

BIOPHOTONIC ROUTE FOR UNDERSTANDING MIND, BRAIN AND THE WORLD

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ABSTRACT: Man is endowed with brain and mind for comprehending reality of the world. Brain is material entity and is observable, while mind is a non-physical conceived entity. Scientific investigations enhance our knowledge of the functioning of brain and its constituents. They indicate mind-brain association but do not rule out the possibility, in which mind is a property of brain. The perceived reality of the world has both objective and subjective components. The objective components are attributed to brain either alone or in association with mind. The subjective components are considered to be the creations of mind but they appear to contain grains of reality. Attempts made to separate these grains have succeeded partially. One hopes for complete success only after the incorporation of a few missing ingredients. It is our contention that the missing ingredients are human being as an entangled quantum entity - photon field, quantum entity's capability to read information from photon fields of other humans and from its own field reflected by the environment. The evidence for the first ingredient is provided by the analysis of spontaneously emitted visible range photon signals by human beings. The other two ingredients put usual charge- photon interaction in proper context. The experimental results relevant to mind- brain interface are briefly described. A few minutes' time series of small portion of these signals determines their nine properties, which establish quantum nature of signal, and specify quantum state of the dominant component to be squeezed state. Six properties differ in signals emitted at 12 anatomical sites of the same person. Profile of a property for a person is the set of its values at 12 sites. Profile is very informative and can discriminate persons with differing holistic features. Cluster analysis offers procedures for measuring qualitative holistic features e.g. procedure for measuring 'meditativeness' of a person. The incorporation of other two ingredients chalks out a route for answering the question who we are?

KEYWORDS: Biophoton; Entangled state; Non-perturbative ground state; Meditativeness; Consciousness

1 Need of a biophotonic route: It is universally believed that mental acts, such as perception, sensation, response, anticipation and speculation are acts of human mind arising from the processing of data, collected by various sense organs from the world over a period of time, in the brain. The belief makes two implicit assumptions of

far reaching consequences, separate identity of mind, brain and the world, and time ordering of their roles in mental acts. Their identities have never been established. Mind and brain are human specific and humans are parts of the world. The arena of operation of mind is made up of thoughts and experiences but we do not know how they arise. The mechanisms of their formation are essential for understanding mind. On examining our thoughts and experiences, we notice that they pertain to different aspects of the world. Let us, concentrate on experiences emanating from measurable aspects of the world and hope that such experience may be amenable to scientific exploration. The experience pertaining to a single aspect or feature of the world may be called primitive experience. The primitive experience of a feature is different in different human beings and it is noticed while sharing experiences. The sharing also brings out commonality in the experiences. The Venn diagram of experiences will have a common region and many differing regions. Common region implies reality of the feature and differing regions imply varying errors in mapping by different persons leading to experience of the feature. The two implications most likely nudged human beings to develop objective procedure for measuring the feature and to discover sources of error in human mappings. Many such nudging helped to evolve the widely used metaphor of a faulty detector for human being and outcomes of detection for experiences. Its position is further strengthened by deconstructing the functioning of human detector in to basic steps and then exploring them. The basic steps are: 1. capturing of data from the world, 2. processing of data (captured and accumulated from past experiences), 3. integrating, rationalizing and converting results of processing into experience, and 4. storing relevant data and experiences for future use. Each step is explored separately and their stage of exploration is preliminary, intermediate or advanced. It is preliminary if supervenience of step on material contents has not been established, intermediate if supervenience has been established but consensus in a model or mechanism for the step has not been reached, and in advanced stage if supervenience has been established and consensus has been achieved. The material contents needed for supervenience of every step are material parts and constituents of human body. The exploration of third step has not moved beyond the preliminary stage, perhaps because of some missing ingredients or incorrect approach. The exploration of first step has reached advanced stage; human sense organs capture bulk of the data and there is consensus about the mechanisms of capturing and transferring data by sense organs but a few discrepancies persist. The exploration of other two steps is in intermediate stage; there is consensus about supervenience and the needed material contents reside in a localized region called brain but knowledge of their functioning is rudimentary obtained from various

imaging techniques that map the firing of neurons in the brain. The time resolution of imaging techniques is around 20s, which is too long to map swift experiences and thoughts. The knowledge from the correlation between neuronal activities and experiences is gained using extrapolation and implicit assumptions. Still, it brings out the involvement of brain in all basic steps e.g. data flow through sense organs is subject to neuronal control and different experiences are associated with firing of neurons at different locations. Brain perhaps, takes part also in activities not reducible to or beyond the basic steps. These explorations have validated the metaphor of human detector, localized brain in a small spatial region and brought out the inability of classical framework in understanding third step dealing with mind-brain interface. The inability triggered investigations for identifying missing ingredients and new approaches. No tangible missing ingredient has been found in the classical frame work and various investigations in the framework usually identify incomprehensible aspects and garb them with spirituality or other similar concepts. Search for new approaches led to the quantum framework that appears promising and, in which supervenience of mind- brain interface appears in sight.¹ Perhaps, mind brain interface is a quantum phenomenon, so that mind and brain are either interconnected and function like two cohering constituents of a composite quantum system or two concurrent aspects of one quantum system. In both possibility, the questions of ordering and cause and effect relation in events involving the two are not legitimate and answerable. Brain is a quantum system in both possibilities, so that its quantum signatures and relevant parameters for its description in the quantum framework need to be searched. Direct experimentation with brain is difficult and hence, we should look for indirect quantum signatures. We argued that brain cannot be a quantum system in isolation but should be in association with some other quantum parts, perhaps the whole quantum body. The detection of quantum signatures in other parts or in whole body may be easier. It is indeed the case. The whole body turns out to a quantum system and in vivo detection of its quantum signatures and of its all parts is easier. They are hidden in visible range photons incessantly emitted by every part.

2. Spontaneously emitted human (bio) photon signals: Visible range photon signals of nearly unchanging and ultra-weak intensity are emitted spontaneously by all living systems. The signals are enigmatic in the classical framework² and only quantum framework can describe them. Procedures have been perfected for extracting holistic properties of signals. The holistic properties of a signal

¹ Stapp Henry P.(2009): "Mind, Matter and Quantum Mechanics" (Book, Springer-Verlag, Berlin, Heidelberg).

² Bajpai R.P. "Special Issue -Symposium in Print on Biophotons and Alternative Therapies". In: R.P. Bajpai (Guest Editor), (2008): Indian Journal of Experimental Biology, 46, 259-432.

contain quantum signatures and relevant biological information of its emitter³. The prefix 'bio' is added to photon for emphasizing enigmatic nature in the classical framework and bio-relevance. The phenomenon, emitted photons and emitted signal are called biophoton emission, biophotons, and biophoton signal. Every portion of live human skin emits photons (rather biophotons) and signals emitted from 33 anatomical sites spread over the entire human body have been measured.⁴ Human being is the most studied system and we have much more information of its various holistic features than any other biological system. It is very suitable for understanding physical significance of biophoton signals.

The unchanging average intensity of a (bio) photon signal allows its study of its finer details by analyzing the digitized time series of a small portion of signal. The time series contains the results of counting photons in contiguous bins or intervals of definite size in the portion. The photons detected in bins fluctuate and fluctuations contain finer details. They are determined from statistical moments and photon count distribution of the time series. The two most informative statistical moments are mean and variance. Mean determines intensity or strength of signal. Variance determines the error in measuring the strength in the classical framework arising from measuring protocol and detector but is an additional feature of the signal in the quantum framework. It depends on number of elements in the time series and bin size of time series. Element dependence is removed by normalizing variance with mean. The normalized mean is called Fano Factor. Bin size dependence is removed by determining the parameters of Fano Factor curve depicting Fano Factor as a function of bin size of the same signal. The time series for different bin sizes of a signal are obtained by aggregating the results in integral number of contiguous bins in the measured time series. Fano Factor curve is reasonably specified in biophoton signals by its intercept and slope and they are two properties of signal.⁵ Photon count distribution of time series determines six properties, four squeezed state parameters,⁶

³ Bajpai R.P. (2009): "Biophoton Emissions: A clue to unravel the mystery of "Life"?" In *Bioluminescence in Focus- A collection of Illuminating Essays*(Ed. Meyer-Rochow V. B., Research Signpost, Trivandrum, India) 357-385.

⁴ Van Wijk Roeland, Kobayashi Masaki and van Wijk Eduard P. A (2006): "Anatomic characterization of human ultra-weak photon emission with a moveable photomultiplier and CCD imaging", *Journal of Photochemistry and Photobiology B: Biology*, 83, 69-76.

⁵ Bajpai Rajendra P., Van Wijk Eduard P.A., Van Wijk Roeland, van der Greef Jan (2013): "Attributes characterizing spontaneous ultra-weak photon signals of human subjects", *Journal of Photochemistry and Photobiology B: Biology* 129, 6-16.

⁶ Squeezed and coherent states are quantum states of electromagnetic field. They are minimum uncertainty and closest to classical harmonic wave field. The expectation value of field in these states can be depicted by thick lined harmonic wave, whose thickness is same everywhere in coherent states but

squeezed state index (SSI) and sum of the squares of residuals (SSR) in estimation with 50ms time series. Photon count distribution could determine these properties only in some photon signals including human (bio) photon signals. The nine properties in different portions of a human biophoton signal have nearly same values; they are holistic properties of the entire signal. The four squeezed parameters specify a quantum squeezed state of photons and their determination proves quantum nature of signal. Small positive value of SSR and a value far from 0 of SSI indicate that only dominant component of signal is in quantum squeezed state and the signal has a small peripheral component not in squeezed state. All nine properties were determined in more than 2000 human biophoton signals. The three squeezed state parameters were $r=2.72 \cdot 10^{-10}$, $\theta=101.91^\circ$ and $\phi=69.53^\circ$ in all signals. We call these values as universal values. The values of remaining six properties differed in signals from different anatomical sites of same person and in signals of different persons at same site. The six properties were site specific and seemed to vary with various holistic features e.g. mood, psychological condition and physiological state. The variability opens up the possibility of determining conversion tables between biophotonic properties and holistic features and thereby, measuring holistic features, hitherto considered qualitative.

We found that SSI is a sensitive indicator of health. It was greater in the range (0.8-1) in signals of healthy persons but was less than 0.8 in signals of persons with any physical or mental affliction and abnormality. We monitored its value in signals from both sides of two hands of a patient of multiple sclerosis under treatment for nearly one year.⁷ The treatment was shining different colored LED's for a few minutes at specific sites according to a prescribed scheme. The patient responded to treatment and the response was reflected by SSI. It was <0.5 just before the treatment and became nearly 1 immediately after the treatment. The recovery was temporary; the patient relapsed to sick state and SSI to <0.5 . The duration of relief increased from a few days to a few months in the course of one year. Since multiple sclerosis is considered to arise from malfunctioning of brain, the monitoring showed that SSI reflects some aspects of brain functioning and these aspects are influenced by shining

variable in squeezed states. The word squeezed originated from the depiction of states in phase space. Classical field occupies a point, quantum field in a coherent state, a circle and quantum field in a squeezed state, an ellipse. Circle and ellipse have same area, so ellipse is a squeezed circle. All coherent and squeezed states are connected with each other and with ground state of free photons by known unitary transformations, which makes all properties of these states calculable. Each of these states is also the non-perturbative ground state of an interacting photon-matter system.

⁷ Bajpai R.P. and Drexel M. (2008): "Effect of Colorpuncture on Spontaneous Photon Emission in a Subject Suffering from Multiple Sclerosis", *J Acupuncture Meridian Studies*, 1, 114-120.

light at few points. SSI was found to be sensitive to the influence of Shiatsu and a few other healing techniques involving only remote mental interaction.⁸ The healing by a healer was monitored in four persons through SSI. SSI did not change with healing in signals of three healthy persons with signals' SSI>0.8 but signal's changed to nearly 1 in one person with SSI <0.8. SSI was also found to be sensitive to local affliction. One finger of a person got burnt and the person came forward to measure SSI of all fingers. SSI was around 0.5 in the signal from the burnt finger and greater than 0.8 in signals of other fingers. SSI was measured in signals from both knees of a person with one defective knee. It was greater than 0.8 in the signal from the good knee but less than 0.5 in signal from the defective knee.

The other five properties of a biophoton signals could not measure holistic features but the variation of every property in signals over the human body could. We used^[5] the variation of property for measuring meditateness of a person. We used biophoton signals measured at 12 sites (right side of abdomen, left side of abdomen, solar plexus, heart chakra, throat, right cheek, left cheek, forehead, palm side of right hand, dorsal side of right hand, palm side of left hand and dorsal side of left) in sixty persons by the group led by Roeland van Wijk and determined the properties of all 720 signals. The persons were in three groups of twenty and the groups were identified by the meditation practice of members; the persons practiced transcendental meditation in TM group, a form of meditation other than transcendental in OM group and did not practice any meditation in NO group at least for 10 years prior to measurements. The values of a property in signals at 12 sites of a person constituted the profile of property for the person. The profile was depicted by a point in 12 dimensional space. Cluster analysis was used for determining the number of clusters and their members from the distribution of sixty points. The analysis minimized distances of members in a cluster with their cluster mean and maximized the distances among clusters means. We performed sixteen analyses, six with single property profiles and five with profiles of two or more properties. Five analyses found two clusters, eight found three clusters and three found four clusters. The analyses finding two clusters placed persons of TM and OM groups in one cluster and persons of NO group in other. The placement was correct in two analyses and nearly correct in three analyses. The latter analyses correctly placed 49 persons but some of them placed one person of TM group, seven persons of OM group and three persons of No group incorrectly. Finding of two clusters implied that five profiles sensed a holistic property connected with meditation

⁸ Sun Mengmeng, van Wijk Eduard, Yuan Beibei, Dusseldorp Elise, Bajpai Rajendra Prasad, van Wijk Roel, van Wietmarschen Herman, Wang Mei, Thomas Hankemeier, van der Greef Jan(2015): "Ultra-weak photon emission as non-invasive system diagnostic tool for detecting early stages of diabetes type II : Towards personalized medicine". To be published.

practice. We may call it ‘meditativeness’. Meditativeness of persons in two clusters were in two bands- upper band contained the values of meditating persons (TM and OM groups) and lower band of non-meditating persons. The incorrect placements suggested that meditativeness was at the lower end of upper band in one person of TM group and seven persons of OM group and at upper end of lower band in three persons of NO group. The detecting capability of meditativeness was better in remaining six analyses. They resolved the difference between meditativeness of persons in TM and OM groups and identified three bands with the ordering TM>OM>NO. One analysis (slope and intercept of Fano Factor curve) placed all persons in correct bands but others placed some persons incorrectly. Two analyses (signal strength and slope of Fano Factor curve) split NO band in two clusters and one analysis (SSR) split OM band in two clusters; they indicated finer details of meditativeness. The quantification of meditativeness of each person is a matter of detail but it achievable. We have arranged all sixty persons in order of their meditativeness from the distance with cluster means in different analyses but did not publish it for obvious reason. We also studied the effect of reducing the number of sites in profile from 12 up to 1. Cluster structure changed marginally up to 4 sites but drastically afterward. Similar cluster analyses with 4 site profile in another set of 50 pre-diabetic persons exhibiting Qi- Yin deficiency of differing severity, could measure the severity of Qi-Yin deficiency^[8]. The analysis of the combined data of two sets showed that meditativeness and severity of Qi-Yin deficiency are positive and negative sides of a common scale.

3. Biophotonic route: Only one property-signal strength- could be determined in spontaneously emitted human photon signals in the classical framework and it had no physical significance. In contrast, nine properties were determined in the quantum frame and profile of every property over the body contained information about holistic features of emitting person. The information will be deciphered and put to use. The very existence of these properties has grave implications and potentiality to resolve many conundrum encountered in building a theory of mind, brain and life. Some major implications are elaborated below:

Existence of quantum entity: Nine properties of a signal determined from the time series of its small portion in implies statistical time coherence in photon emission and statistical coherence is a characteristic feature of quantum nature of signal. Four of these properties specify a quantum squeezed state and thereby removes all doubts that core component of signal is in this state. The presence of a weak peripheral component is inferred from the observation that SSR contains information about holistic features of the person. Slope and intercept of Fano Factor also support two

components of the signal. A quantum photon signal can emanate only from a material quantum system. These inferences are valid in photon signals from 12 sites, so that photon field in the neighborhood of 12 sites is 12 different squeezed states with three common parameters. The overall quantum photon field has therefore, spatial structure relative to and specific to human body. The spatial structure relative to human body suggests that the photon field is coupled to human body. An obvious explanation for the stability and squeezed quantum state of photon field is that quantum photon field is one partner of entangled matter- photon interacting system in non-perturbative ground state of the system. The entangled matter part has to also be in a quantum state. We suggest the name quantum entity for the matter part, which is probably the entire human body or at least its constituents implicated in and associated with spontaneous photon emission. Howard Pattee has been advocating the existence of a quantum entity in living system for more than fifty years. Our arguments and results provide direct evidence of his proposal.

Physical basis of 'life': The entanglement of quantum entity and photon field demands that all holistic properties of the quantum entity are isomorphic to properties of the entangled photon field. The entanglement removes a basic philosophical argument that forbids physical basis of 'life'. The argument is that two physical systems cannot differ in one property alone and there has to be another property that is isomorphic in all aspects to all aspects of the first property. Since a living system was supposed to differ from the non-living counterpart in only one property 'life', it could not be a physical system. Entanglement solves this problem by claiming that 'life' is a property of the matter part of photon- matter system and 'life' is isomorphic to some properties of photon field. This is, perhaps, the reason for our failure to understand the mystery of 'life' in terms of human body and its constituents only.

Two copies of information about all aspects of 'life': 'Life' is a holistic property and has many aspects e.g. firing of neuron, movement of muscles, respiration, consciousness, etc. Its every aspect has to be isomorphic to some properties of entangled photon field. Being non-living, all properties photon field are, in principle, measurable. Hence, every aspect of 'life' is measurable. We need to find combination of photon properties isomorphic to each aspect and their connecting table. It has not been accomplished so far because of the inadequacy of technology to determine various properties of quantum photon field. But this did not forbid some human beings or living systems to have such capability. If some persons have this capability for an aspect and they have also learnt conversion table, say, by hit and trial then they will have the capability of remotely sensing that aspect. Perhaps, mind reading, clairvoyance and other similar phenomena emanate from this capability.

Many ways of managing some aspects of 'life': Different aspects make 'life' an umbrella concept and probably, a bunch of states of the quantum entity are associated with its different aspects. Quantum entity can switch among these states because of external interventions. Bacteria and viruses causing illness are example of malevolent intervention while various therapies are examples of benevolent intervention. Any change in the state of quantum entity has to be accompanied by a corresponding change in the state of photon field. The reverse is also true and any change in the state of entangled photon field should be accompanied by the corresponding change in the state of the quantum entity. The capability to alter state of entangled photon field opens an alternative way of managing health and diseases. Perhaps, meditation practices, acupuncture and many other alternative therapies try to alter photon field. If it is so, then the optimum method of managing diseases and ill health will be person specific and a combination of methods that alter quantum entity and photon field.

Stability and self-reflection: The emergence of non-perturbative ground state signals spontaneous breaking of symmetry. It confers stable structures to both partners and makes their constituents function coherently. The stability of quantum entity is very remarkable and quantum entity can withstand drastic onslaughts like chopping or decapitating of few parts. One possible explanation is that quantum entity is a composite structure of loosely associated parts capable of maintain their integrity in many autonomous acts and yet functioning coherently. The entangled photon field should also have loosely associated components capable of acting autonomously. Some or all components of photon field may get partially reflected by the environment and return back to the quantum entity. The reflected field will have information of environment and of quantum entity. The quantum entity may become privy to information of self and environment by detecting reflected field. It is a novel possibility that allows self-appraisal and mid-course correction.

Quantum channel of communication: The emergence of non-perturbative ground state requires critical density and distribution of constituents and temperature. The matter constituents in the entangled state retain the ability to interact with external photon fields including entangled photon fields of other quantum entities. The interaction does not require external photon field to be concentrated along classical paths of sense organs. The interaction may lead to resonance linking between two or more quantum entities under certain conditions. Perhaps, healers try to establish resonance with subjects during a healing session. Resonance linking allows quantum entities to instantly access each other's quantum field. The above two scenario are example of sensing through all-pervading quantum channel. Its use depends on the ability to assign meaning to sensed signals. We speculate a possible scenario. A human child,

perhaps, has innate capability to detect quantum photon field entering its body through quantum channel and also the photon field entering through classical paths. Initially, the child senses both types of signals but does not know their meaning. Meaning is a cultural concept taught by family and society. The teaching is restricted to signals travelling through classical paths only. The child starts regarding signals received from quantum channel as noise to be ignored and not to be noticed. Occasionally, a child accidentally learn the meaning of quantum signals, say, by hit and trial. The child then becomes privy to information inaccessible to normal children.

Quantum measurement and spirituality: Quantum measurement and quantum system are often invoked for understanding mind-brain relationship and then consequences of quantum measurement are explored but a little uneasiness remain because the system receives information through classical sense channels and processes it using classical computations. The uneasiness is considerably reduced if entangled quantum entity makes measurements on quantum photon signals arriving from quantum channel. Its entangled quantum photon field extends far and wide and may also detect matter present in much bigger region. Both partners can legitimately make quantum measurements. Quantum measurements are in addition to classical measurements carried out on signals reaching through sense channels. Sleep patterns in blind persons correlate with ambient light. Perhaps, blind persons sense ambient light from quantum measurements. The outcome of a measurement probably, triggers a chain of activities in the brain leading to a experience. The measurement and its accompanying activities may be viewed as constituting a conscious event. Quantum detectors will have switching mechanism and dead time. We suggest that the switching mechanism lies in brain activities and dead time is the duration of the formation of conscious event. The capability to alter the durations of various activities and thresholds of various triggers gives rise to many interesting scenarios e.g. reduced activity of brain will consume less energy consumption and quantum entity may express the approval of energy consumption by switching to a happy. Many religious and spiritual traditions envisage the attainment of happy states of different degrees by following prescribed practices. The prescribed practices, probably train brain to enhance threshold of triggers and reduce duration of activities. The state with limiting values of thresholds and duration will be the state of bliss, in which duration of conscious event and gap between two conscious events will be large. Entanglement implies that all alterations in the state of quantum entity are reflected in photon signals. Perhaps, the earlier discussed experiments with meditating persons reflect altering of thresholds and durations induced by meditation practices.

4. Glimpse of the destination: The above implications lead us a possible answer of the age old question, who we are? The probable answer is: Each of us is a quantum entity entangled with a quantum photon field and both represent our individuality. The quantum entity is purely matter and localized while quantum field is purely energy and spread far and wide. The matter part is considered living and energy part, non-living but both contain equivalent amount of information about various aspects of 'life'. The two parts remain tuned with each other; any change in one part, is instantly reflected in other part as well. The photon field is in a squeezed state, whose three parameters have same values in each of us and whose space structure is relative to the body localizing quantum entity. The matter part is a loose association of many autonomous parts. The autonomous parts retain their identity and coherence with the whole body. They confer stability and flexibility. The matter part of a quantum entity senses energy part of other quantum entities and uses it for remote sensing in some quantum entities. The matter part of some quantum entities can also manipulate entangled photon field of other quantum entities for remote intervention. Environment reflects a fraction of entangled photon field back to its quantum entity, which then senses it and uses it for self-appraisal and mid-course correction. The interaction between photon field and matter interconnect two or more quantum entities and sometimes an interconnection metamorphoses into resonance coupling. Healer, perhaps, establishes such a resonance with patients for managing their health. We continuously consume energy for sustaining entanglement by pooling biochemical currency of energy at different spatial locations into a single photon mode. The above speculations are testable and falsifiable. They call for worldwide cooperative endeavor.

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