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RESEARCH ARTICLE

NEUROBIOLOGY NOTES, FROM THE INTERACTION OF MATERIAL BODIES TO THE ORIGIN OF NEURAL NETWORKS, FROM NEURAL NETWORKS TO THE UNIVERSALITY OF KNOWLEDGE

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ABSTRACT

This manuscript raises numerous questions regarding the extraordinary structural and functional complexity of neural networks, and aims to be a starting point for orienting us toward possible answers. Starting from the fundamental premise that matter is the result of the interaction between the particles that form it, I extend this principle to the neural networks that have specialized, over the course of evolution, in increasingly refined and effective interaction/communication activities. I briefly describe the evolution of excitable systems, starting from primitive molecules to more complex ones, and then proceed to the equally brief description of cellular and neuronal evolution, and I also highlight the supposed mechanisms that underlie them. The mechanisms that I have identified in my analysis are the same morphogenetic forces that form celestial bodies and maintain universal order. I have highlighted the concentric and columnar arrangement of neural networks, which is the plastic representation resulting from their stratified superposition, along phylogenetic evolution and embryonic development. In the review of Artificial Intelligence, AI, I highlight the limitations inherent in this new approach, and I criticize it for having been adopted as a new paradigm in neurobiological research. And, I try to demonstrate, that it is a misleading vision that loses sight of the peculiarity of the essence of life and of the organ that seeks to know it, the brain. Finally, this article aims to occupy the territory that few researchers frequent, and that is the one between research at the molecular and instrumental level, and experimental research. It is the space that I claim to be founded on pure logical speculation, which wants to restore the fundamental primacy of the brain in the interpretation of all investigations. Because, in my opinion, all research is reduced to the processing of our brain of experimental and instrumental results obtained with any method. Based on these premises, the objective that I set myself is to present a description based on the logical and realistic exposition of the elementary morphogenetic mechanisms and processes that shape matter, in order to be able to grasp them with our hands and observe them in their concreteness, understand them and therefore make them plastically part of our being and feeling. Which is the highest meaning of knowledge.

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INTRODUCTION

The evolution of the universe is the result of a set of events that began with the chance encounter and fusion in space/time of elementary masses. These events consist of the interactions of elementary particles that make up matter according to the theory of quantum mechanics. In truth, this science theorizes that everything originated from the "singularity", conceived as a kind of *Supreme Being* ante litteram, which generated all matter from sidereal nothingness, and which would have fed itself until it created all cosmic reality. According to this conception, ***nothingness*** acquires such a high and broad value that it contains any property one wants to attribute to it.

Regardless of the properties of the elementary particles involved, the key event of the entire morphogenetic process is their interaction, and this is what I argue in this paper (1). This epistemic approach has no metaphysical foundation, but rather expresses a materialistic conception of communication, taken to its extreme consequences. In describing the mechanisms and causes that led to the formation of the matter of the universe, whatever the epistemic method used, it is necessary to indicate the essential elementary events that have a cause in the whole process (2-4). This is also an implicit principle in the quantum conception, which theorizes that matter is made up of elementary particles, fundamental forces and interactions that underlie them, and validates these interactions as a pivotal event. In other words, it is not the presence of particles that is essential, but their interaction.

The whole conception on which my thesis is based is founded precisely on the principle of interaction as an unavoidable event in the morphogenesis of material things and ultimately also of knowledge (5). And it is the principle that, extended to the most complex molecular organizations, leads us to hypothesize the origin and evolution of neural networks.

Molecules also communicate with each other

From molecular interaction to receptor specialization: The fundamental mechanism of the stimulus-receptor interaction consists in the property of molecules to manifest their conformational structure in vibrational energy. We know from atomic physics that molecules, and in particular the atoms that constitute them, respond to a vibrational solicitation by modifying their arrangement, with quantum jumps of the electrons from the equilibrium orbitals to orbitals of a higher energy level, and when they return to the original orbital they re-emit vibrations with the same energy as that absorbed Fig.1.

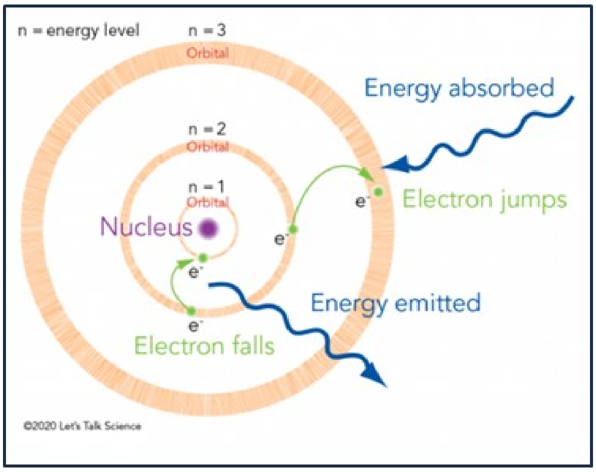

Figure 1. Level variation of electronic orbitals following an electronic stimulus

The vibrations that provide the energy of the stimulus have different origins, mechanical, electromagnetic, gravitational, but for a stimulus to be capable of producing a physically detectable effect, the presence of matter is essential, whether in the form of atoms or molecular atomic complexes. And it is thanks to the vibratory energy that matter emits or receives that the natural phenomena of interaction, molecular synthesis and receptor responses occur, which are at the basis of cosmic evolution. Normally, for a transformation to occur in matter, whatever its nature, an interaction between the elements that form it is necessary. Interaction is the first event of communication, it is an inevitable process linked to the very presence of matter in space/time, consequently in empty space, assumed to be devoid of matter and energy, it is impossible for communication to occur (6).

What is communicated? (Uniqueness of communication)

A material body with its very presence modifies the space/time it occupies with its spatial conformation, consistency, kinetics and with its energetic content; The effect produced is specific and characteristic of each material element, defines it uniquely, and distinguishes it from all the others;

How do you communicate? (Code uniqueness)

We communicate with the manifestation of our essence, using a system of unique codes that are common and shared by all universal matter; The transmission codes must have common properties and must be modulable according to the nature of the communication, and capable of moving in all dimensions and directions of space/time, so as to encounter all the material bodies present, and possibly test their physical and energetic properties, and obtain information from them. If communication is effective, it produces new matter, and each of the interacting bodies loses the properties they originally had.

Why communicating?

Because only through iteration can material bodies modify themselves and the environment, if there is no contact no effect is produced, no transformation or evolution occurs.
Contact between material bodies produces an effective result if it modifies the original conditions of the system (the energy state of the interacting particles, or the production of new substances), or it produces no result at all. But how can material bodies meet and recognize each other to give rise to new entities? The encounter and recognition cannot be left to chance, since in the infinite variety and variability of existing material entities, it will be extremely unlikely that two of these will find themselves in the exact steric-energetic conformation that favors their coupling. One hypothesis is that they use the code emitted by each one. The code that I have defined as the "universal code" (7). When the codes produced by the bodies meet and are mutually compatible (quantum mechanics calls the phenomenon "resonance") then an attraction occurs which leads to their fusion. This is a universal phenomenon that occurs at the microscopic and macroscopic levels. From atoms to macromolecules, the process of communication and mutual recognition is the same Fig. 2.

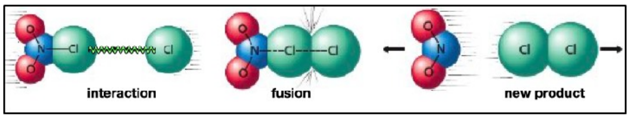

Figure 2. Molecular interaction

According to quantum mechanics, each material entity is characterized by its mass, a specific steric conformation and an associated energy content (which we could define as their "molecular fingerprint"). Through these quantities, particles can recognize each other by the frequencies they emit and eventually unite. So, in short, interaction is at the origin of the transformation and evolution of things, and it is the fundamental phenomenon that puts two or more material entities in relation, to compare and experiment with the possible synthesis of new matter. As the molecular complexity of interacting substances increases, the information content they can exchange increases.

The mechanism of interaction between material elements involves a further condition for this to occur, and that is the need for a physical medium that leads them to their mutual encounter.

This physical medium in the cosmic universe is represented by the field existing in space/time. In the cosmic field, the transmission of waves emitted by the bodies present occurs, which with their informational content are able to transfer their singular properties. Quantum physics distinguishes waves produced by matter into mechanical waves, electromagnetic waves and gravitational waves, and the fields associated with these. Mechanical waves can transfer their characteristic dimensions, length, amplitude, frequency, intensity, to which is added, in electromagnetic waves, an elementary particle with a charge. Thus, waves are simultaneously the vehicle for the interaction of particles, which with their specific field already present the informational content to be transferred.

From Chaos to Molecular Organization: In the primordial sidereal space/time, infinite particles must have coexisted, interacting randomly with each other and occasionally aggregating to give rise to increasingly larger masses such as planets, sidereal bodies, etc., but it is extremely unlikely that, in the extreme conditions of the primordial universe, they produced living matter. The next step was needed, the qualitative leap that organized matter into completely new forms. As the complexity of material bodies evolved and the first living forms were formed, the information to be transmitted increased, and it was therefore necessary for them to also acquire the appropriate physical substrate for direct communication, which was more consistent and effective in its transmission.

Starting from this premise, it is possible to hypothesize the extension of the material substrate of the interaction, from the field, with the associated waves and particles, to the neural networks, the object of this work. With the birth of primitive cellular aggregates, the need for a physical medium for effective communication was so paramount that it led to the evolution of special cells, neurons, and the formation of interconnected neuronal networks capable of interacting with each other and with selective effectiveness (8-9). Neural networks and their fibers allowed them to transfer signals, in all directions, with linear transmission channels that did not disperse the information into the surrounding environment, or alter its content. The additional advantage offered by pathways and fibers in nervous transmission is that in this way the information is conveyed only between interacting structures, with precision, speed and effectiveness. What code do these networks use to communicate with each other?. One hypothesis is that they use the code carried by the specific wave frequencies that each neuron can express. The code that could be defined as the "universal code of frequencies" precisely. When the frequencies of a nerve fibre or more generally of a material body meet those of a similar entity and are mutually compatible with each other, then the recognition occurs which produces the detectable physical effect.

In living organisms the ability to communicate has reached maximum efficiency and effectiveness (10-11). In fact, all living organisms, from the simplest bacteria to humans, are nothing more than a set of molecular complexes capable of emitting and receiving messages aimed at selecting and promoting their knowledge and union in harmony with their environment.

Cell membranes and the origin of life: The decisive event that gave rise to biological evolution on our planet was the formation of a semipermeable membrane capable of separating the atoms and electrolytes present in the primordial ocean, according to their concentration gradients. The first ancestral cell membrane had to contain channel-like formations for the selective passage of atoms, and being immersed in a molecular or electrolytic solution of many substances, it had to be able to select them, separate them and obtain their different concentrations on its sides. The separation of charges produced a chemio-osmotic equilibrium potential across the membrane that had to be maintained with energetic effort Fig.3. In modern living beings the equilibrium potential of cell membranes is -70 mVolt.

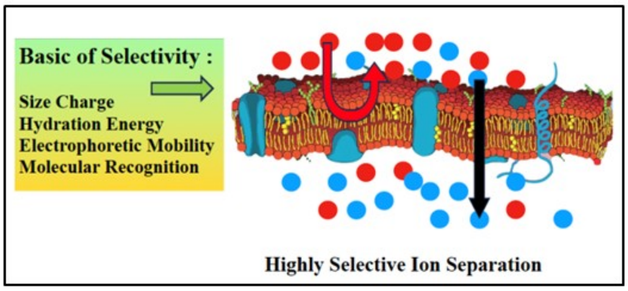

Figure 3. Scheme of cellular membrane

After an imaginary evolutionary leap of millions of years, the membrane closed on itself and separated its internal environment from the external primordial ocean or soup, with which it maintained contact to exchange substances and information. This is the hypothetical origin of the first cells, which in this way were able to maintain their own individuality, to exchange substances and information with the outside and to reproduce autonomously. In an ancestral cell of this type, the occurrence of an effective stimulus on its surface could alter the equilibrium of the solutions and produce the instantaneous outflow of electrolytes, which, to restore the thus altered equilibrium, produced an equally instantaneous flow of charges, detectable from the outside as a variation of the resting potential, which today we know as an action potential, and is presented with the emission of a frequency wave. Ultimately, life is nothing more than the effect produced by a flow of electrolytes, regulated by the complex of protein structures that form channels and ionic pumps present on cell membranes. This mechanism has proven to be so essential that it has been included in the genetic heritage that regulates the synthesis of ion channels and pumps present on all cell membranes and has been passed down in all living organisms, including bacteria.

The complexity of neurons: No other organ in our body can compete in complexity with the nervous system and its structural and functional specialization. The cells present in the central nervous system, the neurons, have a morphological and functional variability that is unmatched in any other organ. Cells are found that have the most original shapes, generally presenting a branched appearance with branches of different lengths that take on arborescent appearances, which thus increase the surface area occupied and the contacts that they can have along the ramifications. A similar shape is also assumed by the cells that form the scaffolding, we would say the parenchyma, of the nervous system, the microglia (12). The various cells are distributed and have occupied concentric layers in the nervous structures over time, each of which is formed by neurons with a similar shape. They have also assumed a columnar arrangement that follows a radial direction. In this way, the information they convey also spreads in a radial and concentric direction like sea waves and has a similar constant flow and reflux over time, which synergistically maintains the system in dynamic equilibrium, and is transmitted in the form of waves. In this extremely complicated branched system, we can recognize specialized communication pathways that use the same codes carried by different molecules, the neurotransmitters. Gabaergic , serotonergic, etc. pathways according to the neurotransmitter used. It's an elegant way to transfer different information within a chaotic system of cross-messaging. The effective stimuli to which the various neurons respond have different forms and natures, they are of a luminous, acoustic, thermal, mechanical type, etc. but with a common denominator, they all have a wave structure. The forms that individual nerve cells, neurons, assume are numerous and they are all specialized in receiving and transmitting stimuli by means of modifications and adaptations of the cell membrane with the production of special appendages. The reception and transmission of stimuli originates in a portion of the neuron that has a branched shape, the dendrite, passes through the actual body of the neuron, the Pirenoforo, which contains the nucleus and other organelles, and continues in the neurite, a thin extension of a cellular pole, to reach another effector cell belonging or not to the nervous system.

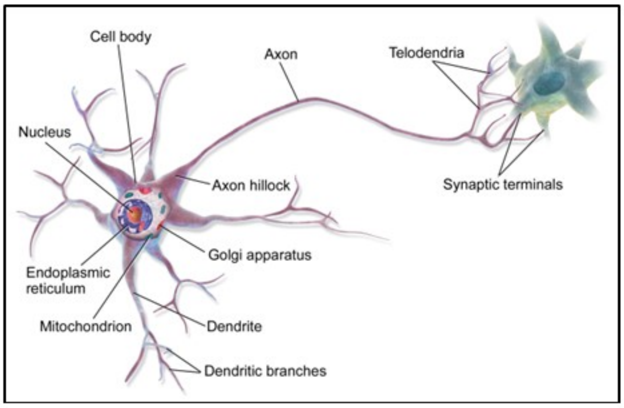

Figure 4. Typical neuron pattern

Fig.4. In the conformation of neurons, the morphological diversity between dendrite and neurite is not always immediately distinguishable, but the functional polarity, also known as " *dynamic polarization"* of nervous transmission, is invariably recognizable. This was first described by Ramon y Cajal , and states that the nerve impulse always travels in the direction from the dendrite towards the neurite or axon. The extraordinary variety in the shapes and sizes of neurons does not always reflect the generic reference model with which they are described, Fig.4. Furthermore, in the infinite connections of neural networks anatomically and functionally interconnected to form nerve centers and pathways, it is difficult to distinguish the beginning and end of these structures. In these interconnected networks, there is no center and periphery from which the structure and the nervous impulse originate, which reverberates throughout the system, to maintain homeostasis active and to be able to respond coherently to the different stimuli they receive from outside or inside, Fig 5, (13).

Figure 5. Representation of a neural network

So neural networks are in a state of constant activity, even during sleep or hibernation, and so they absorb the greatest amount of energy of any structure in the body. Going up the zoological scale, we see a differentiation and specialization of the nervous networks. Neurons increase in shape and number and organize themselves into increasingly complex centers and transmission pathways, both in breadth and depth, until they form various overlapping layers. (14-15), Fig.6, 7. There is a morphogenetic mechanism that regulates the evolution and development of living beings, consisting in the fact that internal and external organs in their formation follow a plan or more plans that determine their symmetry. Almost all vertebrates follow bilateral symmetry during their development, that is, it is possible to divide their body into two mirrored parts. Bilateral symmetry has several advantages, it allows to optimize the motor coordination of the four symmetrical limbs of the animal and allows a more effective locomotion. Furthermore, the presence of 2 symmetrical internal organs is also useful because in case of injury to an organ it can be replaced by the specular one. This has created the need to develop symmetrical organs and systems and control their activities simultaneously. And this is the fundamental reason why the nervous system has a symmetrical structure in order to control both halves of the body simultaneously. The other consequence is the crossing of the motor and sensory pathways coming from the two cerebral hemispheres, in order to control the activities of the two halves of the body Fig.12.

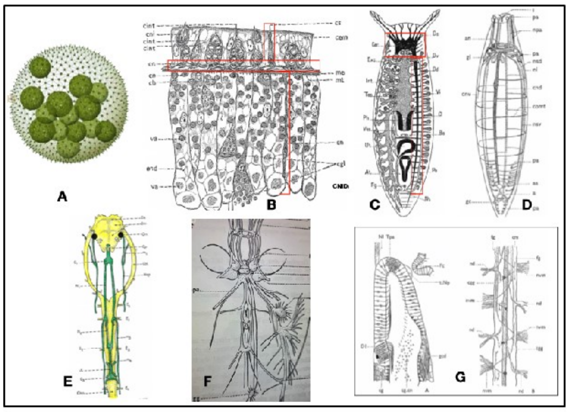

Figure 6. Arrangement of neurons from the outer surface to the inner surface and process of centralization of neural networks, from simplest animals to complex ones: A) Volvox - B) Cnidaria - C) Planaria - D) Ascarides - E) Polychaetes - F) Cuttlefish - G) Amphioxus

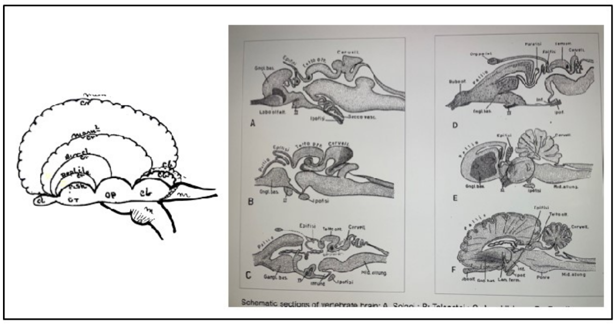

Figure 7. Brain growth diagram, on the left, - and schematic representation of the vertebrate brain on the right: A, Selaci ; B: Teleosts; C: Amphibians; D : Reptiles ; E: Birds; F : Mammals

Control is done with a feedback system of an interneuron that inhibits the activity of one motor neuron while the other is active. In vertebrates, as the complexity of their body increases, the stratification of neurons in the brain areas and centers also increases, until the typical *stratified or laminar structure* of the cerebral cortex is formed (16-17).

Very interesting is the particular arrangement of neurons that can be observed in histological sections of any tract of the vertebrate neuraxis. This arrangement assumes a radial and columnar appearance Fig.8. Cerebral cortical neurons proliferate from the ventricular and subventricular zones and migrate outward along radial glial processes to form the cerebral cortex and laminar cortical layers (18-19).

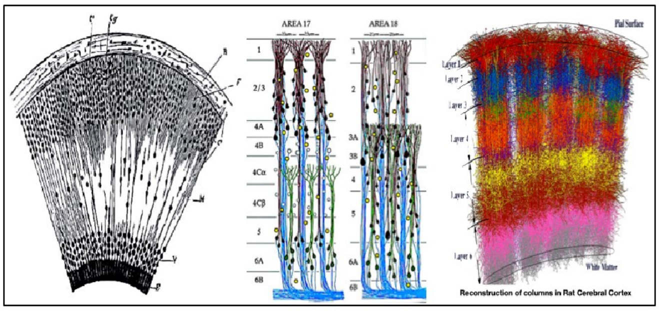

Figure 8. Radial and columnar arrangement of cerebral cortex

From the point of view of phylogenesis, we must note that with the progression of the evolution of the animal kingdom there is a progressive concentration of neurons in the cerebral centers and nuclei, which will become the sorting stations of the projections of the motor and sensory pathways, to and from the cerebral cortex. The cerebral cortex will thus become a mosaic of interactive specialized regions that are divided into distinct functional control areas Fig.9. In the diagram shown in the Figure, the dimensions of the body parts schematized on the cortex are proportional to the brain area involved in their control (20-22). In reality, the distinction and boundaries of the areas are only apparent, because all the brain areas are interconnected, so that an interruption, even due to a partial lesion in one point of the connections, compromises the integrity of the entire system.

Cytoarchitectural structure of the cerebral cortex: We have mentioned the arrangement in concentric layers, along the neuraxis and the thickness of the cerebral cortex, Fig.8.

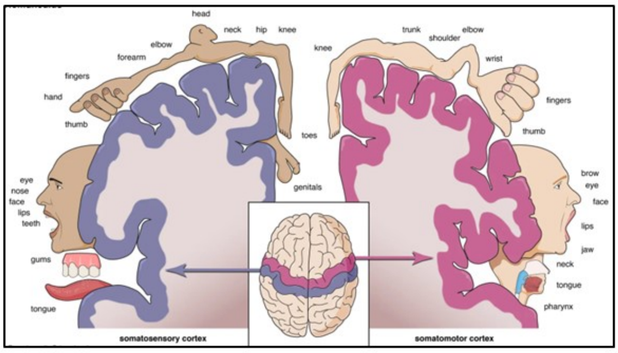

Figure 9. Schematic representation of the brain areas controlling the motor and sensory organs

The six layers that form the gray matter of the brain are occupied by neurons that have a specific characteristic shape that is repeated for each layer. What is the functional significance of the morphological diversity that neurons assume in the various layers, if from a functional point of view, they all obey the same neurophysiological mechanism? It's difficult to answer. Even more surprising is the spiral motion that drives the formation of many structures found in nature, and which also leads to the formation of the myelin sheath and its wrapping around the nerve fibers Fig.10. The myelin sheath serves to insulate the nerve fibers and improve transmission.

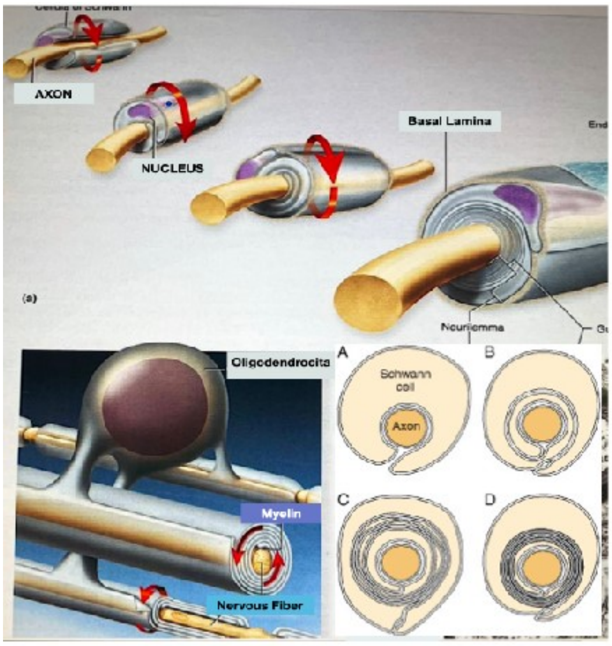

Figure 10. Schematic mechanism of myelin wrapping around nerve fibers

To the morphogenetic aspects described above, we must add that tissue cells originate from the stem cells of the basal germinal layer, and then reach the periphery and assume their definitive functional grade. Even from the evolutionary and embryonic development point of view, where "*ontogenesis recapitulates phylogenesis*" , according to Ernst Haeckel (1834-1919), we witness the same process of concentric development of organs and structures, observable already in the primordial stages of development, in which totipotent stem cells produce functionally mature systems and apparatuses.

In a very interesting article by Chris Fields et al, the Authors propose " *a morphogenetic coordination mechanism used to maintain the symmetry of the body axes, and pre-existing ionic and neurotransmitter gradients that regulate the tropism of individual cells during morphogenesis* " (23). This hypothesis, which I fully share, also explains another fundamental aspect of neurogenetic dynamics, the need for reciprocal contact/interaction between neurons and the molecular exchange of their content, to produce any new structural modification or physically detectable effect. In the case of living organisms, the morphogenetic forces at play are the generative force of reproduction, with mitosis, which follows a symmetrical orientation (bilateral and radial), and the ionic attraction/cohesion force of the cells, which originate from the individual embryonic layers. Both are also subject to the effect of the surrounding environment, which matter cannot escape as it must exist and evolve within it, Fig.11 (A).

Some authors call into question the tension between neurons (24-25) that guides them in a glial matrix as a neurogenetic mechanism. During embryonic development, the early stages of zygote division lead to the formation of a spherical structure called the morula and then to the blastula. This reproductive stage of early cell divisions occurs throughout the animal and plant kingdoms. The generative forces that intervene in morphogenesis in the early stages of embryonic development promote the sliding and adhesion/cohesion of cells onto each other, which, net of the biological mechanisms of mitosis, initially follow a concentric spherical symmetry, the blastula in fact Fig.11 (B). However, this mechanism cannot continue indefinitely, because by itself it would not explain the necessary morphological and functional specialization of tissues and organs that we observe in living beings. The next stage that is going to lead to the formation of organs and systems is the folding of the blastula on itself, with the invagination of one of the poles, and the formation of the gastrula, with which the first division into three embryonic

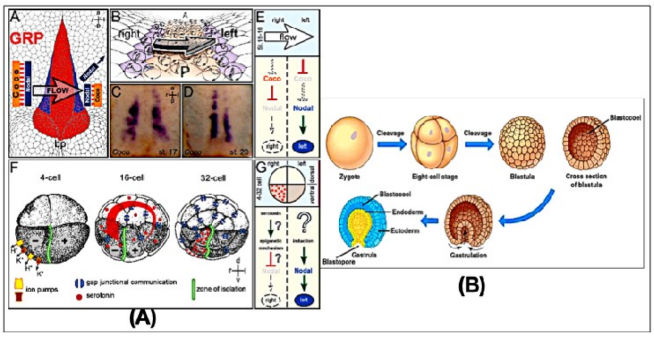

Figure 11. Embryonic development, (A) Interaction between cells and symmetry arrangement; (B) Early stages of embryonic development

layers is obtained Fig. 11 (B). From now on the morphogenetic mechanism will be under the dominion of the force of mitotic reproduction and sliding produced by the stretching of cells over each other and the force of cohesion that maintains structural integrity and preserves symmetry. In addition to this morphogenetic mechanism, a change also occurs within individual cells, under the epigenetic drive of differential protein synthesis which leads to the specialization of tissues and organs, cytological differentiation and neuronal typing also take place.

During this phase it is essential that the cells maintain their adhesion, while for cellular differentiation various substances come into play that promote differential morphogenesis. These substances, called neuronal inducers are: Retinoic Acid , Fibroblast Growth Factor (FGC), the Bone Morphogenetic Protein (BMPs). A leading role has been assigned to the hormonal peptide Sonic hedgehog which intervenes in the differential division of all cells. I would like to emphasize once again the fundamental mechanism of cell adhesion that allows cells to remain in contact and to check that their cell membranes have the correct set of receptors and channels that must distinguish them during differentiation.

In order to reach their final location, neurons must move in their migration in the surrounding substrate which provides the necessary instructions by means of trophic signals. This is a universal evolutionary process that occurs in all living things and is necessary for the differentiation of species. In the advanced stages of embryonic development of the brain, the formation of the sulci and convolutions of the cerebral cortex is the result of the internal pressure of the cerebrospinal ventricular fluid and the expansion of the surface of the cortex, which, unable to extend onto the external surface due to the presence of the cranial cavity, folds in on itself. It is important to underline the role of the genetic heritage in which the cytoarchitectonic changes that intervene in the differentiation of the layers of the cortex during the evolution of vertebrates are inscribed.

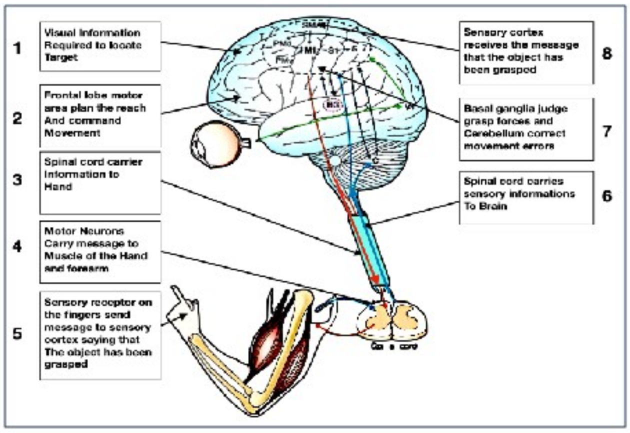

Figure 12. Schematic of the mechanism of voluntary movement and brain-cerebellum synergistic activity

The cerebellum, this unknown: The structural and functional complexity of the cerebellum and its relationship to the cerebrum still remains a mystery in understanding its role in animal evolution and behavior. The cerebellum is a structure of the central nervous system that plays a fundamental role in the coordination of movements, balance and other complex cognitive and motor functions. Its anatomy, evolution, development and functions have been intensively studied in recent decades, with the advent of advanced neuroimaging techniques, molecular studies and neurophysiological approaches. The cerebrum and cerebellum are two distinct, yet interconnected, structures of the central nervous system, each with specific functions. Despite their anatomical and functional differences, they work synergistically to regulate and coordinate many functions of the body (26-27).

Functions of the Cerebellum: The cerebellum is located under the cerebrum and plays a major role in coordinating movements, maintaining balance, and regulating posture. Its main functions include:

➢***Motor coordination***: The cerebellum is crucial for controlling the precision and fluidity of voluntary movements. It regulates the speed, direction and intensity of muscle movements.

➢***Motor learning***: It is involved in learning complex motor skills, such as playing a musical instrument or playing sports.

➢***Maintaining balance and posture***: Receives sensory information from muscles, joints and vision to maintain body balance.

➢***Cognitive functions***: Recent studies have shown that the cerebellum also plays a role in cognitive functions, such as working memory, language, and emotional regulation. The cerebellum is thought to be involved in the modulation of some executive functions, particularly sequential learning.

➢***Emotion Control:*** The cerebellum is implicated in emotional regulation and affective responses. There is evidence to suggest a connection between cerebellar dysfunction and psychiatric disorders such as depression, anxiety, and obsessive-compulsive disorder (OCD). The cerebellum is smaller in size and has a simpler external morphology than the cerebrum, but the number of neurons and folds present in its cortex are 5 times higher than those of the brain. This morphological distinction is already indicative of the complexity of this organ. In summary, the cerebrum and the cerebellum work closely together for motor control: the cerebrum plans and commands movements, while the cerebellum coordinates them, refines them and adapts them to the needs of the body, ensuring fluid and precise movements, (28-32).

The cerebellum also plays a fundamental role in cognitive and behavioral functions. Traditionally considered to be associated with motor coordination, it is now recognized as a hub of the integrated network that connects various sensory, motor, cognitive, affective and social functions. Patients with cerebellar disease exhibit dysfunction in various aspects of cognition, such as verbal fluency, abstract perception, visuospatial cognitive processes, social cognition, and problem solving across extensive cerebellocortical and subcortical circuits. According to Sherrington, 1906, the cerebellum is *'The integrative action of the nervous system* ', and describes the cerebellum as the "head ganglion of the proprioceptive system" and the cerebrum as the "ganglion of the distance receptors". Indeed, his concluding remark of the entire book " *It is then around the cerebrum, its physiological and psychological attributes, that the main interest of biology must ultimately turn* " may have condemned the cerebellum to obscurity (33). The cerebellum is the chiseler of the main cerebral activities of vertebrates, through feedback mechanisms that developed parallel to the evolution of the basal ganglia and the stratification of the cerebral cortex. It monitors and anticipates brain activities so that they are performed with maximum precision, it is the executor of the follow up that keeps all brain functions under control and intervenes by remodulating them in the case of dysfunctions.

Example of the mechanism of motor patterns: How are the movements performed?. We distinguish between automatic involuntary movements, also called reflexes, which occur spontaneously in response to a stimulus, and voluntary movements which are performed to achieve a pre-established goal. With reference to the previous description, an automatic reflex movement is encoded in the sensorimotor circuits of all individuals of a given species, is activated by an environmental stimulus and produces a stereotyped response. Patellar reflex, alert and flight, eye closure, etc. As such, these reflexes are part of the hardware of the genetically encoded and well-established sensorimotor systems in all animals, because they are essential mechanisms for the survival of the species. The execution of a voluntary movement to achieve a defined goal requires multiple activities, summarized in the following steps:

- central voluntary stimulus, is the goal to be achieved,
- execution requires the activation of different neural circuits:
  - visual system,
  - muscular system,
  - kinesthetic system for position control,
  - continuous feedback control of all phases of movement,

Finally we get control of the result achieved with respect to the starting goal from the central stimulus Fig.12.

The transition from aquatic to terrestrial life of vertebrates involved the acquisition of four mobile limbs necessary for movement on land, and the implementation of neural networks for motor control. The ability to perform coordinated movements with all limbs requires the participation of the entire sensorimotor system. The set of motor and sensory systems have been perfected for the execution of increasingly complex and precise motor patterns. The first necessary stage for the execution of effective movements with the four limbs required their coordinated and symmetrical control, so that the contraction of the limbs on one side of the body had to correspond to the relaxation of the limbs on the other side Fig.13, for the simple reason that the simultaneous contraction of all four limbs would make any movement impossible.

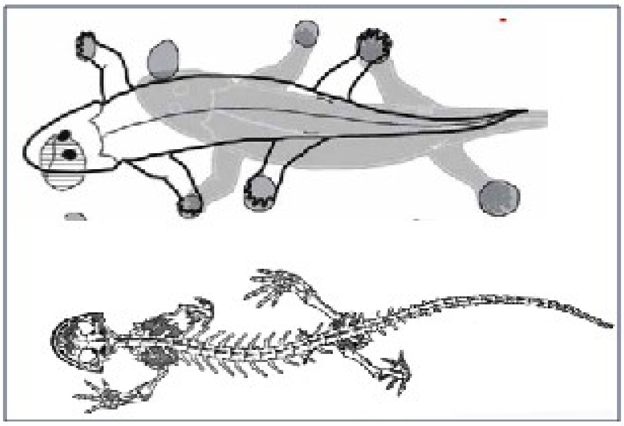

Figure 13. Schematic drawing of limb movement in tetrapods

The need for coordination of movements has developed the cross-control of the motor pathways of the limbs on one side of the body and at the same time of the contralateral part. This possibility has been obtained in the course of evolution with the crossing of the motor and sensory pathways, so that those directed to the homolateral symmetrical limbs and organs are also directed to the contralateral ones . The crossing occurs at specialized transition points present in all the metameres of the neuraxis with the crossing of the midline, called decussations or commissures Fig.14. The alternating motor control of the two halves of the body occurs with the intervention of interneurons that inhibit the motor neuron of one side when the other is active.

The prehensile limbs of primates: In primates, prosimians and monkeys, evolution has led to the development of the extremities of the limbs into prehensile hands and feet, to make them capable of performing fine movements and grasping and manipulating objects, made possible with the acquisition of the upright position. To perform such fine movements, it was necessary to further develop the brain with the addition of nerve pathways dedicated to them.

Neurobiological basis of neuronal and synaptic transmission: Sensory systems are distributed on the surface of the body that is in direct contact with the outside, and are specialized to collect stimuli of various types coming from the environment.

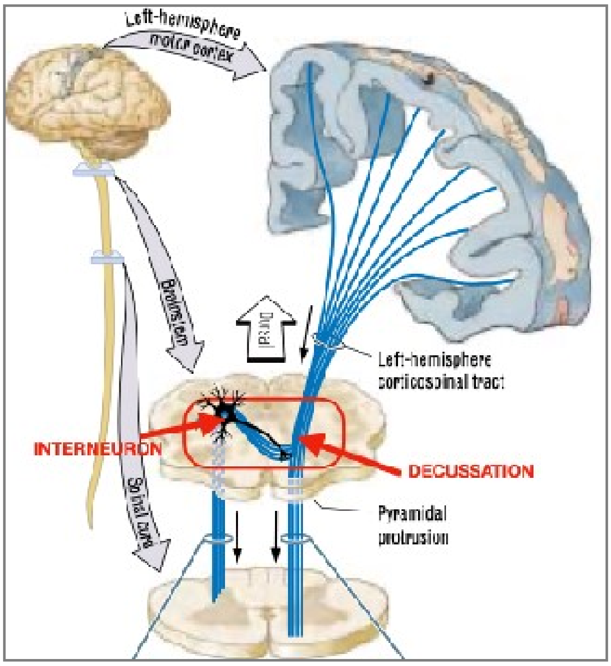

Figure 14. Crossing of the pyramidal motor routes

External stimuli are mechanical, electromagnetic and gravitational. The signals are passed to the brain, which must examine them to develop an adaptive response. Sensory receptors are the only inputs for external and internal information, they transform the internal or external signals they receive into wave codes and frequencies and transmit them to the neurons in the cortex where they are decoded for processing the information received. The fundamental mechanism of the stimulus-receptor interaction is of a molecular nature and consists in the property of molecules to modify their conformational structure in vibrational energy. We know from atomic physics that molecules, and in particular the atoms that constitute them, respond to a vibrational solicitation by modifying their electronic arrangement with quantum jumps from the equilibrium orbitals to orbitals with a higher energy level; when they return to the original orbital, they re-emit vibrations with the same energy as that absorbed Fig.1. The vibrations that provide the energy of the stimulus are of different nature, but for a stimulus to be capable of producing a physically detectable effect, the presence of matter is essential, whether of atomic dimensions or of molecular complexes. And it is thanks to the vibratory energy that matter emits or receives that the natural phenomena of molecular synthesis and receptor responses have occurred, which have produced cosmic evolution. Once the information has been processed by the neurons of the nerve centers, the response is produced and sent with the same wave code, to the muscle fibers of the effector organs, for the necessary response. In this way the communication process closes and completes its cycle. The universal code for communication between living beings is produced by frequency-modulated oscillations that neurons are able to receive or generate. Transmission in nerve cells occurs through neurotransmitters that act on protein channels, pumps and receptors present on the neuronal membrane and regulate the flow of ions. The molecular basis of the movement and morphology of neurons and all other cells is the cytoskeletal network (34).

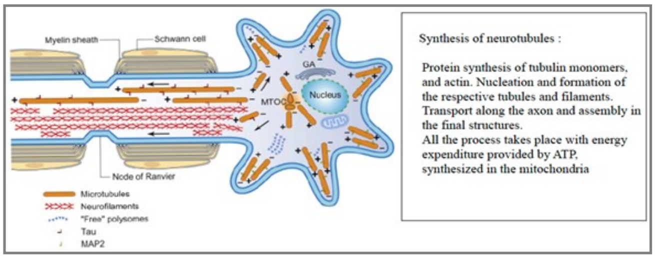

Figure 14. Schematic of protein synthesis for the formation of microtubules and actin

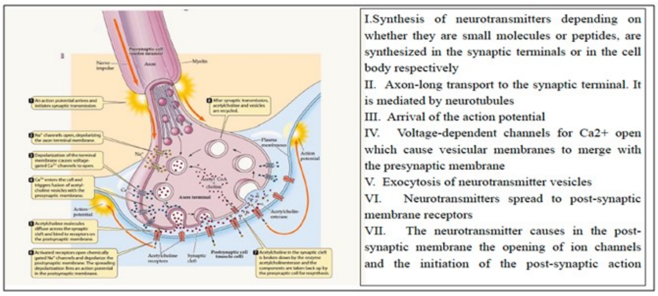

Figure 15. Schematic representation of neurosynaptic transmission

All cells contain a network of protein microfilaments, the cytoskeleton, which forms the molecular scaffolding that produces cellular movements. In somatic muscles, microfilaments produce voluntary movements; in visceral muscles, they produce contractions necessary for vegetative functions, such as gland secretion, pulmonary respiration, and the contraction of blood vessels and the heart. The cytoskeleton is formed by thread-like polymeric protein structures of various sizes, the microtubules, the microfilaments and the intermediate filaments, which aggregate and disaggregate and control the movements of the cell and its internal organelles. By means of extensions, the microtubules form the protein substrate, which guides the cell in its exploration movements of the surrounding field and in the acquisition of their shape (35). With its movements, the cytoskeleton produces on the cell surface the formation of flat-shaped protrusions, the lamellipodia, or thread-like protrusions, the fillipodia, which propagate in the direction of the cell movement (36-38). The cytoskeleton is the molecular motor that guides the cellular movements of all living beings, from protozoa to the most evolved animals, and is clear evidence of a common phylogenetic origin. These movements carry the neurons to their final location where they establish contacts with the effector cells to which they are destined.

Microtubules form the mitotic spindle during cell division, which is essential for the correct distribution of chromosomes to daughter cells, and are also involved in the transport of protein molecules used to form support structures or to transport synaptic vesicles, Fig.14. Protein synthesis of microtubules, called neurotubules in neurons, and actin filaments occurs according to the following phases: Furthermore, it is also essential to remember the role of the cell membrane, which ensures the exchange of substances with the outside, maintains energy homeostasis and the electrolytic and osmotic composition of the cells, and uses the protein channels and receptors that form the transport structures present on its surface. I emphasize that the fundamental mechanism underlying morphogenetic forces and the functioning of excitable cells consists in the distribution and passage of ions through semipermeable biological membranes and in the frequencies generated by these.

Synaptic transmission

Synapses are the fundamental structures where nervous activity is processed. They are divided into electrical synapses and chemical synapses (39). In electrical synapses the passage of ions occurs directly through the contact of neuronal membranes in specialized areas, while in chemical synapses the transmission occurs through the release of synaptic vesicles containing neurotransmitters, which pass from the presynaptic membrane to the postsynaptic membrane. Depending on the type of neurotransmitters used in the various synapses, the neurological effect of excitation, inhibition, modulation is obtained (40-43). Synaptic structures therefore represent the true effectors of neuronal functioning. This mechanism is so essential that it is written into the genetic heritage that regulates the protein synthesis of channels and ion pumps in the cell membranes of all living organisms, including bacteria. Nervous and synaptic transmission can be represented synthetically in the following phases Fig.15:

At the synaptic level, retrograde signaling (or retrograde neurotransmission) is also present and is a process by which a retrograde messenger, such as anandamide or nitric oxide , *is released from a dendrite or postsynaptic cell body and travels "backwards" across a chemical synapse to bind to the axon terminal of a presynaptic neuron.*

The purpose of retrograde neurotransmission is to regulate chemical neurotransmission. For this reason, retrograde neurotransmission allows the neural circuit to create a feedback loop. Retrograde neurotransmission serves primarily to regulate typical, anterograde neurotransmission, rather than to actually distribute any information, and is similar to electrical neurotransmission. In contrast to conventional (anterograde) neurotransmitters, retrograde neurotransmitters are synthesized in the postsynaptic neuron and bind to receptors on the axon terminal of the presynaptic neuron.

The Universal Code of Communications

The fundamental task that neural networks perform in living beings is collecting information from the external and internal environment to produce responses aimed at adaptation. It is essentially a feedback mechanism that maintains the homeostatic balance of living beings in their natural habitat and ensures their survival in changing environmental conditions. In doing so, this mechanism promotes evolution, which we have briefly described above. Neural networks are divided into a receptor component that collects external stimuli, a modulatory component formed by interneurons, and an effector component that translates the information collected by the receptor system into behaviors aimed at adaptation. Sensory systems are distributed on the surface of the body of living beings, and being in direct contact with the outside, they are specialized to collect signals coming from the environment, which as we have described several times, are of a mechanical, electromagnetic and gravitational wave type. The signals are passed on to the central control organs, the cerebrum and cerebellum, which examine and decode them to develop an adaptive response (44). Once the information has been processed by the neurons of the nerve centers, the response is produced and sent, with the same code, to the effector organs. In this way the communication process closes and completes its cycle. In conclusion, the universal code for internal and external communication of living beings is formed by *frequency modulated oscillations* that neurons are able to receive or generate. In both cases, oscillations can appear either as micro-oscillations of the resting membrane potential, or as rhythmic oscillations of variable amplitude of action potentials, which are then transferred to the oscillatory activation of post-synaptic neurons. At the macroscopic level of neural ensembles, their synchronized activity can give rise to oscillations observable with instrumental recordings (45). Oscillatory activity of neuronal networks has been widely observed at different levels of organization and is thought to play a key functional role in information processing. However, a unified interpretation of the phenomenon is still lacking.

Thus the flow of incoming and outgoing ionic charges, generated by the neurons' ionic pumps, maintains the resting potential and generates the microspikes. For example, Purkinje cells exhibit spontaneous electrophysiological activity in the form of both sodium-dependent and calcium-dependent spike trains. Even more surprising is the effect produced by high frequency sound waves on blocking the nervous transmission of pain, or by the effect of magnetic stimulations (46). In general, action potentials can be generated chemically, optically, mechanically or by electrical stimulation in various types of neurons (47-48). This demonstrates very clearly that the efficient causes of transmission codes are produced by the wave frequencies and their modulations, and not by the flow of charges that generates them.

We perceive mechanical frequency variations as sounds, because they are decoded as such at the level of the cerebral cortex. Similarly, we perceive variations in light frequencies as colors or images because they are decoded as such at the level of the cerebral cortex. What we observe in the case of colors and images is not produced by the type of photons but by the frequencies associated with them. In the living world, it is the flow of ionic charges itself that produces wave frequencies. Confirmation that sounds and colors are recognized at the brain level as frequency waves comes from experiments or surgical interventions of ablation of the occipital and temporal cortex which produce central blindness and deafness. The division of brain areas into separate centers and lobes allowed resident neurons to specialize in decoding different frequencies. In cases of damage to the sensory cortices, through experimental or surgical ablation, we witness the plastic vicarious reuse of the damaged functions in other functional areas. The different shapes of neurons and their distribution in the layers and columns of the cortex probably reflect their specialization in the reception and transmission of specific frequency ranges. This is certainly true for all receptors that have acquired a shape and structure suited to collecting the stimuli to which they are sensitive. For example, the cones and rods of the retina are specialized to collect a range of light lengths, but the signal transduction is carried out at the level of rhodopsin. Personally, I am convinced that the functional essence in excitable systems must be sought in the infinite possibilities of modulation of amplitude and oscillatory frequency produced by the molecular vibrations of matter, which give life to the symphony of the "universal code" and allow their communication. The mechanism underlying the genesis of the code produced by molecular kinetics remains a mystery.

Therefore, wave frequencies play an irreplaceable role in providing information; they are specific, extremely fast and effective in transmitting messages exactly where they are needed, with precision that can be modulated at an infinitesimal level.

Neural network systems are wired, that is, they use fibers made up of nerve filaments to transmit messages. In this way, messages are transported within a physical medium and do not disperse into the environment and precisely reach their biological target. Vascular networks work in the same way, transporting oxygen and nutrients to target organs in blood vessels with capillary precision.

Cerebrospinal fluid and CNS vasculature

The nervous system of vertebrates is immersed and surrounded by a liquid called cerebrospinal fluid, or CSF, which has a characteristic composition and is the fundamental external environment in which brain activity takes place. The production of cerebrospinal fluid is strictly regulated in quality and quantity by a homeostatic mechanism essential to ensure the correct functioning of the CNS. The presence of the cerebrospinal fluid keeps the CNS in a fluid, and as such incompressible, environment, which serves not only to protect it from trauma, but also to provide nourishment and maintain the correct osmotic pressure. The fluid is produced by the choroid plexuses and continuously maintained in electrolyte balance by the arachnoid granulations. Its alteration leads to some serious pathologies Fig.16.

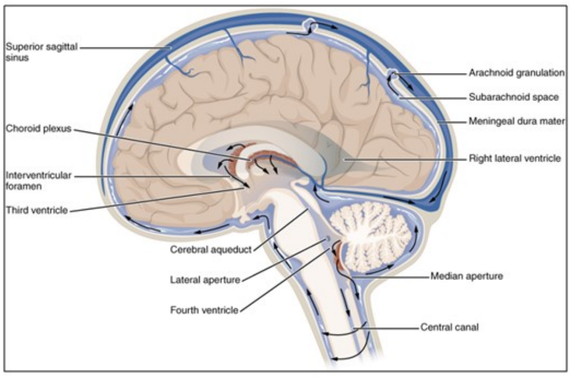

Figure 16. Cerebrospinal fluid

There is also an internal liquid environment in the CNS formed by the blood vessels from which the neurons are separated by the Blood -Brain Barrier, but it ensures the supply of nutrients and oxygen to the brain tissues. The essential role played by vascular structures and blood cannot be overemphasized. Interruption of blood supply for just a few minutes has catastrophic consequences for the brain.

Artificial Intelligence AI in the study of the nervous system

The infinite structural and functional complexity of the nervous system, which we have outlined in the previous paragraphs, has been studied using the most diverse technologies that until now have provided us with fragmentary and superficial information. In recent years, computers have been widely used to attempt to build artificial networks that can mimic the connections between neurons and provide us with insights into the mechanisms underlying these functions.
Such an approach has produced an unnatural paradigm and analogy between artificial networks of electronic circuits of computers and natural neural networks of living beings, I underline the attribute "living" which alone indicates the fundamental gap that distinguishes the two systems (49). is how the use of Artificial Intelligence was introduced in the study of nervous networks. Comparing a network of electronic circuits with the most basic neural network leads to aberrant conclusions, for the simple reason that an electronic circuit has limited possibilities for exchanging information, whereas a neural network can process an infinite number of communications and can reach awareness of the processed events , going beyond the mere perceived message.

Among the many articles that examine the limits inherent in AI, I report the following consideration:

“Computer professionals and brain researchers need to address the limitations of computers and need to comprehend the exceeding complexity of the brain and consciousness. Paradigms require that conceptualize beyond current computer models. Quantum computers need to be developed that are capable of handling the complexities of such tasks.” (50).

But there is a relevant and decisive epistemological aspect that resolves the fundamental contradiction inherent in the approach to knowledge with AI.

If it is true, as many argue, that AI is indispensable for understanding natural phenomena and can even surpass the knowledge capabilities of neurobiological systems and the human brain, does this mean that we cannot interpret and manage the information that AI makes available to us, perhaps with next-generation quantum computers, given this gap that separates the two systems (51-53)?. Artificial Intelligence lacks the requirements that make living matter unique: variability, flexibility, and the ability to adapt to changing environmental conditions and therefore to evolve and improve its state, have consciousness and feelings. Finally, only the brain can become aware of its own existence and research what its role is in the evolution of the universe.

From the real world territory to its representation in the brain map: The ability of living beings to act in their environment depends entirely on how they manage to finalize their behaviors to achieve a goal. In order for living beings to act effectively and achieve a goal, it is necessary that they first have a complete and realistic representation of the environment in which they live, so as to recognize their living space and the characteristics it presents, and this is achieved with the activity of all the receptor systems with which they are equipped. Furthermore, to exercise this activity, it is necessary that the nervous system is in a state of alert and vigilant, with all the sensory and motor systems active. Furthermore, it is necessary that they have already acquired, with previous experience, the motor patterns necessary to move and act in the space they occupy. To performing new movements, it is necessary to first learn them with exercise in order to acquire them, and then put them into action. Voluntary movements are achieved with the coordinated activity of the cerebral and cerebellar motor centers that, in addition to activating the muscular system, must retrace during execution, all the memorized steps and the complete scheme for that particular movement. Once the new skill has been learned, the system is able to use it if necessary in the same situations. In other words we can say that the territory, which is the reality that surrounds us, is acquired through the sensory systems and is recorded in the form of a map in the central nervous system. This is how you acquire the checklist of motor skills for walking, playing tennis, playing an instrument, etc. The physiological capabilities of body systems are similar in every living species, only the way they are executed changes, which is specific to each individual. Because each individual modulates behavioral patterns with his subjective experience. This is why we all know how to play soccer but there is only one Maradona. How do we recognize the real world of things, and where does recognition occur?

It is said that understanding occurs at the brain level, but how does the brain represent reality to us?

Let's try to retrace the path that starts from the observation of the external world through the stimuli that it sends to our brain. We have said that material things emit electromagnetic waves that reach the brain through the senses in the form of specific vibrations and frequencies. But once the frequencies have reached the target cerebral cortex, what happens, how are the vibrations transformed into corporeal objects, with their color, smell, taste, sound and consistency so that we can recognize them?

The answer may be that objects are transformed by the brain's neural circuits into holograms, just as with holograms we have a virtual representation that we can nevertheless grasp with our eyesight. But if this interpretation is plausible for the sight of objects because we do not necessarily have to touch them to recognize them (as happens in dreams where we can "see" even complicated scenes and events, to the point of experiencing the emotions they cause us), or for sounds which are pure vibrations, for all the other senses physical contact is instead necessary, to experience their consistency and concreteness. In every case, knowledge of the real world is an evanescent holographic representation that the brain represents to us, even when we manage to transform things and objects with our manual ability. In this case we transform the holographic and artistic representation from the brain image into real objects, and into artifacts using real tools.

How does the brain work?

The following description presents my personal interpretation of the fundamental mechanisms that they promote the meeting of elementary particles in the formation of matter , and on which neural networks are articulated in the process of collecting and processing stimuli. Vibrations, Oscillations and Frequencies are the physical quantities on which the origin of the universe and the cognitive systems that can represent it are based. The brain functions as a recording system that is able to perceive information emitted in the form of frequencies and vibrations that it receives from the outside world, and reproduces them in the phase of conscious recognition. The frequencies that our senses can register are within a range limited by the vibrational properties of the receptor systems of the sense organs with which we are equipped. We can receive images and sounds within the frequencies of the visible and audible spectrum.

While other animals have developed sensory systems capable of vibrating at different frequencies than ours. For example, dolphins, whales, bats, bees, emit and receive frequencies that only they can recognize and are different from ours Fig.17.

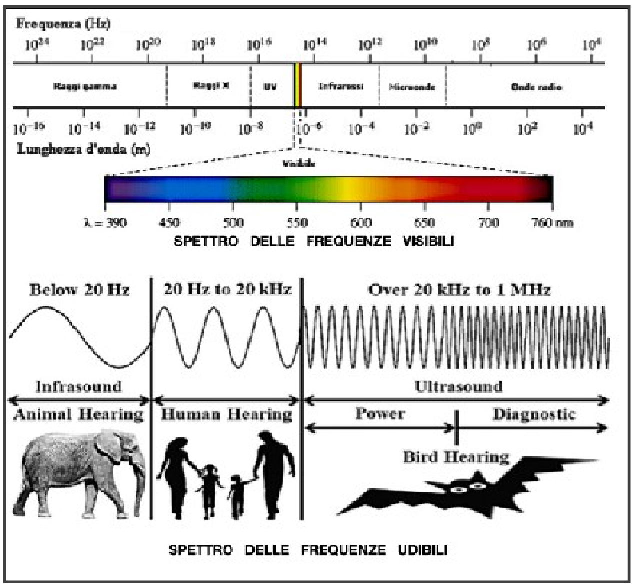

Figure 17- Visible and audible frequency spectrum

Other animals can recognize infrared frequencies that we cannot. This depends on the vibratory capacity of the neurons and receptors that these animals have acquired through natural selection. Animal neurons have a response threshold to the stimuli they receive that is completely different from ours. In animals, recognition occurs in the neurons of the cerebral cortex that receive and decode the frequencies of the stimuli and transform them by recomposing them, with the help of all the brain areas involved, in the form of holograms. All animals recognize the properties of objects in the external world from the frequencies they emit. I repeat what I have repeatedly argued that the frequencies emitted by substances depend on the molecules from which they are formed.

For example, a flower emits frequencies that depend on the shape, color and scent of the molecules it is composed of. Thus the properties that objects transmit can be infinite, because the combinations of the molecules that compose them are infinite, and the molecules themselves acquire the properties of the set of atoms from which they are formed. And that's how a select number of atoms produced a symphony of sounds, colors, states of aggregation, which the universe transmits to us. The recognition of the external world occurs in the same way in which it is perceived, with the participation of all the senses of the brain. The brain represents the world to us with a virtual stereoscopic and holographic image. We see images, hear sounds, smell smells, and perceive the consistency of things even with our eyes closed or in the confines of a dark, acoustically isolated room deprived of sensory stimuli. We recognize objects because we have acquired and recorded all their characteristics in our memory and they are represented in our brain.

We also learned language through the acquisition of sounds and the graphic signs that indicate them, with individual phonemes and graphemes. We remember a symphony because we have memorized the individual notes that compose it in the auditory area of the brain, or we remember a story or a poem because we have recorded it in the brain with the sounds and rhythm of the individual phonemes. We can perceive and recognize the real world only if it produces sounds and vibrations of the right frequency to which our receptors can respond because they have acquired it through natural selection. For this reason we do not hear ultrasound, which does exist, or see infrared rays. We perceive the real world as a symphony of vibrations and frequencies. Finally, we perceive it in three-dimensional form, because we have double and symmetrical sense organs that together contribute to stereoscopic recognition and allow us to recognize the size, position, distance and edges of objects and from which part of space the stimuli come, and we distinguish them from everything else, as long as their intensity is sufficient to reach our senses. The neurosensory mechanism is the same for all living beings and is based on the variation of frequencies, oscillations and vibrations that substances emit. All living beings contain the same elementary substances and the same molecular structure as matter present in nature, even if they have then merged in different combinations in individual species.

So all the matter that makes up the universe, from bacteria to galaxies, vibrates at the same frequencies and with a single universal code, to which we ourselves vibrate. All sciences, from astronomy to quantum physics, know the universe by the frequencies they are able to collect. Probably the matter that we describe as dark matter, or black holes, we do not perceive precisely because it emits frequencies that we cannot register, or does not emit them at all. We owe the existence of matter and the universe to the elementary substances that formed them at the beginning of time, with the emission of frequencies with which they recognized each other, communicated and united in real things, without interruption. It is those same elementary substances that today compose our bodies, that allow us to know the real world, when the molecular frequencies of this are similar to those of our body, overlap and enter into resonance.

Volumetric sensitivity of objects

We can appreciate the volume of objects with tactile and visual sensitivity. When we hold an object in our hand, we recognize its size according to how much we stretch our fingers to hold it. The more our fingers spread and our hand opens, the larger we perceive the object to be, and we recognize its size even with our eyes closed. We know the size of objects with sight because vision is stereoscopic, one eye sees at a different depth than the other, so that when we observe with both eyes the two visions add up and coincide and we appreciate the size and distance of objects.

A simple experiment helps us understand how binocular vision works. If we stare at a stationary object at a certain distance, if we observe it by alternately opening and closing our eyes one at a time, the object appears to move while in reality it is still. The same phenomenon occurs with hearing. If we listen to music in monophonic mode, we will feel like we are hearing a single sound with both ears, while when we listen to music in stereo, we hear the sounds alternately first with one ear and then with the other. In conclusion, I believe that the brain records the map of frequencies that the objects in the territory have evoked, and when similar objects appear in other contexts it is able to reconstruct their shape by making the memorized frequencies coincide with those emitted by the objects. In the absence of the objects, the brain sees them as holograms.

The will: Will is always expressed through voluntary behaviors. Willing means being able to achieve a goal through voluntary movements, and includes a series of executive actions that lead to the achievement of the goal. Only after the goal has been achieved do we become aware of it. While all other activities are not voluntary, there is no will to listen to music, because it is enough to turn on the radio to listen to music, moving to turn on the radio is the voluntary component of this activity, after which hearing comes into action, which is totally passive, it does not require a voluntary action to come into action. The same goes for any other activity that requires the intervention of the sensory systems. Therefore any voluntary activity is totally dependent on the muscular motor system. In its ancestral form, the will of primitive living beings was not yet expressed and behaviors were under the dominion of sensory stimuli, evoked by reflex circuits that did not require particular decision-making commitments.

Hunting prey or fleeing from a predator were stereotyped behaviors, responses to natural stimuli aimed at preserving the species. In other words, will requires the use of the motor system for its implementation, which intervenes after the decisional stimulus. In order to fully understand how will works, we must analyze where the decisional stimulus, the trigger stimulus, starts, which makes us decide and move to achieve that particular goal. Probably the primary stimulus, the start up that evokes the will is inherent in our cognitive system, and arises from a physiological or mental need for something that we feel the need for, perhaps unconsciously, therefore it motivates us to satisfy this internal request. Probably we are not immediately aware of where this need emerged from, only after having obtained it are we satisfied with the result. This behavior presupposes a state of awareness of oneself and one's needs. Fundamental vital activities do not belong to this behavioral sphere, because they are evoked by essential physiological stimuli such as hunger, thirst, sleep or reproductive stimulus, because they are spontaneous behaviors that do not require a prior decision, but obey an internal physiological stimulus.

So, if we want to outline volitional behavior, whatever the start of the voluntary act or the area of the brain from which it originated, and whatever its nature, emotional, rational, physiological, etc., its achievement necessarily requires active, conscious behavior that engages the motor system. While the neural origin of the will was remaining obscure, its mode of execution has been ascertained, Fig.11. In other words, by will we mean the behaviors that are revealed and finalized with a movement. I repeat my thesis: voluntary movements are such because they are oriented towards the achievement of a goal stimulated by an internal conscious need. Ultimately, will is the manifestation of a stimulus, the primary cause of a need that arises from the cognitive and emotional sphere, of which we are not aware until the decision-making moment; we recognize it when it becomes the trigger, with the incipit of the movement, which is the only event of which we have knowledge and awareness. Wills that are not translated into voluntary movements, and are not expressed, remain wishful desires and drown in the sea of subjective aspirations. If were a doctor, or a professional athlete, I had to necessarily start acting coherently to reach the goal. Otherwise it remains an unexpressed desire, an aborted will. In other words, behavior is the only means we have to express our desires, ambitions, emotions, ideas. And it is the medium that connects and relates our deepest essence with our environment and with others.

DISCUSSION

Considerations on the Significance of the Activity of Nerve Networks

Schematically, the evolution of neural networks has followed the following development:

- Increase in the complexity of neuronal networks from a single-layered arrangement to the formation of concentric layers and neuronal aggregates, in nuclei or ganglia, interconnected by means of nerve fibers that carry chemical or electrical contacts (synapses) and propagate information along the neuronal network;
- **Dynamic polarization of nerve** impulse transmission which always travels in the direction from the dendrite towards the neurite or axon.
- Organization and **columnar arrangementof the various** morphologically and functionally distinct cellular layers, in 6 layers. This arrangement groups the functional units of the nervous networks into interconnected columns, *Neurobiome*;
- Process of **concentration and cephalization of neuronal networks** , oriented in the cranial direction to form major receptor centers (sight, hearing, smell, taste) which are fundamental for sensory orientation in the direction of movement;

The following questions still remain open:

Why do neurons in different parts of the CNS have different shapes?

Why do they change shape and functional specialization, if they all adopt the same mechanism of exchange of frequencies produced by the ionic flow?

The nervous system and skin both derive from the embryonic layer of the ectoderm. They therefore have a common phylogenetic origin from the external layers of animal bodies that communicate directly with the surrounding environment, this is a clear indication of their fundamental function, to interact with the environment. They therefore represent the intermediary that connects the external and internal world of living beings, right from the early stages of embryonic development and are of fundamental importance for evolution, adaptation and survival. The entire functioning of neuronal networks is based on interaction and communication with vibrations produced by molecular messengers, neurotransmitters, and on the progressive expansion of the contact surface between individual neurons, with dendritic arborization and neuritic extension of synapses that amplify the ability to communicate. Even the folding in sulci and gyri increases the surface of the encephalon, and of the cerebellum that can accommodate an increasing number of neurons.

So that interaction is the primordial event necessary to communicate and know the reciprocal characteristic properties of living beings, and allows them to evolve towards increasingly complex systems, to finally be able to understand the universal laws that guide and govern everything.

CONCLUSION

If we observe the functioning of the systems, organs and architectures that form living beings, we must conclude that molecular interactions are at the basis of everything. No cosmic event in the universe, whether inanimate or living beings, occurs without the active participation, interaction and contact between material bodies. From this we can deduce that neural systems and networks have evolved to be able to recognize and give an epistemological meaning to the matter from which they are formed and to the reciprocal interactions that animate them.

And it is amazing to note how a few selected material substances, in addition to being able to form the cosmic architectures we have described, are capable of organizing themselves in a special way, to obtain that fantastic result that we call life. To remain in the realm of pure speculation, the interpretation I present here of the meaning of nervous systems is the natural and functional one that the observed phenomena suggest to me, but I cannot explain the reasons for it. Therefore, research must continue. Sooner or later, the same matter that forms the networks of complex neural circuits will be able to know itself.

Disclosure: The Author of declares that he has no conflict of interest in this article

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