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Consciousness as the Cosmic Ordering Principle and the Interplay of Order and Disorder in the Physical and Biological Systems

Tripathy Asima^{1*} and Pradhan RajatKumar²

^{1*}Post Graduate Department of Zoology and Microbiology, Bhadrak Autonomous College (Department of Higher Education, Govt. of Odisha), Bhadrak, Odisha, India, PIN: 756100, Email: asimatripathy09@gmail.com

²Post Graduate Department of Physics, Bhadrak Autonomous College (Department of Higher Education, Govt. of Odisha), Bhadrak, Odisha, India, PIN: 756100, Email: 2rkPradhan@gmail.com

ABSTRACT

We investigate and discuss the role of the opposing principles of order and Disorder in Physical and Biological systems in ensuring stability, growth and evolution and to bring forth the potential role of the cosmic mind as a universal ordering agency. We analyze its role in decreasing entropy by coarse-graining and hence in determining the initial low entropy state of the big bang universe. Since all physical and biological systems have either cycles of order and disorder alternating, or may have chaotic evolution with non-linear laws, the same is expected of the dynamics of the whole universe as well. The entropy of the initial state of the universe could be low because of the reduction of degrees of freedom (DoF) as one moves from physical encoding to neural encoding and then on to psychic encoding of information in a nested manner by coarse-graining. It is by such encoding that this cosmic agency enables the universe to pass through the big crunch phase and then rolls it out as the big bang universe from the initial state of low entropy.

KEY WORDS: Order, Entropy, Chaos, Evolution, Cosmic Mind, Big bang

***Corresponding author**

Asima Tripathy

Post Graduate Department of Zoology and Microbiology,
Bhadrak Autonomous College (Department of Higher Education, Govt. of Odisha),
Bhadrak, Odisha, India, PIN: 756100,
Email: asimatripathy09@gmail.com

1. INTRODUCTION:

According to Inflationary Big bang cosmology our universe can be considered to have begun in a highly ordered low entropy initial state since it is evolving forward in time and is assumed to be self-contained *i. e.* isolated and hence according to second law of thermodynamics, its entropy can only increase in the forward direction¹⁻³. Reversing the evolution backwards and extrapolating closer to the instant of big bang we infer that the initial state must have been a highly ordered state⁴. The expansion of the universe is isentropic, but there are local density clumping due to gravity, leading to formation of denser structures such as galaxies and stars within them etc. The current entropy of the *observable* universe is largely in the super massive black holes ($\sim 10^{104} k$, $k =$ Boltzmann Constant, and then the next contribution is from the Cosmic Microwave Background Radiation (CMBR) at a uniform temp of 2.7 K filling the whole universe $10^{90} k$, which is almost on par with that due to cosmic neutrinos⁴. The attractive nature of gravity (the Planck regime onwards) makes it play the role of a local ordering agency in our universe. To answer why gravity is attractive or why the universe started out in such a low entropy state, either we have to move along an infinite past regression of causes as in the very speculative string-inspired pre-big-bang scenarios^{5,6} or, we have to settle for a probabilistic emergence of the universe as a quantum fluctuation with a highly improbable fine-tuning for life to emerge in future (as has happened in our pocket universe), which is bound to be anthropic reasoning anyway⁷.

In a hot Big Bang inflationary scenario for the emergence of our universe, as the temperature gradually fell after the initial exponential inflation phase, protons and neutrons formed from Quarks in a soup called Quark-Gluon Plasma (QGP) that was there just after a few milliseconds after the Big bang when the temperature was $\sim 2 \times 10^{12} \text{ K}$ ⁸. Thereafter, nuclei were synthesized in the course of evolution of stars, which were formed in galaxies by the gravitational condensation process. In each of these formations, smaller constituents came together by attractive forces, overcoming whatever repulsive forces that might be there, to form larger wholes and the process continued till the formation of earthlike planets, where biological macro molecules like proteins and nucleic acids could come up and provide the basis for life to manifest.

On the other hand, it is well known that living systems are self-organized complex systems in continuous exchange of matter and energy with the environment and the process of living entails maintenance of its self-organized state which is a state of low entropy by degrading the matter-energy inputs to higher entropy final states. Thus they subsist on not just the matter-energy input but also on their lower entropy. The organism itself is a lower entropy configuration. And the required substances for its sustenance are also necessarily in lower entropy configurations, which implies that

order is fundamental to the manifestation and continuation of life. Biomolecules including the long chained proteins, the DNA and the RNA themselves are all low entropy configuration of their constituents. And to maintain such configurations lower entropy substances are taken in, processed and utilized in such a way that the second law of thermodynamics is not violated⁹⁻¹⁰.

Right from Big-Bang to the formation of living planets with macromolecules providing the basic building blocks for life to thrive, some ordering agency appears to have been at work against the principle of increase of disorder of the second law. From macromolecules to the evolution of living systems and for the continuous evolution of species thereafter, there is the need for an underlying ordering principle that has acted all through against the principle of increase of disorder till now and will also continue to act in future. Living systems are inevitably associated with an astounding amount of order and organization, although disorder in the form of fluctuation, noise and chaos also plays a crucial role in their systematic dynamics¹¹⁻¹².

Kauffman writes:

“Thus I find myself wondering if the web structure of a metabolism may reflect not the contingent consequences of this particular history of life, but some underlying *ordering principles* in biology. Selection, in a kind of selective meta-dynamics and as if by “an invisible hand”, may act on individual members of a species to alter the statistical structure of their fitness landscapes and the richness of their couplings to other partners so as to attain ecosystems poised at the phase transition between order and chaos ”¹³.

Cramer also tried to address the same age-old fundamental questions by analyzing the interplay of order and chaos in living systems *viz.* What is life? How do ideas arise in our brain? Is there a vital force?¹⁴

What is this invisible hand, this ordering principle? What is its nature or structure? Whence it came? And why is it acting against the principle of increase of disorder? What is the purpose of its ordering operations in a physical universe of matter and energy governed by the second law? Why could not the initial highly ordered pre-big bang state of the cosmos be maintained indefinitely, if this ordering principle was present? Is it a conscious ordering agency or a blind law of order like the law of disorder? Is the movement towards greater order as ingrained and as fundamental in the physical universe as the movement towards greater disorder? Are both the local orderings, the gravity-based structure formation in the macro-cosmic scale and the electromagnetism-based living organisms on earth in the microscopic scale, the handiworks of one single cosmic agency?

Some of these questions we will try to address in this work by looking at the interplay of order and disorder in physical and biological systems. But the answers are not yet very clear and need an inevitable integration of biology and physics with psychology and philosophy for a complete

and satisfactory solution to these conundrums in which direction some definite steps have been initiated recently by us ¹⁵⁻¹⁶.

We propose that the evolution of the cosmos and of life and also the evolution of species, are all supported by the operations of the ordering actions of an “ordering agency” as we see a gradual progression of its manifestation in the various stages of evolution, right from the big bang to the planets with macromolecules and from viruses to the human stage ¹⁵⁻¹⁶. This has been sometimes called *dissolvement*¹⁷⁻¹⁸. Movement towards greater order is not natural to physical systems, and as far as it is seen in physical systems, it is either short-lived or accidental or is at best periodically altering with movement towards disorder, as if pitted against the former with equal might. It is only by observing its operations in living systems that we can infer about its nature whether it is the act of an agency or it is just a physical law like the second law.

2. ORDER-DISORDER INTERPLAY

At the human stage intelligence reaches a point where it can observe patterns in space and time and can try to have a complete picture of nature as a meaningful process involving the vast panorama of existence from inanimate things like matter and radiation on to the living creatures like humans themselves. The question is how the current state of nature might have come about as a process in time and from which initial condition it might have started its evolutionary cores. Whether evolution of life was a process of biogenesis preceded by a biogenesis or it was something else which has directed the course of both a biogenesis and biogenesis as a more fundamental cause?

Let us take an example: Upon entering a library, we find the books and journals in a partially ordered condition and our query is to figure out the true initial condition from which it has evolved to that. Clearly two possibilities arise with equal validity-

1. The initial state was a more ordered condition which in course of time has lost the order partially.
2. The initial state was more disordered and at the present moment it has already developed a partial order.

The first possibility (order to disorder) may result from just about any form of interaction other than that with an ordering intelligent agency, while the second one (disorder to order) requires more evolved human-level intelligence that can teleologically work to restore order.

Therefore, it should not be surprising if we ponder whether life must have evolved from nonliving initial conditions or it could be the other way around ^{15,19}.

Emergence of the living from the non-living can be seen to be a local ordering in the globally increasing disorder. While in purely nonliving systems, emergence of any local order is considered purely accidental and short-lived, in living systems there is a goal-directed activity for their

maintenance and also for increase of the order for as long as possible, which we call survival, be it of an individual or of a species or of the entire biota.

If the interplay of order and disorder is seen at all scales of space and time in all systems, when the entire universe is taken as one isolated system which has been evolving from a state of higher order towards a final equilibrium state of maximum disorder, and if order is to be associated with consciousness, should it not be present all along in the course of the evolution of the universe? Recent researches by us have all pointed to the role of consciousness (*i.e.* urge) in evolution of life and of species^{15,16,19-21}.

3. INTERPLAY OF ORDER AND DISORDER IN LIVING SYSTEMS

Biological systems are far-from-equilibrium open systems requiring continuous goal directed interactions with the surroundings to maintain homeostasis. The maintenance and growth of an organism through cell growth and cell division proceeds by such interactions as would guarantee a global validity of the second law of the thermodynamics for entropy increase while locally assuring its decrease. The increase of disorder associated with the maintenance of local order and is achieved through dissipation and hence Prigogine called living systems “dissipative structures”¹⁰.

Individual organisms are driven by their adaptive urges towards evolution into newer forms suitable to the demands of the environment they are placed in. Identical adaptive urges leads to speciation when the species collectively respond to the same demands. This is the mechanism of evolution of species¹⁵⁻¹⁶.

Evolution of species has been classified into five broad categories.

1. **Adaptive Evolution: (Divergent Evolution):** In divergent evolution, a single species undergoes evolution into different species to adapt to different ecological niche.
2. **Convergent Evolution: (Convergence):** In convergent evolution, different species develop analogous traits due to similarity of adaptive pressure in the similar habitats.
3. **Parallel Evolution: (Parallelism):** In parallel evolution, the organisms develop along similar paths though they are separated in space and time but subjected to strong selection pressures.
4. **Progressive Evolution(Evolution):** In progressive evolution, an organism develops from simpler form towards the more complex forms and Biological organization. This is what is meant in general by the term “evolution”.
5. **Retrogressive Evolution: (Devolution):** In retrogressive evolution, the organism reverts backwards to simpler forms from an earlier more evolved complex form in response to selection pressures resulting from various reasons *e.g.* reversal of ecological conditions.

In trying to understand the connection of chaos to living systems, Bird proposes an alternative view and argues for the existence of an ordering principle ²²:

“Evolutionary biology rests on the assumption that although events are fundamentally random, some are selected because they are better adapted than others to their environment...Randomness means not disorder but infinite order. Complexity arises not from many random events of natural selection (although these are not unimportant) but from the "playing out" of chaotic systems— which are best described mathematically. When we properly understand the complex interplay of chaos and life, we will see that many events that appear random are actually the outcome of order.

Evolutionary scientists have even gone so far as to ask: “How does one detect that a system has become organized? For that matter, what does one mean by “organization” in the first place? Where is the “self” in self- organization? ²³”

Not only is the individual organism an ordered self-organizing system but also societies of animals are an effect of the same ordering principle which is universally working alongside the principle of disorder. One can easily list systems having various cycles of emergence and dissipation of order at various scales of spatial and temporal existence.

From all these considerations we are led to propose that consciousness in some form or the other is responsible for ordering processes. Depending on the intensity of manifestation of consciousness, we see a proportional approach to greater order and organization by removing disorder from a system. Cyclicity of order and disorder may then be understood as being a consequence of natural tendency of the material substance to evolve towards maximum disorder working against the ordering activity of consciousness. Thus by such interplay of order and disorder have evolved all the cycles of nature in non-living as well as living systems cutting across all spatial and temporal dimensions.

4. CYCLICITY AND THE POSSIBILITY OF RETROGRESSIVE EVOLUTION

Evolution of species is depicted as a forward progression through branching of the tree of life, but modern biology admits that in some species there has been a retrogression leading to a return to its less evolved predecessor viz. in case of *Herd mania*, there has been retrogressive metamorphosis ²⁴.

Lankester argued as follows ²⁵:

“If evolution occurs for better adaptation to changing environments, what can be the explanation for such retrogression without corresponding reversal of the environmental conditions,

apart from the various cyclic processes? But the fact is that there has been no such exact reversal of environmental conditions ever in history. In our view, it may be a general feature that retrogression in some form or the other is always present simultaneously with evolution in all stages in howsoever imperceptible measures it may be.”

The interplay of order and disorder that is seen in all natural processes as explained in the preceding paragraphs can provide a possible clue to the understanding of retrogressive evolution. The higher branches of evolution representing better adaptation are characterized by more order compared to the lower ones which have comparatively less order. Interplay of order and disorder does bring about cyclic processes with order alternating with disorder in many systems. Thus evolution, considered as a natural process of progression towards higher order and organization must be having similar cycles where evolution alternates with retrogression as seen in *Herd mania*.

After the stage of *Homo sapiens* is reached, consciousness becomes more clearly manifest as the “discerning mind” which is the instrument of higher order compared to the instinctive mind of less evolved species. Thus the discerning mind is highly capable of seeing and enforcing order in nature while the instinctive mind is not as capable. Interplay of disorder-producing instinct and the order-enhancing intellect can lead to such cycles across and within species.

5. EVOLUTION BEYOND THE HUMAN STAGE

True evolution beyond the human stage, therefore, lies in developing a mind with higher order directing the process of thought, feeling and will, rather than having any new morphological endowments or alterations. This is evidenced by the phenomenal growth of systematized knowledge, wherein the ordering ability of higher evolved minds is most prominently manifested. It is due to this particular ability to discern order, recognize patterns in nature, hitherto unknown or unrecognized that we have the vast edifices of science and other allied branches of knowledge. The proposal by Darwin of the theory of evolution itself is the result of the exercise of such ability to see a pattern of temporal progression amongst the millions of species.

Thus if the higher evolved species do not make use of their higher endowments, such as perception and enforcement of more order, they may well be risking a falling backwards towards a lesser evolved stage, wherein such higher abilities will no longer be manifested since it will be a stage of lesser order compared to the previous one. It must be noted that this process of retrogression goes beyond accepted Taxonomic understanding of evolution and may very well occur within the same phenotype since the aspect of order is associated with the manifestation of organizing intelligence. This is precisely the reason why we see evolution of consciousness to different degrees

in different species as well as amongst the members of the same species (more clearly manifest in *homo sapiens*).

We have proposed here a possible mechanism for retrogressive evolution by interplay of order and disorder in which higher order and lesser order manifest in the different stages of evolution, the key point in this analysis being the presence of cycles in all systems where such interplay exists.

The phenomenon of alternation of generations (metagenesis) in ferns, algae and bryophytes vindicates this particular observation that periodicity is a general feature of systems having interplay of order and disorder. Schrödinger even goes on to remark that such *metagenesis* may be visualized to be occurring in case of man and animals and even amongst all subhuman species in the process of gametogenesis wherein haploid reproductive cells meiotically proliferate very fast in the gonads⁹. After fertilization, there is mitotic division only all the way. This has an interesting parallelism with the big bang inflationary cosmology: In the human male for example, the single primordial germ cell that meiotically divides very fast (to about the number of sperms in one ejaculate) is akin to the inflationary phase of the big bang universe. Prior to that there is a long quiescent phase of the primordial germ cell which mimics the quiescent state of pre big bang cosmological scenarios in many models^{5,6}. After the fertilization, mitotic divisions in the zygote are on an average rather much slower compared to the meiotic divisions, which corresponds to the normal slow accelerated expansion of the universe. The existence as primordial germ cell is thus a low entropy state from which starts the journey of life just in the same way as the journey of the universe starts from the low entropy initial state with the big bang.

6. SCALE INVARIANT CHAOTIC EVOLUTION OF THE UNIVERSE

In species interactions the prey-predator interactions predominate across the entire landscape of living organisms and recently it has been generalized to include all kinds of interactions¹⁹⁻²⁰. The primary mathematical model that describes the prey-predator interaction is the Lotka-Volterra model of coupled differential equations for the species populations evolving in time in response to interaction strength, ecological parameters and also the number of other species involved²⁶⁻²⁷. The results show in general an aperiodic alternation of the species populations due to perturbing parameters to the original cyclic periodicities²⁸⁻²⁹.

Recently the Lotka-Volterra type model was applied to the chaotic evolution of the whole universe itself with similar bipartite or tripartite or even 4-way interactions between among dark matter, dark energy, matter and radiation has shown the existence of strange attractor for values of the Equation of State (EoS) parameters for dark energy(*de*), dark matter(*dm*), matter(*m*) and radiation(*r*) in the ranges: $-1 < W_{de} < 0, W_{dm} \geq 0, W_m \geq 0, W_r \geq 0$ with positive Lyapunov exponent

showing the chaotic evolution of the densities³⁰. Note that the EoS parameter connects the pressure with the density of the interacting species. The universe in this scenario does not repeat itself but oscillates. Self-similarity in scale invariant way being a part of chaotic dynamics, it can explain the emergence of similar patterns of time evolution in systems across various scales.

Chaotic evolution in purely physical systems and purely biological systems are quite well known. But when applied to the whole cosmos with its components such as dark energy etc. in mutual competition, it can govern similar dynamical evolution from micro- to macro- dimensions. When the period of the cycles is extended to include all abiotic as well as biotic evolution under one scheme of chaotic evolution, it can be visualized that the current state of evolution may have proceeded from a previous era of cosmic involution, where consciousness had regressively withdrawn itself into its deep slumber in inorganic matter-energy³¹⁻³². That is to say, the whole process of evolution is nothing but a successively more potent manifestation of the unmanifest with consciousness as the constant background, which is present all along in the history of the cosmos. The cosmic blue print for such a manifestation can be assumed to be in the cosmic mind¹⁵.

7. COARSE-GRAINING OF INFORMATION AND SECOND LAW

While we have tried to argue in our recent works for the existence and operations of a cosmic mind for the evolution of life and of species, the same in the context of the genesis and evolution of the cosmos itself has to be established¹⁵⁻¹⁶. The role of the conscious observer in quantum theory, Relativity and quantum field theory have been dealt with employing a dualistic viewpoint³³⁻⁴⁰. In all these works the ubiquitous cosmic mind or universal consciousness somehow makes its presence apparent both in the mathematical and conceptual sense. As an all-pervading presence that makes possible rise of knowledge in an individual observer, this cosmic consciousness can also be attributed to be the conscious ordering principle in the evolution of the cosmos itself.

Rise of definite knowledge itself is an act of bringing order in the psyche that was, prior to measurement, having a larger entropy due to lack of information, and it is consciousness that does it³³⁻⁴⁰. Consciousness alone can bring order in a universe moving towards ever greater disorder and entropy. It being beyond matter-energy and hence beyond space-time, can easily be a transcendental presence working continuously even across the big bangs and big crunches of a pocket universe and of the whole multiverse. Its time-transcending non-local, simultaneous, causal-teleological action seems anthropic to us, who are bound by the time's arrow in an expanding universe³⁷⁻³⁹.

In a meta-evolutionary sense, it has to be anthropic because all the evolutionary urges of all individuals was stored in the cosmic mind and they are to manifest along with their respective objects for satisfying those urges¹⁵⁻¹⁶. According to the stored data in the cosmic mind, the structure

of the universe gradually manifests in its details with time cycle after cycle of the universe. Storage of data in the psychic domain is achieved with coarse-grained architecture leading to huge decrease in entropy⁴¹. The data are arranged into different compartments like drive/folder/file/data in artificial intelligence systems such as computers. The psychic operations are such that the entropy at the level of drives (drive entropy) will depend on the number of drives only and not on the (fine-grained) entropy of contents of each drive. Similarly, at successively greater levels of details, the information unfolds as the universe evolves according to them. Similar series of entropy compression in nested compartments occurs in the universal consciousness: cosmic mind/collective mind/local species mind/individual mind/experiences (data). This is the cosmic blue print or software which we can call *subtle-ware*. This can at once explain the extraordinarily low entropy of our universe at the big bang, since the details were not there in the beginning. Coarse-grained entropy always increases with time and this, in a way explains the existence second law in our universe^{42,43}.

As the *subtle-ware* runs, the details gradually unfold and manifest at different levels up to the rise of individual minds in the field of universal consciousness. This differentiation can be assumed to happen at the Planck era, where space-time and fields (matter-energy) are undifferentiated and each Planckian element is fundamentally indestructible. Each such element then evolved further to have one associated individual unit of consciousness tethered to it, which was earlier undifferentiated from other individual units, since at that pre-Planckian stage all were in a condensed pure BEC state, assuming the fundamental Planckian DOF to have been bosonic. This is therefore a initial state of lowest entropy.

The separation of the mind (subtle information field) from the energy (Gross quantum fields in curved space-time) thus appears at the Planck era, which can be visualized as the first-ever spontaneous symmetry breaking in the history of the universe⁴⁴. Thereafter, with exponential inflation the GUT field (quanta) and gravity (space-time) become separated and with time, further spontaneous breaking of symmetry separated the QCD fields from the electroweak and then on, the morphic (electromagnetic) field separated, and through it, finally the various forms of individuals and the objects manifest. The galaxies and stars and planets all form only after the morphic (em) field separates. The morphic (em) field is finally necessary for imparting form to the individuals and their objects of experience. The whole process all along was unfolded and guided by the information contained in the cosmic mind, which is the totality of all subjects and the *subtle-ware* of their experiences¹⁵.

The information about the entire physical universe encoded in its myriad objects ($\sim 10^{122}$ bits) is perceived by an individual, and is thus compressed into a set of corresponding neural correlates of that individual brain involving much less number of DoF (neural network states with $N \leq 10^{11}$

neurons) and hence with lesser entropy⁴. Thus the Physical entropy is much reduced when translated into neural entropy of an individual. Brain. This neural entropy reduces further when it is gradually epigenetically encoded into the DNA of the experiencing individual with just about ~ 20000 protein-coding genes or at best with ~10⁶ genes, non-coding sector included. It becomes almost one-to-one, if we count the number of base pairs in the diploid human genome which comes to ~6.469 × 10⁹ base pairs as the basic DoF. The coding of experiences occurs via epigenetic marks^[16,45]. This genetic entropy is much larger than the entropy of the same information encoded in the individual psyche with still less number of DoF, psychic experiential states which can be counted to be at best within, may be, only a few tens of qualia, as we move to the next level of coarse-graining in terms of them (qualia) (such as color and sound etc).

It thus seems quite possible that entropy can be reduced by putting all information in a particular drive/folder as degenerate (and hence equivalent to glossing over their internal differences) and then computing it for only the drives or the folders at their level. The entropy of the universe was so low at big bang because of such degenerate encoding or coarse-graining at the psychic level in the cosmic mind that had no difference in individuals and objects which all degenerately inherited in it at the big bang. In fact even zero (or nearly zero) psychic and physical entropy for the universe at the big bang is also possible in this picture as an extreme case of the universe being in a pure quantum mechanical state⁴⁶.

It has recently been shown by us that in states of greater concentration there is a decrease of neural recruitment and thus the neural DoF employed are less in number in states of intense concentration leading to elongation of subjective time⁴⁷. It is pertinent to ask whether the reduced entropy of the initial state of the universe is associated with such concentrated state of the cosmic mind, as if meditating, before the beginning of “creation”!

8. CONCLUSION

We have reviewed the interplay of order and disorder in the dynamical evolution of physical and biological systems and have extended it to the whole universe. It turns out that there is a decrease of entropy due to use of levels of coding of information in a nested hierarchy: from Physical to Neural to genetic to Psychic. Such encoding of information leads to the reduction of DoF utilized and hence of reduction of entropy as we move to a purely psychic encoding in the cosmic mind. Note that the total information stored remains fixed but at different levels, the information is put in different drives and folders and files and thus reduction of entropy occurs at different levels depending on the degrees of freedom.

The experiences of an individual are stored in his neural memory, in his genes, in his individual psyche, in the collective psyche and also in the cosmic mind simultaneously. At successively broader levels of coding the entropy becomes progressively lower and lower and as it unfolds after the big bang it keeps producing the entropies by decoding at successively grosser levels till it gets to the state of material objects. This is the explanation for the increasing entropy and the basis of second law in our pocket universe.

The ideas proposed here need to be further strengthened by subsequent interdisciplinary researchs in physics and biology. A thorough going investigation of the role of the mind in the genesis and evolution of the universe is yet to be done with the seriousness it deserves. In the days ahead, it is expected to gain more and more attention of researchers as psychology gets integrated with biology through neurology and physics.

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