Machine-Enhanced Anomalous Cognition

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ABSTRACT: For at least 45 years researchers have studied the statistical properties of electronic true random number generators for signs of anomalous mental phenomena. Research published[1-3] over this period shows no significant increase in Effect Size or degree of mental influence, expressed in terms of a derived Information Rate. Methods are presented for increasing the Information Rate by 1,000 to 10,000 times previous levels by using a type of bias "amplifier" with a statistical efficiency approaching 100%, bringing Machine-Enhanced Anomalous Cognition (Psycho-Responsive™ Technology) into the realm of practical applications.

The development of Psycho-Responsive Technology began in 1992 along the lines of the Princeton Engineering Anomalies Research Laboratory (PEAR)[4]. Cumulative results published in 1987 by PEAR[1] strongly suggested that the conscious intention of a human operator could cause tiny but persistent deviations in the statistics of a true random number generator. The most popular target for these experiments was an electronic binary random number generator, often referred to as a Random Event Generator or REG. The idea was for an operator to intend the generator to produce either excessive ones or zeros as determined by simple statistical analysis of the generated bits.

The biggest limitation of these early experiments was the miniscule measured Effect Size: the fractional number of bits "flipped" either from zero to one or one to zero, depending on the operator's intention. The typical Effect Size was so small that months or even years of repeated trials were often required to accumulate enough data to demonstrate significant statistical results. This made the results difficult to replicate and ultimately unusable for any practical application.

Increasing the Effect Size became the first and primary goal. Only a tremendous increase of hundreds to thousands would allow an effect to be detected within a few seconds: a requirement for any useful technology to emerge. The first naïve attempt was made by boosting the rate at which random bits were generated and measured. This was based on the incorrect assumption that the bias observed was a per-bit bias and the cumulative statistical effect would therefore scale up as the square root of N, where N is the number of bits processed per second[5]. Many previous tests had been done with generators using around 200 bits per second. It seemed reasonable that a 16 Mbps generator would reveal a measurable effect about 283 times faster ($\sqrt{16{,}000{,}000/200}$); perhaps in as little as minutes of testing. Results from testing the relatively high-speed random generator clearly indicated that the direct effect of mind did not occur as a constant per-bit bias: there was no significant change in Effect Size.

This high-speed generator was based on thermal noise, a voltage fluctuation appearing across all resistive elements produced by thermally excited vibrations of the charge

carriers, i.e., electrons. Thermal noise appears to be "perfectly" random because of the Central Limit Theorem. That is, there are so many vibrating electrons contributing to the total electric field or voltage noise on the resistor's terminals that the result is a nearly perfectly Gaussian distributed output. Although there is a quantum mechanical component to thermal noise, this component is limited by the large correlations of the motions of electrons in the partial conductor (resistor).

I conjectured that a purely quantum mechanical noise source might be more susceptible to mental influence. Therefore, two types of generators were constructed and tested. The first was an optical generator that used a beam of polarized photons passing through a polarization beam splitter rotated such that half of the photons exited each of the two output ports. The two output beams were detected by very low-noise PIN silicon photodiodes. Their output currents were subsequently subtracted to remove the equal and opposite DC components, leaving only the sum of the photon shot noise from each diode. This noise was amplified using very low-noise amplifiers and was found to correspond exactly to the theoretical amplitude of pure quantum shot noise over about four orders of magnitude of the input beam intensity. This generator approached quite closely the ideal of a pure quantum noise source.

The photonic generator was tested for responsivity to intended influence, but again there was no significant increase in Effect Size detected. As an additional confirmation, a generator was constructed using variations in nuclear decay times in a 1μCi Americium-241 source. This too was considered to be a predominantly quantum mechanical source, and finally, it also showed no special disposition to be affected by mental intention yielding no increase in Effect Size.

What seemed to be the obvious approaches to increasing Effect Size had all failed, but certain conclusions could be drawn:

1. The exact nature of the random generator does not seem to be a major factor in mind-machine interaction Effect Size, or at least any differences are too small to determine at the level of responsivity of the generators tested.
2. The observed effects are not imparted linearly as a bias on a per-bit basis.
3. Given conclusion number 2, one could further surmise that the mental effect on random generator statistics is a higher-order effect and possibly non-linear.

Further contemplation and study gave rise to the idea that the statistical variations observed as direct mental effects were non-stationary, and included a temporal component correlated with data processing and possibly with operator feedback. This would allow long-term (or high-speed) statistical measurements to converge in the limit to perfectly random expectations, while short-term, synchronized measurements could display significantly non-random behavior. This change in perspective was the key that would eventually crack the seemingly unbreakable Effect Size barrier.

In the light of the foregoing insight the question that immediately arises is: how does one effectively search for unknown patterns or relationships that can occur at unspecified times? This question began a years-long search covering both state- and transition-space

analysis, factor analysis, neural networks, clustering and numerous other approaches. It eventually became clear that the only way to increase Effect Size from a statistical point of view is to selectively reduce the total number of bits in a processed stream while efficiently retaining some characteristic of the remaining bits that represents the results of the mental effect. This is essentially equivalent to increasing the signal-to-noise ratio of what appears to be a random bit sequence. And indeed the unprocessed sequences appear by all statistical tests to be random with information theoretic entropy of 1.0 bits/bit and information content of 0.0 bits/bit.

In 2001 after many fruitless experiments, the tumblers finally clicked into line and the key turned, revealing a seemingly trivial algorithm in retrospect, easily implemented either in hardware or software: a simple data manipulation that approaches 100% efficiency both statistically as well as information theoretically.

The algorithm described in words is: take two consecutive bits from the bit stream to be processed. If the bits are equal, output a single bit of like kind, else no output. That is, if the bits are different, discard them and take the next two bits in the stream to process. In this way the average number of output bits will be one-quarter the number of input bits, while the bias of the output bits will be twice that of the input bits. This process can be repeated on each output bit stream until the final output bits, although few in number, may have an enormous bias. (It must be noted that the baseline statistics of the random bit stream must be extremely good since any bias will be amplified and appear as a constant offset.) This algorithm allows the possibility to respond to higher order patterns since the output bits are irregularly extracted from the input stream. The following functions relate the average output bit rate (br_{out}) and bias (B_{out}) to the average input bit rate (br_{in}) and input bias (B_{in}). Bias, B, is expressed as the fraction of ones to total bits with B ranging from 0 to 1 and 0.5 being the unbiased expectation.

$$B_{out} = \frac{.5B_{in}^{\ 2}}{.5 - B_{in} + B_{in}^{\ 2}} \tag{1}$$

$$\overline{br_{out}} = \overline{br_{in}}(.5 - B_{in} + B_{in}^{\ 2}) \tag{2}$$

Equations 1 and 2 can be rewritten in terms of Effect Size (ES). Effect Size ranges from –1 to +1, where "–1" indicates that 100% of the intended mental effects were misses – opposite the intended result – and "+1" denotes 100% hits, or every bit correlated with the intended result. For practical reasons, only the range of $0 \le ES \le 1$ is of interest. Using the relation

$$ES = 2(B - .5), \tag{3}$$

Equation 1 becomes

$$ES_{out} = \frac{2ES_{in}}{1 + {ES_{in}}^2} \quad (4)$$

and equation 2 becomes

$$\overline{br_{out}} = \overline{br_{in}}(1 + {ES_{in}}^2)/4 . \quad (5)$$

Statistical efficiency may be considered as the ratio of output to input Effect Sizes times the square root of the ratio of output to input bit rates, or

$$Eff_{stat} = 1\Big/\sqrt{1 + {ES_{in}}^2} . \quad (6)$$

By inspection the statistical efficiency is very nearly 100% up to quite large input Effect Sizes. For example, using ES_{in}=0.1, the efficiency is greater than 99.5%. Compare this with the maximum statistical efficiency achievable by simple majority voting. The maximum occurs for majority votes of three bits (the minimum possible) and only reaches a value of $\sqrt{3}/2$ or 86.6%. For large numbers of bits majority voted[6] the efficiency approaches a limit of about 79.79%, providing the ES_{in} is small.

The new Effect Size "amplifier" allowed the construction of the first generations of Psycho-Responsive Devices or PRD's. Unlike the first failed attempts using high-speed generators, the PRD's seemed to produce better results at higher bit rates, or more specifically, larger numbers of bits processed to produce each resultant bit. In fact it was determined later that the performance appeared to increase approximately with the square root of the number of bits processed. This discovery provided a way of predicting the bit rate required to yield a particular performance level.

Now the goal became designing super fast true random number generators. The first effective PRD was actually an array of 64 devices, each containing a 16MHz generator. The data from all the devices was sent via USB to a single computer where it was combined and processed further. This gave an aggregate bit rate of 1.024Gbps. Subsequent PRD generations constantly increased this rate, with individual devices processing 128, 256 and finally 1024Mbps. An array of the 1Gbps devices is still in use for testing, but the latest PRD version can process 1.5Tbps in a single device at a total computation rate of about 4-6 trillion operations per second.

Accurately quantifying the degree of mental effect on PRD's or other devices is an essential step in the development of Psycho-Responsive Technology. Using Effect Size *per se* does not adequately account for a number of variables that occur in experiments and applications development. Therefore, a more fundamental and universal measurement was needed. An appropriate measurement was developed using Shannon Information Theory. The parameter adopted is a form of Information Rate, or the theoretical error-free information transfer rate in bits of usable information per unit of time. For binary data the information rate (R_I) is

$$R_I = br(1-H)\,, \tag{7}$$

where H is Shannon entropy and br is the actual rate at which bits of information are generated. Entropy is defined:

$$H = -\sum_{m=1}^{M} p(m) Log_2 p(m)\,, \tag{8}$$

where M is the number of possible states and p(m) is the probability of m occurring. For this derivation the hit rate, HR, is the probability of making a correct binary prediction;

$$p(1) = HR\,. \tag{9}$$

Therefore,

$$p(0) = 1 - HR\,, \tag{10}$$

and combining equations 8-10;

$$H = -(HRLog_2 HR + (1-HR)Log_2(1-HR))\,. \tag{11}$$

Useful comparisons between various published data and PRD results can be obtained by applying equation 7. Note that equations 7 and 8 can readily be generalized to more complex data types including remote viewing results.

After preliminary analysis of some of the published research results, units of millibits per minute (mbpm) were initially chosen for quantifying binary information rates. A large data set published in the 1987 book, *Margins of Reality: The Role of Consciousness in the Physical World*[1] was selected as a good candidate for establishing a baseline for comparison due to the breadth and duration of the data collection, as well as the reputations of the researchers involved. Page 352 of the book contains a table labeled, 'REG Data Summary by Operator'. This is the data used in the following analysis. Assumptions used in this analysis are that each run consisted of a collection of 200 bits, and that each 200-bit block was produced within a one second interval. The published means were rounded to only two significant digits, so the hit rates were calculated from the z-scores (four significant digits) and the number of bits, N:

$$HR = \frac{z}{2\sqrt{N}} + .5\,, \tag{12}$$

where N=200 times the No. of Trials. A separate result was also calculated for all data excluding Operator 10. The results are shown in Table 1:

Table 1

Source	PK^+	PK^-
All Data	0.5001839	0.4998305
Operator 10	0.5004110	0.4994788
Exc. Op. 10	0.5001236	0.4999250

The PK^+ indicates a positive, or increase intention while PK^- indicates the opposite intention. This data is transformed using equation 7 into information rate and presented in Table 2:

Table 2

Source	R_I^+(mbpm)	R_I^-(mbpm)
All Data	1.17	1.00
Operator 10	5.85	9.41
Exc. Op. 10	0.529	0.195

Note that removing the results of Operator 10 from the averages reduces the information rates by over 90%. The PK^+ and PK^- z-scores are reduced to +1.593 and –0.966 respectively, and the differential z-score, ΔPK, becomes 1.809, with p=.035 one-tailed probability. The adjusted results indicate the degree to which a single operator, number 10, dominates the data set. Finally, this analysis provides a baseline performance level based on a large, multi-year data collection. The average information rates are 0.36 millibits per minute for the typical operator and 7.6 millibits per minute for the best performer (Operator 10).

In contrast to these "baseline" results, the first 1GHz PRD array yielded an average information rate of about 33 mbpm. Over a three-year period the information rate increased almost exponentially over time, reaching a typical value of 4000 mbpm and a peak rate of 60 bits per minute (1 bit per second). This is approximately three orders of magnitude beyond the 1987 baseline levels. Most of the increase was produced by applying the bias amplification algorithm and by subsequent improvements to faster and faster random number generators. However, as the information rate reached a level where significant results could be reached in minutes or even seconds, certain characteristics of processing, testing, operator feedback and other more subtle interactions became observable and even quantifiable. This allowed additional advances to be made; some by a classical engineering approach and some by intuitive leaps of invention. These latter advances led to another significant breakthrough: the Psycho-Responsive Device as a type of quantum computer that is programmed by direct interaction of mind.

A quantum computer may be broadly defined as any device that makes direct use of quantum mechanical phenomena, such as superposition and entanglement, to manipulate data to produce meaningful results. The general method used to test with a PRD is for an operator to intend or visualize the output bits or "Psi bits" from the PRD to match "Target bits" that are produced by a true random number generator *after* the Psi bits are determined. In other words, the Psi bits are predictions of the future Target bits. A true random generator is used to produce target bits because they are truly unknown at the

time the Psi bits are produced, and they are by classical definition "unpredictable" by any means. Testing with a 1Tbps PRD consistently yields predictions with an accuracy of 55-75% at a rate of about 1 bit per second. (65% accuracy or hit rate at 1 bps yields an Information Rate of 4 bits per minute)

Given the PRD test results described above and the assumed unpredictability of the target bits, several hypotheses can be considered:

1) It's all just a mistake; an experimental error due to wishful thinking. This possibility has been reduced to a very low probability through years of careful experimental design and constant testing of all aspects of the hardware, software and interpretation of results. Positive z-scores exceeding 4.0 ($p<.000032$) have been achieved many times in a matter of minutes, while significant negative values are only seen by intentional influence. Hundreds of "no intention" or unobserved baseline tests always conform to normal statistical expectations.
2) Something "spooky" is going on that cannot begin to be explained in the context of known science. While this explanation may be at least partly correct, it is in no way useful and is not consistent with a scientific approach to expanding knowledge and understanding.
3) The observed results are consistent with quantum mechanical properties of entanglement and superposition. The results of the PRD's manipulation of data are output bits that have the property of being partly entangled with the Target bits.

Once a Psi bit is measured, i.e., collapsed or determined to a specific state, something is known about the quantum probability distribution of the corresponding Target bit. The superposition of 1/0 states is no longer equi-probable. This may appear to imply a direction of causality where none need exist. There are theories of retrocausality[7] that propose an effect that moves from the future observation of an outcome to the present wherein the present information is subtly adjusted so as to be consistent with the specific future outcome. These theories would seem to be an unnecessary complication. Moreover, there is no temporal or spatial difference between quantum entangled "objects." Objects is in quotation marks because it is not material objects that are entangled, but rather the underlying quantum waves[8] or probability functions (mathematical abstractions for the sake of our limited understanding) that are entangled. We merely presume physical objects to be entangled because when we make an observation or *measurement*, what is observed or measured is the result of collapsing or determining probabilities of objects into specific physical manifestations of objects.

The views of entanglement presented here are intended to provide a more intuitive explanation for a property that may be counter-intuitive for many readers. It does not represent a formally correct definition, which is beyond the scope of this paper.

For a PRD to compute useful information, not just meaningless deviations from statistical randomness, one must hypothesize that underlying properties of mind are coupled to quantum probability waves. In this way a specific image or relationship clearly focused on and held in mind can affect millions, billions or even trillions of quantum

superpositions of 1's and 0's in the random number generators that feed the processing elements. This property of mind supplies the program for the quantum computer by altering probabilities and establishing the precise entanglement of the quantum elements in the generators so that when superpositions in these elements collapse into specific 1's and 0's that are sent through the PRD, the output bits will have the special properties required to produce the visualized results.

There may be some question to what extent the processing elements participate in the overall quantum nature of the computation. The actual processing may be entirely deterministic after the random generators produce output bits. On the other hand, the processing typically has enormous complexity, is never observed directly, collapses bit streams irreversibly and can produce the same output with astronomical numbers of different internal patterns.

Once it was realized that PRD's behaved as quantum computers, it became possible to design a better PRD because certain theoretical and practical information is known about quantum computers. One crucial point is that quantum computers always produce probabilistic answers. This requires multiple running of the computer and majority voting of the answers to reach an answer with an acceptable probability of being correct. The multiple runs approach will produce the same results as multiple identical computers running the same program simultaneously followed by a majority vote of their outputs. This latter configuration was used to design enhanced hardware PRD's, and was found to be so effective that a version using only 1-2kbps of true entropy produced significant responsivity to mental influence. This approach combined synergistically with a patented[9] technique for producing true random bits at 1-2kbps using hardware already included in standard personal computers. The result was a "Software Device" that can be downloaded or installed from a disk and run on virtually any personal computer. PsiTrainer™ PC is this form of PRD.

In conclusion I have shown that it is possible to tremendously increase the responsivity of objective devices to direct mental influence. I have also shown how to reach information rates 1,000 to10,000 times higher than the baseline rates of previous researchers. Nothing in our current research has indicated any limit on how high the information rate can be made through improvements in hardware, user interfacing and data processing. There seem to be limits on how clearly and for how long a human operator can focus on specific intentions. Whether this will be an ultimate limitation is not obvious at the current level of technological development.

Certain common features have been observed during the many hundreds of testing sessions with PRD Technology:

1) Continuous and concerted focus of intention or visualization is always required. Any lack of attention, drifting or loss of focus will result in greatly reduced or null results.
2) Every new operator, or an experienced operator when significant changes have been made to hardware configuration or processing methods, requires an initial

learning period. Depending on variables such as the amount of prior experience or inherent abilities, results will be null or insignificant for a period of time ranging from a few minutes for highly trained operators to several hours or even days for totally inexperienced operators.

3) After the learning period has passed, every session will follow a pattern of rapid initial rise in Effect Size followed by a peak shortly after the beginning of the session, and then a gradual decline down to some positive basal level substantially lower than the peak. Experienced operators can maintain the basal level longer and at a higher level than newer operators.
4) Persistence, regularity and motivation to train greatly boost the abilities of any operator. These abilities are cumulative over the long term and show persistence in other areas of the operator's life.
5) Certain known conditions of the operator will greatly reduce or nullify mental effects. These include physical discomfort or illness, mental upset or distraction and physical or mental fatigue.
6) There seem to be intangible or environmental factors that can reduce or nullify mental effects, and occasionally increase them for short periods of time. After years of testing with multiple operators it has been noted on a handful of days that no operator at the lab could achieve significant results for most or all of the day. This is quite odd considering the consistent, at-will ability to achieve significant results, even though maximal effort is sometimes required. On the other hand, there have been a couple of days when multiple operators were breaking records for peak results. These observations are essentially anecdotal because no obvious correlation has been found with known factors that might explain them[10].

Some areas for further research and development include: communications, enhanced decision making, medical diagnosis and treatment options, enhanced computing machines, lie detection, enabling the handicapped, locating lost or hidden objects, and increasing correct prediction probabilities for everything from games of "chance" to market moves.

The outcomes of this type of research and development may have a significant impact on theories and concepts concerning the relationship of mind and physical reality. The introduction of practical applications of machine-enhanced anomalous cognition and Psycho-Responsive Technologies in the immediate future could also have a significant economic and social impact.

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