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## MIND AND BRAIN

### NOTES

By "matter" we understand a metalanguage shortcut to the physical concept of discretized, integrated high density areas of Gravity/Inertia Field. Inverted commas stress its contrast to the common so called materialistic usage of the term, which denotes a meaningless reified abstraction void of physical sense and absent from physical vocabulary.

Concurrent physics sees phenomena in the general form of C/D polarity of continuous/discrete aspects. In order to comply with the common usage we shall use "matter", indicating with inverted commas its meaning of discrete aspect of involved phenomena.

In the context of the C/D polarity, mind and brain are respectively continuous and discrete polar counterparts, the P-Equivalent aspects of the phenomenon "reflection".

Let us stress that our posited mind-brain relationship has nothing to do with any metaphysical dualism, but is an entirely physical instance of the fundamental physical C/D polarity.

In "STRUCTURES OF MIND" we have correspondingly defined "mind" as continuous background support of sensual events and thus a synonym of "awareness" as defined in "TIME, AWARENESS AND EVENTS", better fit for structuring and for the currently vital "mind-brain" Problem.

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Now, brain with its neural network is clearly a scientific abstract model justified, as all abstractions, by its capacity to coordinate particular "neurological" events-observations.

One of the most persistent, most deeply enrooted illusory "transcendental reifications" consists in considering brain's neural network as a "real object" in the "World out There".

One of the most noxious too, because, once reified, it's often promoted to the utmost foundation of the phantasmagoric, illusory, transcendental "reality".

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## INFORMATION PROCESSING

In the present chapter we shall substitute for "reflection" its technical synonym "information processing".

Information Processing may be schematized with help of three entities: Processor, Input and Output. Input, a set of Receptor devices, feeds the Processor which generates Output, a set of action Trigger devices, fed partially back to the Input as the cybernetic feed-back..

Within this schema and in an arbitrary - not preprogrammed or memorized - situation, action involves the perceptual- motor coupling, i.e. relating all Receptor/Trigger couples, in order to select those pertinent to the particular act.

Now, discrete "material" Processor cannot exceed  $2 \cdot 10^{47}$  operations per gram and second (Bremermann's limit[\*] (BL)).

Enormous as it may seem, it turns out to be negligible.  $2 \cdot 10^{47}$  is a small number when compared with processing rates that one would need to carry out certain search processes. For example, Minsky gives the number of all possible move sequences in chess as about  $10^{120}$ .

Conservatively estimated Input and Output of an advanced organism contains  $10^6$  devices each. Supposing simplest 2 state devices, relating Input with Output requires  $R = 2^{(2 \cdot 10^6)}$  operations. Its  $\text{Log} = 602060$ , indicates R to be 1 with 602060 zeros. On the other hand BL for a kg (roughly the mass of the brain) is about  $2 \cdot 10^{50}$  or 1 with 50 zeros.

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Dividing R by BL we get about  $10^{20}$  zeros seconds as the lowest limit of time required by discrete "material" brain to relate conservatively estimated input and output of an organism. The practical "synaptic" limit<sup>\*\*</sup> is by about 34 orders longer, because the neuron structure of the brain is much coarser than the atomic granularity implied by the BL.

Thus, Morphogenesis, behavior of living Organisms, Human complex scientific and social Projects clearly require some additional agent different and incomparably faster than the raw discrete "matter", let alone the neural brain.

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## MIND, BRAIN AND THEIR INTERFACE

### MIND

The chapter "STRUCTURES OF MIND" postulates a Structure homomorphic with the "Three Worlds" of Ref1, encompassing three faculties: Sensorium, Imagery and Symbolism, accounting for mind's functions, such as perception, imagination, cognition, symbolizing, inference, reflection and understanding.

### BRAIN

Brain's structure pertinent to information processing encompasses specialized cells called Neurons and their interfaces called Synapses. A neuron consists roughly of several dendrites, of a cell body and an axon. Dendrites are receptors of electric impulses which travel through them to the cell body and make it "fire", sending electric impulse further down the axon till axon terminal.

Axon terminal lies close to dendrites of neighboring neurons, separated from them by synapses.

A synapse consists of:

1. a presynaptic ending that contains neurotransmitters,
2. a postsynaptic ending that contains receptor sites for neurotransmitters and,
3. a synaptic cleft or space between 1 and 2.

Neurotransmitter is a chemical released by impulse reaching the presynaptic ending at the axon terminal and travelling through the cleft to the postsynaptic ending in vicinity of a neighboring neuron's dendrite.

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Neurotransmitter reaches the dendrite and triggers an electric impulse that travels down to the cell body of the neighboring neuron which in turn may fire.

This network structure of neurons-vertices and synapses-edges allows millions of neurons to "talk" with each other. However, it would imply so far chain reactions in which a single impulse will fire the whole network rather than create any local pattern. That's why we have two sorts of neurotransmitters: activating and inhibiting.

The receiving neuron "counts the votes" and decides to fire in case of sufficient "activating majority" or else to stay idle. While freely stretching an arm, the triceps contracting neurons will get activated, while those of the biceps inhibited in order to relax the opposite bending force. In controlled stretching both activations and inhibitions will be precisely measured out to achieve the desired action. Neurons are connected so that when they fire together, they "wire" together, to form stronger synaptic connections. This is the brain's dialectic counterpart of mind's learning faculty defined above.

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## BRAIN-MIND INTERFACE

We have seen that discrete "material" processor of the size of human brain would need about  $1e600000$  seconds to process the Information involved by a simplest action of an advanced organism. This is a hypothetical limit of what the evolution may reach in another billion years. The practical limit of brain's neural network by itself is about  $1e900000$  seconds.

Consequently, the discrete "material" brain, including its neural network structure cannot account alone for human and living organisms' behavior and needs for it the association with the continuous mind..

We must look for some polar interface, whose continuous and discrete aspects can interact respectively with continuous mind and discrete brain supporting mind/brain covariance.

Field suggests itself as a continuum, whose discrete singularities are sources "generated" by firing neurons. Many Neurologists see field as mind itself. We cannot accept it, because we see mind on the one hand as synonym of awareness, observing, but not observable and, on the other hand not as a polarity, but as a continuous aspect of the polarity mind/brain. Polar, observable field may only function as a transformation interface.

Another, more complex and rather exciting theory proposes Field generated hologram as interface to mind, or mind itself. Hologram has many striking features, starting with totality being in each part. Some Neurologists claim that memories are not stored in any specific location in the brain,

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but appear to be distributed over the whole brain, much as any portion of a holographic image is distributed over the whole structure. Suppressing a part does not change anything in the image, else than making it fainter. The dynamic TimeSpace of the holographic image is homomorphic with our Imagery structure and may interface with it. Again, like in the case of Field, we might see the hologram as a possible interface, but not as mind itself.

We shall just mention here a rather poetic theory of pan-hologram based on "holographic paradigm". A small group of researchers sees "real universe" as a holographic blur of frequencies and the brain also as a hologram which selects some of this blur's frequencies and transforms them into sensory perceptions. In this "ocean of consciousness" we would be the "weary rivers that wind somewhere safe to sea". There is a striking affinity of this paradigm with religions of the East which have long upheld, that the physical world is Maya, an illusion, and although we may think we are physical existents moving through a physical world, this too is an illusion. Most, if not all protagonists of the paradigm are attired by eastern beliefs, include the paranormal in their inquiries and some report about shamans making instantly disappear and reappear entire groves of trees.

Let's note that so far we have justified the need of some covariant continuum with consideration of the processing speed. Another necessary justification is provided by the Morphogenesis. Whether we consider it from the point of view of Haken's Synergetics or Thom's Catastrophes, it consists in ordering a continuum.

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## FINAL NOTE

Brain and mind structures described above are models satisfying all model requirements, including falsifiability.

Brain-mind interface, perhaps the most exciting area of inquiry, produced so far only theories, i.e. deductively consistent structures lacking factual falsification.

### References:

Ref1: Popper and Eccles "The Self and Its Brain"  
(Springer International) Page 327, Fig  
E5-7, etc.

### [\*]BREMERMANN'S LIMIT

No discrete "material" system whether artificial or living can compute more than  $2 \times 10^{47}$  bits per second and per gram of its mass.

This limit refers to a self-contained system where the power supply is included in the "matter" and where "computation" is defined as the transmission of information over one or more channels within the system. Recognizing that computation requires energy for changing physical markers and for recognizing such changes in subsequent steps, the limit is obtained from Einstein's relation between energy and "matter",  $E=mc^2$ , and Heisenberg's uncertainty principle, which specifies the inaccuracy or noise in the measurement of energy.

Current computers as well as the brain are far from approximating this limit because they don't utilize atomic events for the storage and transmission of information.

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Ref2: [Bremermann's paper](#)

## OPTIMIZATION THROUGH EVOLUTION AND RECOMBINATION\*

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Part I. Limitations On Data Processing Arising From Quantum Theory

Part II. Evolution Processes and Optimization

Part I is pertinent to the derivation of the limit and to its implications for the Mind-Brain issue.

### [\*\*] BRAIN'S COMPUTATIONAL POWER

The total computational power of the brain is limited by several factors, including the ability to propagate nerve impulses from one place in the brain to another.

Propagating a nerve impulse a distance of 1 millimeter requires about  $5 \times 10^{-15}$  joules. Because the total energy dissipated by the brain is about 10 watts, this means nerve impulses can collectively travel at most  $2 \times 10^{15}$  millimeters per second. By estimating the distance between synapses we can in turn estimate how many synapse operations per second the brain can do.

This estimate is only slightly smaller than one based on multiplying the estimated number of synapses by the average firing rate, and two orders of magnitude greater than one based on functional estimates of retinal computational power. It seems reasonable to conclude that the human brain has a raw computational power between  $10^{13}$  and  $10^{16}$  operations per second.