*Introduction to Finale Debate*

# HOLISTIC APPROACH IN BIOLOGY AND NEUROSCIENCE

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I propose the following reflections on the major issues that have been discussed in previous sessions of this workshop based on my professional and personal interests in epistemology, cognitive psychology and vision science. I also hope that my modest final contribution to this Workshop will open a window to interdisciplinarity, to the psycho-bio-physical unity of knowledge, and to its foundation on the radical ontological unity of the universe.

In human sciences the importance and strength of science depend on its capacity to explain (or to understand the causes of) our phenomenological experience, described by disciplines dealing with phenomenology. Instead of explaining this experience, we would just emphasize its three essential traits: unity of consciousness, holism or campal experience, and indetermination or free will. Our own personal and social experience is the *explicandum* of the human sciences (let us say, what needs to be explained based on its causes). And the *explicans* are the psycho-bio-physical causes (let us say, the explanatory causes or real structures), which, in turn, direct us to the radical physical support that evolutively produced life, and later, sensation-perception, integrated consciousness, the psychological subject in animals and humans, and the cognitive-emotional unity of human life.

The fundamental question of the bio-human sciences is: What is the physical support that makes intelligible the psycho-bio-physical ontology of our phenomenological experience? The importance of this question depends on the monistic hypothesis about the evolutionary process. From the *big bang*, for billions of years there was only one physical universe. From this physical basis must have taken place firstly the mechanical structure of life. After that, at some point of evolution, it emerged psychophysical sensitivity and consciousness, that is the psychic world. Thus, in principle, there is only a scientific hypothesis: the ontology of the physical world should provide a sufficient explanation of the evolutionary process. That is, the emergence of living beings who have their own phenomenological properties in animal and human psychism. I repeat the question once again: What is the physical support that makes intelligible the evolutive emergence of the psycho-bio-physical ontology? The answer obviously depends on the physical sciences' image of the world.

## 1) The balance between classical and quantum mechanics for the scientific explanation of mind

Throughout the first three sessions of the workshop, three causal systems known to science as an explanation of animal and human psyche were presented.

 

First a mechanical-deterministic one (founded on a mechano-classical vision of the universe); this has been the point of view of Steen Rasmussen. Second, a system of interactions in neural assemblies that are classical engrams, patterns, or networks (for classical neurology basically founded in cause and effect systems of mechano-classical interactions), this has been the point of the contribution of Giorgio Innocenti. Third, a system of interactions based on the quantum properties of matter (a system based on living organisms that would possess niches in which quantum interaction phenomena could happen), this has been the position of Stuart Hameroff. The fundamental questions which have been discussed could be expressed by some issues like these: May these three explanatory systems be isolated? May mind have an explanation merely physical, mechanical and deterministic? Is the neural system only a serial or connectionist PDP computer system? Is a living being only a robot with an epiphenomenal consciousness? Can we explain mind only as a classical system of mechano-classical interactions between neural assemblies? Might there not be a better heuristic hypothesis, so that we could unite classical and quantum mechanics for a more accurate explanation of all our personal and social phenomenological experiences? Shouldn't we better seek a balanced explanation between classical and quantum physics?

We know that modern science began by describing the objective and macroscopic world in the classical mechanics of Newton. In the twentieth century science knew deep and fundamental properties of the physical world, describing them in quantum mechanics. Thus, science considers that the classical world has been caused by matter responding primarily to the quantum properties. Therefore, an intuition or immediate expectation of science would be that life and sensitivity depend on the evolution of both the properties of the classical world and the properties of the quantum world (which are ultimately the same.) The hypothesis would be that the explanation of life is a balance between classical bodies (stable, rigid, deterministic and produced by genetic codes) and the quantum states submerged in these classical bodies (which explains the phenomenological properties of animal and human psychism). Only reducing exclusively the explanation of life to a classical system of causal interactions (i.e. only to a part of science) is, in my opinion, what is known as reductionism. Human sciences defend a monistic view, but should not be reductionist (that is, it should take into account also quantum physics).

I think that something as essential to us like our own human, personal, and social life, as described by phenomenological disciplines, has probably been falsified by a «reductionistic», mechanistic, and deterministic image, by an essentially «robotic» image of the universe, life, and psychism. We feel it is important and enriching to be open to an emerging alternative image of a holistic universe, which seems to allow a more integrated and unitary knowledge that is more congruent with our own phenomenological experience. This holistic universe explains the nature of natural systems, and especially, of living systems or entities within those natural systems.

The classical response, based on classical physics' image of a discrete, differentiated, and mechanical world, leads to classical neurology. But a new

heuristic response, constructed from an image of a world composed of holistic fields, leads to quantum neurology. Classical neurology uses formalizations inspired by a discrete and differentiated world. The new quantum neurology should be inspired probably by still to be conceived and implemented new formalizations based on a new holistic ontology. In my opinion science does not expect quantum and classical ontologies to be mutually exclusive. On the contrary, it hopes that the two ontologies are mutually enriching, and can be coordinated and integrated within a single harmonious system.

## 2) How to understand the mechano-classical fundaments of mind

Therefore what is this «physical support» on which the classical explanation depends? The classical explanation of psycho-bio-physical ontology was grounded on the idea of corpuscle, giving rise to an understanding of the world as composed of differentiated, discrete, and discontinuous entities, but resulting in reductionism. Physics now differentiates between two types of particles or matter.

First, there is bosonic matter, formed by a certain type of particle possessing the property of unfolding more easily in fields of unitary vibration. Consequently, the mass of bosonic particles, like photons, lose their individuality when entering in a state of unitary vibration extended in a field, and constituting a state recognised as quantum coherence. The wave function's symmetry depends on these properties. The Bose-Einstein condensates first described these states of coherence. Modern physics has described a multitude of quantum coherence states within the strictest experimental conditions.

Second, there is fermionic matter. These are particles whose wave function is asymmetrical, so their vibrations have difficulties entering into coherence with other particles. They persistently maintain their individuality, not fusing with other particles and remaining in a state of unitary indifferentiation. Electrons and protons, essential constituents of atoms, for example, unite and form material structures according to the four natural forces: gravity, electromagnetic force, strong nuclear force and weak nuclear force. Nevertheless, every particle maintains its individuality. Every electron in an atom, for example, has its orbit, which, when completed, makes the electron vibrate in its orbital space. According to quantum principles, we cannot know exactly where the electron is. Its location in space depends on the «collapse of the wave function», produced, for example, by the experimental intervention of an observer. Because the *big bang's* energy caused the folding of this type of fermionic particles, the classical macroscopic world exists: stellar bodies, planets, living beings and man. Their folding accounts for differentiation and the possibility of a multitude of things, like the survival of living beings with stable bodies and standing firmly on the surface of the earth.

In the microscopic world, actions and cause-effect series are associations and dissociations of independent particles, atoms and molecules through ionic unions and covalences following the four previously mentioned forces. Shared orbits of electrons can be formed in covalent links, but they are very localised and

probably do not nullify the electrons' independence. However, causal interactions do not break the enclosure and differentiation of the component elements in the classical macroscopic world of fermions. Holistic fields thus do not appear in a world of physical fields.

These causal systems are partly classical and deterministic. The conditions that blindly produce a bond or dissociation follow the laws of physics and chemistry. These systems however can give rise to indeterminate states. We do not know the precise effect of a state produced among a multitude of possible states. We attribute the effect to chance. This happens in the physics of chaotic systems and in biology, for example, in cytoplasmic biochemistry that gives rise to Darwinian selection. The fermionic evolution (mechanical-classical) of the universe has produced states or loops of indetermination, but what is finally produced in these indeterminate environs is caused by blind and deterministic cause-effect series.

Accordingly, both the presentations of Rasmussen and Oviedo suggest some questions:

First on the nature of *life*. Is life just a system of deterministic interactions? What role does the emergence of «sensation» play in the production of the essential characters of life? Would a robotic system (a cybernetic system with anticipation of the future) be a living entity? Would it be similar to what we call «life» from the phenomenological experience? Is what the traditional biology has studied as living beings (similar to our psychical experience) or are they pure mechanical and deterministic systems with an evolutionary cybernetics that have been created by adaptation to the environment? A virus, for example, is it a living being? Does a virus have «sensation»?

Second on *computation*. It seems plausible that life was possible because living systems performed a series of bio-physical processes (hence «computational») to ensure optimal adaptation to the environment. It must be admitted that these natural bio-physical processes can be simulated on the computer. However, the natural processes of life (e.g. in a cell), are they regulated by a computer, either serial or connectionist (PDP)? For example, is there in the cell some kind of digital information, programs, or central processing unit? Cellular computing, should it not be better understood as computation or sequence of physical states, evolutionary learned, that is, as series of cause-effect interactions of natural deterministic systems?

Third on *sensation and artificial life*. Building a protocell in its early stages could be just deterministic (mechano-classical). But, in higher stages of cellular evolution, cannot «artificial life» occur without producing «sensation»? This would imply that the cell would learn how to connect automatically sensations (stimuli) with optimal adaptive mechanisms (responses, response programs). Can we talk about artificial life producing sensation without regard to quantum physics? How to handle matter according to quantum principles to produce artificial life? Could we produce by biological engineering real sensory systems arising from the ontology of «sensitive» matter?

Now, regarding the discussion about dualism that was suggested by Oviedo's presentation: In my opinion, Oviedo's position is similar to the one that John Eccles defended for many years: the identity theory (i.e., reductionism) is not compatible with humanism (human values, freedom, morality, poetry…); therefore, we must accept dualism because only dualism is compatible with humanism. From my point of view, the human sciences today (I mean the emergentist neuroscience of neural networks, but I do not include the computational theory of man) is perfectly compatible with humanism. Therefore, if a humanistic scientific monism that represents the way of thinking of the majority of contemporary science is possible, why should we go to a dualism that installs Christianity and religions in an anachronistic philosophy?

In conclusion, in our view, can the mechano-classical foundations of mind be understood without referring to quantum mechanics? Could there be artificial life without an artificial quantum technology for manipulating matter and producing sensation? Could an anachronistic dualism be seen as an appropriate choice for the hermeneutics of Christian faith in the cultural framework of modern science?

## 3) The neural fundaments of mind

Classical explanation contemplates networks of interacting neurons within fermionic matter's system of causation. When speaking about neural networks, I do not refer primarily to systems of artificial neurons that permit parallel distributed processing within the framework of connectionism as a man-made architecture. By neural networks, I refer specifically to biological networks of living neurons making up our brains. Authors refer to these networks as patterns, canons, structures, engrams, or neural maps.

What we call classical neurology would be, on one hand, the understanding of these neural networks: their assemblies and diversification and modularization, and their branching structure and topologies of interconnected and interactive systems as, among other things, functioning units; and, on the other hand, the knowledge of their correlation with events phenomenologically called *qualia* that constitute the essential elements of our psychical lives.

Let us see the sentence: «man is his brain» or «the mind is a set of functional states of the brain». If we move in this general tenet, without deeper scientific explanation, we can admit an interaction between brain and mind (or psyche). The psychical world is that of our ordinary experience (a world therefore human, not robotic or deterministic), meanwhile the physical world is the neurological networks or neural circuits that we describe in neuroscience. Therefore it is postulated, according to evidence, that the mind depends on the interaction of networks and neural systems. Also, on the other hand, states of neural networks depend on the psychical activity. But if we don't want to deepen the scientific psycho-physical knowledge, we move then in a position that has been qualified in philosophy of mind as «psycho-physical and

interactionist agnosticism». We postulate a causal interaction, but we give up looking for their root causes.

But there are thinkers, scientists, who have answered the question: how to understand the brain in its constitution and in its dynamic role? The knowledge produced so far about the brain responds to a certain image. For many scientists it seems to lead to the conclusion that brain functions are based on classical interactions and reduced to them. Many authors have thought this way, according to the so-called «reductionism». Why do we tend to think so? Because what we see in the biological body and in the neural activity are only classical interactions: a) there are independent entities that are part of the fermionic «classical world» (bodies and biological systems, cells, neurons, genes, molecules, atoms, synaptic buttons, chemical-electrical nerve currents, jets of neurotransmitters, covalent and ionic bonds, etc.); b) entities that produce together a classic set of interactions that lead to form mechanistic, deterministic, robotics systems which today tend to be interpreted by computational models (serial or connectionist).

Now, if living beings (the brain) are purely classical systems, then the adaptive action (their conduct or behavior, ultimately, their life, and man's «human life») are caused or produced by a mechanical causal-deterministic system (classical). We know that some neurologists have revived in modern theory of mind a radical «determinism» that seems to fulfil these positions.

Innocenti argues that the explanation of the mind is based on a neural differentiation process, even more in humans, which allows new neural functions and new psychical abilities. The thesis is, therefore, that the bio-physical evolution was up to produce the neural system that explains human and animal mind. Therefore, this means that neural differentiation and specialization should explain the phenomenological experience of mind.

Consequently, we could see in the background some key questions:

First on *sensation*. Which perspective do the majority of neurologists adopt to explain the nervous system? Do they view it as a production system for connecting sensation / response, affection / effection? As an automated and cybernetic complex system (as might be for example the first stage of cellular evolution)?

Second on *computational brain*. Are there any neurologists who advocate for a computational theory of mind according to the strong computer metaphor (of mind, i.e. brain and nervous system)? What are their reasons? What is the difference between brain function and a computer operation? Parallel distributed processing (PDP) in a connectionist network, how does it differ from the actual performance of real neural networks in living beings? Can the computational theory in the strong sense be integrated with the neural network model and with the self embodied model?

Third on *neural assemblies*. Most neurologists are working with neural modules and assemblies, according to physical principles of interaction as understood in classical mechanics (interactions between different entities). It is the classical neurology (macroscopic neurology). Is this enough? These neural assemblies,

understood in a biophysical mechano-classical sense, can they explain the phenomenological experience of a «holistic psychical field» (for example, the unitary sensation of being or of having a body (Damasio)? Is it enough to say that brain functions as a whole (*holos*) and that all systems and assemblies are interconnected?

Fourth on *assemblies, indetermination*. Edelman's neural Darwinism, the infinity of engrams, patterns, maps and neural networks in brain, are they sufficient to explain the indetermination? Is it sufficient to understand neural networks only as a classical deterministic cause and effect system?

Fifth on *quantum neurology*. Can neuroscience today be a science closed to the heuristic way of quantum neurology? When we speak of holism in the brain, is it enough to understand the total connection between modules and brain patterns and the global interaction between them? Or, rather, is it necessary to postulate a quantum interaction which would allow holistic sensation and consciousness of reality fields?

## 4) The quantum fundaments of mind

Where can we find an adequate «physical support» to ground in a sufficient manner the phenomenological properties of psychism? All matter, bosonic or fermionic, is «radiation» in its ontological core. Bosonic matter tends to be diluted easily in a unified whole, in vibrating fields, losing the individuality of its particles in states of «quantum coherence.» But although fermionic matter firmly maintains its individuality, it can also produce states of coherence, as verified in extreme experimental conditions. Note that fermionic matter also pertains to the quantum world, since knowledge about quantum mechanics is applied to it (e.g., the electron in its orbit is a vibrating wave).

What do we understand by «quantum neurology»? A more general definition could be the following: It is the search for and investigation about the quantum properties of the most primitive matter in order to relate them to the neuronal system, in view of establishing the appropriate «physical support» to explain the phenomenological properties of psychism.

The most general form of quantum neurology is the so called hypothesis Von Neumann-Stapp. Science must explain how the phenomenological properties of animal and human psychism are possible: the unity of consciousness in the psychical subject, the holistic experience of fields of reality and the *choice* or election, in part indeterminate, which we can see as freedom in the human case. The differentiation and discontinuity, mechanical and deterministic, of the classical world fails to explain satisfactorily the properties of the psyche. At least, so have considered many philosophers, scientists, neurologists and psychologists. In contrast, quantum properties such as quantum coherence, quantum superposition, quantum indetermination, action-at-a-distance (non-locality or EPR effects) can offer us a closer insight into the real ontology of the psychical world. The Von Neumann-Stapp hypothesis proposes then a heuristic hypothesis:

the «physical support» of the psychical world should be sought in the ontology that is displayed in the properties of the quantum world.

Pertinent to quantum neurology is also the Penrose-Hameroff hypothesis. The hypothesis essentially argues that the cellular cytoskeleton's microtubules, distributed widely in the entire neuron, could possess the appropriate physico-biological characteristics allowing the phenomenon of quantum coherence to occur in them. Vibrating states in quantum coherence would have a wave function in «quantum superposition» (being in multiple states at the same time and not being in any state). But in certain moments, a «wave-function collapse» would be produced. The Hameroff-Penrose hypothesis would postulate that states of consciousness (and all their accompanying *qualia*, e.g., in a visual image) would result from the entrance into quantum coherence of vast quantities of microtubules of different neurons and brain modules due to the effects of action-at-a-distance or non-local causation, already known in quantum mechanics from the imaginary experiment of Einstein, Podolsky and Rosen in 1935 (EPR effects).

The hypothesis thus opens new avenues to explain the phenomenological properties of psychism. Superposition and quantum coherence states due to action-at-a-distance (EPR effects) would be the most appropriate «physical support» to explain the unity of consciousness and field sensations (proprioception and vision); producing «sensation» would be a field property of matter, as long as there is a «psychical subject» capable of «sensing.» Behavior's indetermination-freedom would have its physical support in indeterminate quantum states and in the property of superposition. The subject could induce the collapse of the wave function in a flexible manner, allowing the descending control of the mecano-classical mechanisms of movement.

If the Hameroff-Penrose hypothesis contemplates a world that has found its niche in the classical world of fermionic matter, living beings would not be viable if they did not have an interface system coordinating the interaction of the classical world with the quantum world. This classical-quantum world interaction would be two-way: from the external physical world to the activation of neuronal and microtubular subsystems that produce images (the image's qualia), and from the quantum superposition generating the collapse of microtubules that allow voluntary actions and the descendent control of the subject's motricity. The two-way interaction would thus be bottom-up (ascendant) and top-down (descendent).

In the workshop framework let us see the battery of questions suggested by a reflection on the possible quantum basis of mind:

First on *ontology of matter, sensation, consciousness*. Hameroff-Penrose hypothesis is built upon its assumption of quantum effects in microtubules. If the property «sensation» emerges of quantum states of matter, what ontological properties should be attributed to the primordial matter that causes the universe and the biological organization? What characteristics would have emergentism as a theory?

- However, why does the ontology of matter have in fact the property of producing sensation? Would it not have been possible that the subject wouldn't have had a «sensitive» ontology and the universe would have been a robotic and blind universe? What can science say about why the ontology of matter is in fact «sensitive»?
- If it is correct to say that the universe has begun in quantum states, what were the causes of the formation of that macroscopic mechano-classical universe that produced the formation of that world of differentiated and stable objects, which produces only a deterministic causal interaction?
- The fermionic matter that shaped a differential atomic world and the macroscopic bodies, has it in itself the quantum properties? Could quantum states of coherence, superposition, or action-at-a-distance (EPR effect) also occur in classical systems?

Second on *microtubules*. In addition to the quantum states produced in the cell structures called microtubules, through the computation realized in the tubulin dimers, is it plausible that biological systems have also evolutionarily developed other quantum states, based on other biological structures, also useful to sense optimally the environment and survive in it? That all matter of a living being has the property of sensation (the matter of my body is «living», is alive), should be based solely on the action of microtubules? To have a sensation produced by quantum effects or properties of the same matter, would it ever need a process of «orchestrated» «objective reduction» (orqOR) in accordance with the Hameroff-Penrose hypothesis? Similarly to classical neural patterns, do quantum interactions between microtubules have certain mappings that allow them to represent the world? Do microtubules have arranged logical networks that allow them to represent the real world order?

Third on *reductionism*. What are the consequences of considering humans based only on a narrow understanding of the mechano-classical physical world? Is a real humanism in terms of reductionism possible? Is a classic explanation of mind possible, for example that of Edelman's neural Darwinism and his «dynamic core»?

Fourth on *humanism*. What humanism is possible from a quantum understanding of mind? What is the current state of the Hameroff-Penrose hypothesis? Are there perspectives that can make scientific research advance further? Are there agencies that provide funding for scientific research to answer questions of little immediate practical value?

## 5) The evolutive mind

Modern science leads to a monistic idea of evolution and, within it, to an idea of the origin of the human mind as the final stage of this process. Holism is a way to see the physical universe, which not only understands that reality consists of differentiated and separated entities, but actually takes into account fields

where the differences disappear in the undifferentiated unity of the universe. When monism was interpreted according to the mechanistic and deterministic principles of classical mechanics the evolutionary process was understood as a deterministic and robotic process that made not easy to justify how it related the ontology of the world with the ontology of God. However, modern progress in understanding the holistic ontology of the universe, in the context of the properties of matter described by quantum mechanics, has made more plausible that the ontology of the universe could be based on the ontology of God. God would be the final unity of the universe, the fundamental consciousness whose ontology would have produced the fields of consciousness in living beings: the believer can then speculate imagining that God could be that final holistic ontology of reality beyond the quantum vacuum, the sea energy, the implicate order of Bohm or the *sensorium divinitatis* about which Newton speaks in the *Scholium Generale* of his Philosophiae Naturalis Principia Mathematica. However, we must say that the new holistic vision of the universe does not impose the scientific, philosophical or rational necessity of the existence of the Divine. Quantum holism is compatible with a non-religious atheistic interpretation of the universe. However, we say that this holism makes it more credible and plausible today that the universe may have a final religious interpretation. Teilhard de Chardin was one of the forerunners of this monistic and holistic vision of the universe based on divine ontology. No doubt he would have enriched their philosophical vision, if he had known the current scientific thinking on quantum holism and its explanation of the ontology of the mind.

Here are some questions suggested by the presentation of Ludovico Galleni:

First on *Teilhard and modern science*. The worldview of Teilhard de Chardin and the explanation of mind in modern science, do they match? How do they differ? Are there contributions in which Teilhard was ahead of his time?

Second on *matter*. What is the idea of matter in Teilhard? Did Teilhard anticipate emergentism as an evolutive theory? Does the philosophy of Teilhard defend a monistic understanding of man?

Third on *the human phenomenon*. What's the origin of man? Does Teilhard see the emergence of man in a strict «evolutionary continuity»? What is the position of Teilhard regarding dualistic anthropology? According to Teilhard, is a human dualism defendable? What causes induced the hominids to evolve towards intelligence and human reason? Does Teilhard have an evolutionary theory of hominization? How should we understand 'moving forward', 'teleonomy' or 'teleology' in Teilhard? In what sense is the world described by science autonomous?

Fourth on *complexity / consciousness*. The emergence of «sensation» in matter, how is it produced according to Teilhard? Has the way that complexity has evolved in living organisms (e.g., sensory-perceptual systems) been influenced by sensation-consciousness systems? That is, the complexity and evolutionary design of living organisms, do they depend on the influence of the emergent property of sensation, perception and consciousness? Is the evolutionary

interaction between complexity and consciousness essential to explain the way in which living organisms have formed the nervous system? Are evolutionary designs building organisms to survive on the functional basis of sensation-consciousness systems?

Fifth on *the holistic connection to Earth*. Are the concepts of Teilhard on Geobiology and the Biosphere a forerunner of modern holistic thinking? Do modern hypotheses on the origin of the quantum mind have a precedent in Teilhard? What is the mystique of man belonging to the Earth? Is there a unity between Teilhard's psycho-bio-physical holistic anticipation and the current trends in biology and anthropology?

Sixth on *Teilhard and religion*. What are the strengths of the integration of science and religion in Teilhard? Has modern theology, especially in Catholicism, come to assimilate the scientific and philosophical implications of Teilhard (that is, of modern science) or does it continue to ignore them?

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