifestations (M^5)" (17), and extended as " M^* : Vector Representation of the Subliminal Seed Regime of M^5 " (13). This model postulates that the anomalous effects do not emerge from direct intercourse between the conscious mind and the tangible physical world, but have their origin in interactions that take place between the depths of the unconscious mind and the intangible substrate of physical events, wherein the Cartesian distinction between mind and matter ultimately loses its functional utility. In this merging domain of pure potentiality, the role of uncertainty takes on

more profound implications for the structure of reality: the cat is neither alive and dead; the physical world consists of neither waves nor particles; the distinction between self and non-self evaporates; statistical odds are undetermined; and information waits to be born. When meaning, emotion, or need drives us to choose one perspective from the many available potential options, the random probabilities that characterize this regime of uncertainty are accordingly altered and reflected in the emergent events and experiences. While these changes in the inherent odds may be miniscule in and of themselves, with a sufficiently large database, or a sufficiently large community of individuals, or organisms, in resonance with each other and with a common purpose, the cumulative impact on the manifest physical and cognitive domains can become significant and measurable. Or, in the words of a traditional Navajo saying: "When you put a thing in order, give it a name, and you are all in accord; it becomes" (37).

This model has been developed further in a recent paper, entitled "Sensors, Filters, and the Source of Reality" (18), wherein we also propose that the common interactions of a personal consciousness with its proximate environment are very limited and relatively superficial aspects of a potentially much vaster creative process, whereby more profound information can be acquired and individual experience can be significantly altered to an extent dependent on the depth and breadth of the interpenetration of the individual mind and its cosmic source. Such interactions are both enabled and restricted by the intervention of an array of physiological, psychological, social, and cultural influences, or "filters", which condition perception, and thereby conscious experience. Since most of these filters function on an unconscious level, however, we seldom invoke interpretations of our experiences other than those consistent with our filtered preconceptions. By bringing these influences to conscious awareness it becomes possible to re-tune these filters and thereby to modify experiential reality to a measurable degree.

INFORMATION, UNCERTAINTY, AND LIVING SYSTEMS

The Chinese character for wind is *feng*, as in the Daoist principle of *feng-shui*, which literally translates as "wind and water" and represents the balance or harmony of opposites in living with nature. *Qi*, the character for breath, or life force, frequently represented in the familiar "yin/yang" symbol, also symbolizes the harmony of complementary processes. It is perhaps no coincidence that Niels Bohr, author of the quantum mechanical complementarity principle, chose this symbol for his personal coat of arms, with the motto "Contraria sunt complementa". The message of the wind seems to be that there is an inherent uncertainty in this balance of opposites,

or complements, which is essential to the dynamics of all living systems. Indeed, it may well be the raw material out of which our anomalous effects are assembled. Radical as this hypothesis may be, it is consistent with our unsuccessful efforts to establish defensible and quantitative indications of information acquired in the remote perception experiments by successive refinements of the analytical techniques, or to improve the creation of informational signals from the background of random noise, i.e. by conscious, objective strategies in our human/machine experiments.

Evidence for the fundamental importance of noise in the generation of information can be found in other, less controversial domains of study. For example, similar departures from canonical expectations appears in contemporary engineering applications of "stochastic resonance", wherein a deliberate increase in the overall level of noise in certain kinds of lasers or sensitive electronic circuits can actually enhance the detection of weak, fluctuating signals (25,26). Yet other studies have demonstrated that the introduction of an element of chaos into certain types of nonlinear processes, such as the interaction of two otherwise independent random oscillators, can stimulate synchronous behavior between the transmitter and the receiver (24,36). In each of these instances, a small component of information or order has been added to a sensitive nonlinear physical system, not by reducing the ambient noise, but by increasing it. Counterintuitive as this concept may initially appear, it touches on some of the inexplicable characteristics of our anomalies findings, such as their inherent irreproducibility. The subjective complaints of "constraint" that we heard in the course of the unsuccessful three-laboratory replication effort or in the refinement of the remote perception descriptor questions may have been attempts by the unconscious to tell us that our efforts to eliminate as much noise as possible by "tightening" the protocols or "sharpening" the focus of the experiments were inappropriate. What we actually should have been doing was introducing additional stochasticity, or at least utilizing that which was already present more effectively.

In a context closer to the field supported by this journal, it is interesting to note that even the accepted model of biological evolution incorporates the need for uncertainty in enhancing subtle informational signals. The processes whereby living species are postulated to adapt to their environment by selecting for specific traits that emerge in the process of random genetic mutation is itself strongly dependent on the generation of a form of biological "noise" emerging from the massive redundancy of continuously recombined genetic information. When the randomness of this process is constrained, as in repeated inbreeding, the short-term advantage of increased predictability of inherited traits may be offset by longer-term weakening of the genetic

strain of the species.

Several hints arising from our studies of consciousness-related physical anomalies suggest that the underlying mechanics of their expression may be more closely related to unconscious biological processes than to those of the cognitive brain. These include the lack of evidence for learning from repeated experience; the ubiquitous series position effects that are clearly associated with unconscious subjective dimensions; the gender-related differences in effects; the susceptibility of null-intention baselines to distortions from chance behavior; the oft-repeated reports from participants that they are most successful when they are not consciously striving to produce results; the apparent effects of interpersonal resonance; and the results achieved by animals.

Of necessity, all living systems straddle the consciousness-imposed divide between the realms of subjective and objective, and thus embody a complementary dynamic of self/not-self in their essential exchanges of information with their environments. Survival of the individual or of the species demands a degree of flexibility in the course of adaptation that is afforded by the intrinsic uncertainty in their interactions with random processes, and may even be enhanced by their exercise of some degree of volition to achieve an optimal outcome. Living systems also embody the rich complexity that makes them capable of self-reference. In so doing, they generate an uncertainty, which, consistent with the implications of Gödel's Theorem, limits the precision with which they can represent themselves. It is interesting to speculate whether the "anomalies" we have observed may be nothing less than a manifestation what of the ancient Chinese called *qi*, or life force, and the ancient Greeks called *pneuma* or breath: the harmony of opposites that is whispered by the wind.

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