

Informational Operability of the Brain: Novel Approaching Perspectives in Neuroscience and Neurology

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Information is an essential player in the human organism and living structures [1]. However, little is known actually about the information concept and information role applied to the brain operability. Within the effort to introduce the concept of information in the living organisms, specifically in the human brain, new and spectacular results could be obtained, if this concept is adequately defined and used. In figure 1 is shown a schematic representation of the Informational System of the Human Body (ISHB), where the information concept was used to distinguish the main forms of the brain functionality, as follows.

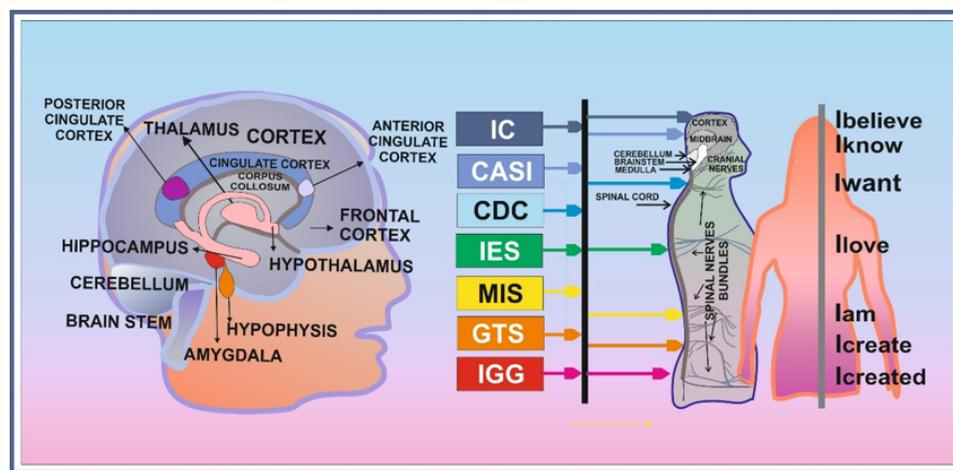


Figure 1: Schematic representation of the informational system of the human body and its components/brain supporting zones, and their projected cognitive centers in mind.

If it is defined the Center of Acquisition and Storing of Information (CASI) as the sum of the involved areas of the brain in this range of activities, we have to understand that the brain operability in this case is referred to the conversion of the sensor's received internal and external information (hunger, thirst, pain or sight, hearing, smell, taste, touch respectively, to name only the main categories), into adequate signals, which are and can remain registered on these corresponding areas of the brain, mainly in the prefrontal cortex for short-term memory (max. 2 min.) and in the hippocampus for long-term memory. From the informational point of view, the perceived internal/external information transduced by sensors is transported by means of informational agents (ionic K^+/Na^+ waves and neurotransmitters along the intra and inter nervous cells respectively), through informational circuits to the brain operational areas. The activation of these circuits allows the exploration of the internal and external reality.

Thalamus, with a central position in the brain (figure 1 left side), is an informational relay station for info-integration/distribution and direct/feedback info-communication of the sensory signals (like sight, hearing, taste, touch, heat/cold, pain, some smells and others), from inferior perception levels (like spinal cord/brain stem), to the hierarchical cerebral cortex [2] and cerebellum (automatic motor-related headquarter of the acquired abilities), and is an essential/imprescriptible component supporting consciousness. The high density of neurons in cerebellum can be explained just by the complexity degree of the info-motor abilities. Temporoparietal junction (an area near temporal/parietal to occipital lobe) plays an important and specific role in memory, integrating information from thalamus/limbic system, visual/auditory/somatosensory circuits, involved in the right side in self-spatial recognition, attention, empathy/sympathy, and in the left-side in language, reasoning of other's beliefs. Practically, the info-integration consists in the participation/connection of various specialized cell networks transporting a certain category of sensorial signal, to the co-participative activation/firing process of a common multi-perceptual network, this one transporting this time a composed signal in a unique inseparable component, as it is the case of the multiple (usual) perception in quale/qualia experiences.

The Info-Connection (IC) pole of the organism (figure 1 central zone), supported by the anterior/posterior cingulate cortex during the current operations (figure 1 left side), allows the automatic (educable) selection of the useful (among GOOD/BAD) information [2], according to the inherited/acquired survival/adaptation needs, and the daydreaming/introspection respectively. As it was recently explained, the high energy consumption of the posterior cingulate cortex, switching/disrupting the actual attention from the external reality to the daydreaming state over the internal world, is due to the necessary maintenance in stand-by activated state of both informational fields of data [3].

As the value of the action potential is the same (around 55mV) for any firing nervous cell, any of them will transmit an electrical signal of the form of a YES/NO Bit-type informational unit, like a switching transistor in our computers. The inter-cell transmission by inhibitory/excitatory neurotransmitters induce (YES) or not (NO) a new electrical pulse in a neighbor cell, this process developing a local co-acting cell network, depending on the characteristics of the initial signal [3]. Moreover, the communication between the chemical informational agents and the surface receptors of the cell is controlled on a similar way by YES/NO (Bit-type) selection, because only the appropriate neurotransmitters are received by the corresponding receptors, through a key/frog fitting-like process. Therefore, in terms of information, the frequency and number of electrical pulses of a cell, determining the type/composition of the emitted neurotransmitters in the synaptic gap, determine in fact the info-transmission strength to the next neighbor cell, so the intimate "vocabulary" of communication. As an example, let consider the sight circuit at human, which is highly developed, involving more than 50% from the brain cortex. Following the similitude with the operability of the informational devices, the specific signals collected by the optic nervous system from the eyes, converted in the brain into specific composed sets, similarly with that entering into a monitor of computer, are able to recompose the pixels of an instant image collected from reality, "projected" on the "sensory mental screen" in the prefrontal cortex. The imagistic circuitry used to recall the stoked data is the same with that of the perception, but with corresponding reduction of image resolution.

The mechanisms of memory are not yet well understood, but it is more largely accepted the idea of the reconfiguration of microcircuits of nervous cell networks in hippocampus, contributing to memory by the number and frequency of impulses (functional plasticity) and the combination/correlation between cell network partners (structural synaptic plasticity) [4]. These are the main mechanisms constituting the "language" of the brain info-communication between its various modules, which are specialized zones for info-processing, according to the informational type received from sensors and the dedicated functionality. Synchronization process in the gamma waves range (30-70) Hz during the mind concentration, could play also a role in the global control of the perceived information. Physical-chemical chains of reactions, typical for epigenetic processes, induced especially by repetitive/long-time informational changes/cues of the external environment, are also participative mechanisms, determining permanent changes in the stable memory of the cell, which is the informational library - the DNA molecule, but without alter the species genetics. The "intriguing" electrical (cell-firing) activity during the sleep (within the delta waves range < 4Hz), maintained higher - at the corresponding resting/relax level, in spite of the disconnection of the external sensors, can be explained by the inner surveillance of the metabolic maintenance (at a minimal "stand-by" dynamic state),

similarly for instance with an informational device with semiconductor junctions, which needs a permanent background stand-by polarization, independently if a signal is applied or not [5].

Language is the final form of the human informational communication with the environment and society. The events, objects and phenomena from the contact with reality are transposed in information, expressed by words. The analytic judgment of reality and reactive decision is achieved by the Center of the Decision and Command (CDC), supported by cortex in general and by the prefrontal cortex in special. Information is therefore revealed by concepts, significance, symbols, operated as virtual information, and the output of the processed information at this level is expressed by attitude. The decision is the result of a chain of operations in CDC, as new information expressed/expressible by language and memorized in CASI, elaborated by a chain of elemental YES/NO steps from the received or collected set of information from CASI, on the basis of the decision criteria. The inter-relation CASI-CDC is therefore very close, this dual operational unit appearing as fundamental for the co-operability of the brain with conceptual/significance information, and the language as a basic tool of expression. The informational output is completed by the motor-actions not only to activate the vocal related system, as it is shown in figure 1 by the horizontal line from CDC towards this system, but also by gestures/posture, measurable also in Bits [6]. The corresponding vertical black line in figure 1 just represents the information/motor-action interface, schematically indicating the mind-body relation, the general interface between the info-operational (virtual) and body (matter) executive organs/systems [7], in this case referred to the driving/decision/command information and the corresponding executing elements.

The emotional reaction to information is sustained by the Info-Emotional System (IES), consisting in the limbic system (mainly composed by hippocampus, amygdala, hypothalamus), connected through the mind/body interface (black vertical line) with the motor-distributer (heart) of the nutrient fluid (blood) to the body zones in momentary need. The intimate informational agents are, besides the electrical info-induced pulse-waves in the nervous cells, the inter-cell synaptic neurotransmitters, of which nature determines the mood (emotional) states [8]. The operability of CDC is therefore closely related with CASI and also with IES in a continuous process during the judgement, emotions playing an important contributor role to the decision. The protagonist of the limbic system is amygdala, an ancient alarm component, activating danger signalization and anxious states, counterbalanced under normal conditions by the prefrontal judgment control. All of these informational functions are fulfilled therefore by specialized nervous cells/brain zones, according to the adaptation/survival needs.

The “hardware” – (matter-consisting) body, supporting the “software” informational system activity, is mainly sustained by the Maintenance Informational System (MIS), managing the material (foods, water, air) “combustion”, to assure the energy and substituting/regenerative body micro-components through the metabolic processes. According to the above discussion on differential functionalities, within this automatic/autonomic system, the isolated loops nervous cells are rather operational in this case than the cell-networks from the cortex [9]. MIS is connected especially to medulla and the lowest zone the brainstem, managing the vital autonomic functions of the organism, referring to cardio-respiratory and digestion, controlled and integrated through the functions of hypothalamus. The info-genetic operability is managed by two informational systems: Genetic Transmission System (GTS) and Info-Genetic Generator (IGG), which leads respectively the genetic preparation and transmission (info-genetic output of the organism) and the body development and growth according to the age (inherited info-genetic input from the parents). Both of them are mainly supported especially by the hypophysis and hypothalamus. These systems express/communicate (= >) information at the cell level, through a specific genetic “language” of 4-type letter alphabet (adenine, thiamine, guanine and cytosine nucleotides) by means of structuration/destructuration “embodiment/disembodiment” processes, like DNA=> mRNA=> Proteins, with the participation of amino-acids, where DNA and mRNA are the deoxyribonucleic and messenger ribonucleic acid respectively [1].

At the interface ISHB/conscious mind (schematically represented by the vertical gray line in the right side of figure 1), the ISHB components communicate with mind by the cognitive centers (ISHB = CASI+CDC+IES+MIS+GTS+IGG+IC) => (I = Iknow+Iwant+Ilove+Iam+Icreate+Icreated+Ibelieve) respectively, which are the constitutive components of consciousness – the personal state of full spectrum

perception-(sentience/awareness) of the internal and external reality – where “I” is the own subjective self, and the components are suggestively called: Iknow (memory), Iwant (decision), Ilove (emotions – love being the life driven force), Iam (health/power status), Icreate (sociability, sexual behavior, family), Icreated (inherited genetic body/behavior – predispositions/abilities/talent(s)), Ibelieve (trust/beliefs, daydreaming/introspection). Neurological bases (info-body connections, the role of the thalamus/temporoparietal junction as sensory hub/station integrators/distributors), the info-operability of the cortex/cingulate cortex and of the other zones of the brain, support this informational model.

From the perspective of ISHB, it can be successfully approached a large range of topics in neurology/psychiatry/neurosciences, namely understanding/modeling of consciousness [10], the mind-body equilibrium and health [11], neuro-dynamics of aggressiveness [12], addiction and mood disorders [7], specific role of the anterior/posterior cingulate cortex [2,3,11], in neuropsychology and behavioral science – a sharp definition of attitude and its quantitative evaluation [13, 14], the psychic operability of the beauty/ugly opposite binom [15], geriatrics and neuro-rehabilitation therapy [16], in biomedical engineering and biotechnology [5], in life science [17].

Conflict of Interest

No financial or conflict of interests.

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