

The evolution of our brain and the Theory of Minimum Brain (MB)

A structural way for understanding the evolution of our human brain.

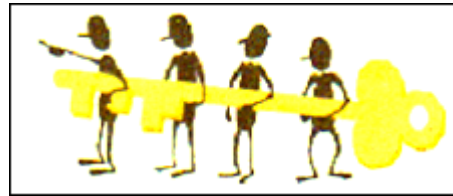
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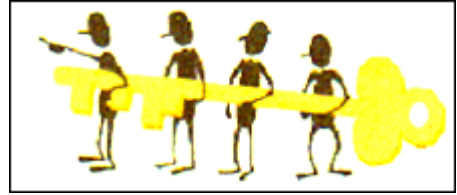


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Devotement

...this manuscript is written for my loved daughters Clara and Isabelle!



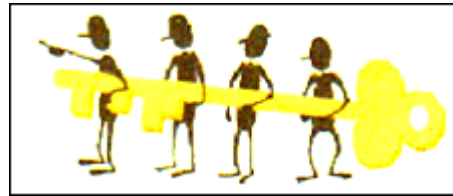
1. Abstract

By using the theory of Semiotics by Charles S. PEIRCE a better understanding of **the evolution of our human brain** is possible. Semiotics seems to be sourced in evolution of human species. **Sidarta RIBEIRO, Angelo LOULA, Ivan de ARAUJO, Ricardo GUDWIN and Joao QUEIROZ** wrote in (1) about African Vervet Monkeys (*Cercopithecus aethiops*). They showed that the Theory of Charles S. PEIRCE (1839-1914) can be used already in that low state of evolution. That's new in Biologics.

The using of Signs (icons, indexes and symbols) begins in **instinctive survival- and flight-reaction and guide up till communication and language**. A clear thread can be showed. Charles S. PEIRCE was in direct scientific communication to Charles DARWIN, about 150 years before. He did not know these connections. They get seriously thinkable in our days.

The model for a "**Minimum Brain**" is founded also in D.O. HEBB (7) and the "Closed Nerves-System" of Humberto MATURANA (5) and others.

A new Paradigm **HOP-IT** of the author brings the questions: What is information in our brain? Where begins information in our brain? Possible first answers are made.



2. Semiotics-Theory of Charles S. PEIRCE

He lived from 1839-1914. PEIRCE got famous by his relations in philosophical logic, mathematics (PEIRCE-Function) and grammar of language (formal semiotics). Today and in this paper a significant relation of his theories to evolution of our brain can be showed in case of Vervet Monkeys (1). He didn't yet know this, he fixed his theory in his time as typical human.

First of all let's remember on PEIRCE at about 1860. The **investigation of language and communication** is based on his **Semiotic-Theory**.

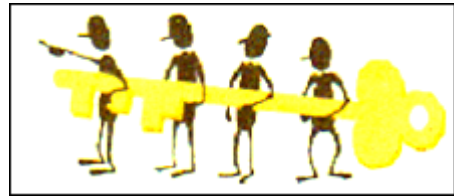
He (eventually) defined in the 1860s "**Semiosis**" as an "action, or influence, which is or involves a cooperation of three subjects" (4 p1). It's today better to say: three interdependent separate "(logical) elements":

- a) **Object**
- b) **Sign**
- c) **Effect on an Interpretant.**

These have a triadic relation, no disaggregation into possible dual relations is allowed.

In PEIRCE's Semiotic-Theory a new difference is made between the origin or generator of a Sign (a), the Sign by itself (b) and the Effect in the acceptor (c), he called him the Interpretant.

PEIRCE takes the Sign as existing separate logical unit or element. It can be a special sequence of sounds or an optical appearance of even known or unexpected new accidents.



The carriers of a Sign (= Objects) may be living subjects or not living things, living natural organism or physical materials in many forms. An irreducible relation is created, coming from the carrier-origin and leading over the Sign himself to the acceptor or Interpretant.

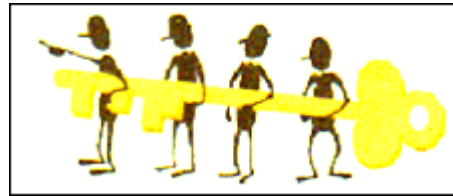
The Sign gets valid in the Interpretant as subjective acceptor. This subject is a real subject, because it starts a reaction or not, depending on the relevance of the Object to the Interpretant. An irreducible relation between all three elements gets so biologically real valid.

PEIRCE defines this Sign in an irreducible relation between a stimulated Meaning (=real Sign in the Interpretant) and a special physical Object. He made over 60 different definitions of Sign. Three main groups stayed till today.

PEIRCE´S three main classes or typologies of Signs:

- a) **Icon**
- b) **Index**
- c) **Symbol**

We can say that these terms are still used in different appearances in ISc (Information Sciences) today. In the 1860s they had much more philosophical semantic but let´s research their definition by PEIRCE. As an additional source literature (4) is used.



2.1. Icon

Source: Greek **εικων** = picture, emblem, allegory, ensign, symbol.

Typical characteristics: **likeness, semblance or similarity** to a real object.

In **Informatics** it's a graphical picture of a software-element, startable by clicking on the screen.

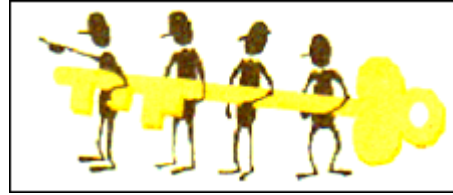
So we can say: "an Icon of an object" is "a Sign of a located object, which is similar to it and makes a similar impression in Interpretant". It generates an irreducible relation between PEIRCE's three semiotic elements (local Object, Icon, starts a valid Effect in Interpretant).

2.2. Index

In **Linguistics** it is one word with different semantics as it is used by different persons.

In **Informatics** it's a relation between two or more rows of numbers. The first one (the index) is constant. The second and following, to the index related rows are **variable and changeable**.

PEIRCE used it for a spatial and temporal relation between Effect-Sign-Object. One Sign (=Index) stands for **variable** physical objects at one place at one time and produces correlated variable effects in Interpretant. The effect is dependent on knowledge and experiences of Interpretant. A true PEIRCE's **Index compels, enforces attention of Interpretant to the Object, it denotes the Object**.



2.3. Symbol

In **Neurosciences** it is a mental picture or terminus in our brain, a well-known element of human **cognition**.

The value in **ISc** is treated in following separate chapters.

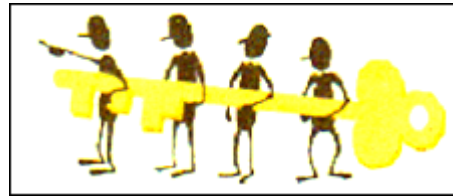
PEIRCE defines it as a relation between Object and Effect in Interpretant, which bases on a **determination by habit, law, rule or convention**. It stimulates a law, etc. in the Interpretant, is in a defined and “memorized” relation. This definition is a result of regularity. It leads to a secondary level in the brain of the Interpretant. A Symbol is stimulated outside but is a connection of possible more than one stimuli in the brain (=memory) of the Interpretant. Therefore it needs time to “remember or recognize”, to connect and find all these stored stimuli of these law or habit.

That’s the basics in PEIRCEs Semiotic. Let’s now look to the influences in Neurobiologists and Neuroscientists of present time.

3. New results by Sidarta RIBEIRO, Angelo LOULA, Ivan de ARAUJO, Ricardo GUDWIN and Joao QUEIROZ (1).

Charles Robert DARWIN (1809 – 1882) published his Evolution Theory 1859 in his book “On the Origin of Species”, nearly at same time as PEIRCE started his Semiotic-Theory in the 1860s. A direct relation between DARWIN’s Evolution-Theory and Semiotics by PEIRCE was not possible. Informatics did not yet exist!

The present Neurobiology (QUEIROZ, RIBEIRO, 2002, (1 p10)) sees a possible correlation between PEIRCE’s Symbols on one side and neural correlates of our human brain in evolution of our symbolic language on the other side.



3.1. The „Minimum Brain“ of any animal with a nervous system.

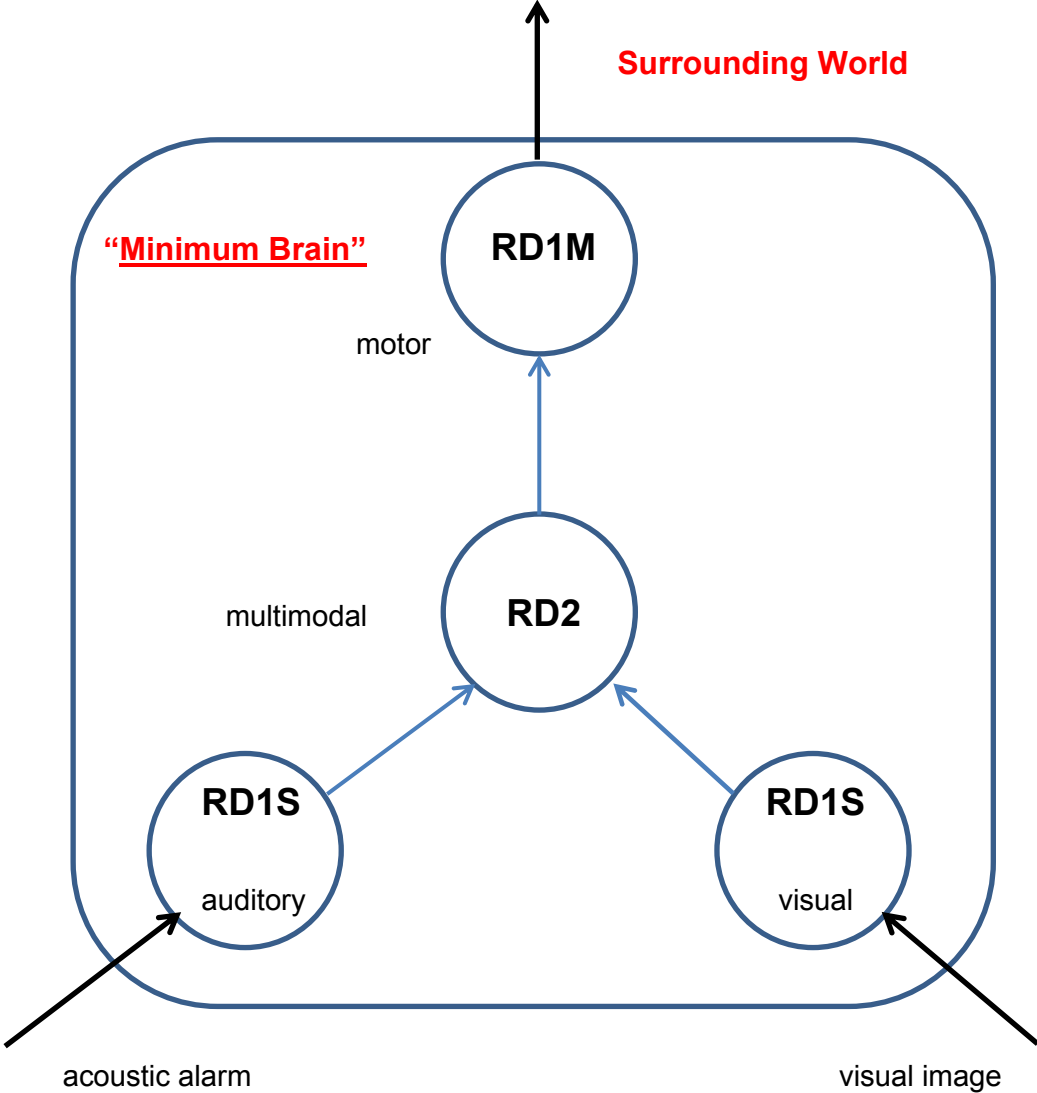
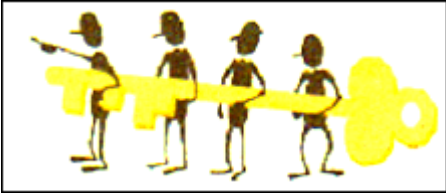
This “**Minimum Brain**” (**MB**) satisfies very basic neurobiological constraints, common in principle to any animal with nervous system (1, p 4).

QUEIROZ et alias (1, p 4 ff) figures out four interconnected representation domains (RD) of a minimal brain:

- a) Domain of **primary auditory sensory** representation (**RD1S**)
- b) Domain of **primary visual sensory** representation (**RD1S**)
- c) Integrative domain of **secondary sensory association** (**RD2**)
- d) **Motor** representation domain for **behavioral output** (**RD1M**)

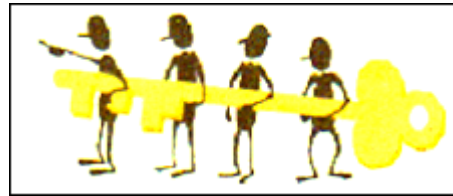
This MB is in live connection to a perceptible external world containing **images of predators or acoustically alarm-calls**.

This is a structural reduction, but is very useful for understanding the evolution of our brain. Look at following picture.



Surrounding World

Picture 1



3.2. Evolution of our human brain

The usable result for ISc is that these basic areas are thinkable functional units. They evolved in different organic-biological areas of the living brain. As we know since DARWIN this development of our Nerves-System is a permanent evolutionary-timed biological happening.

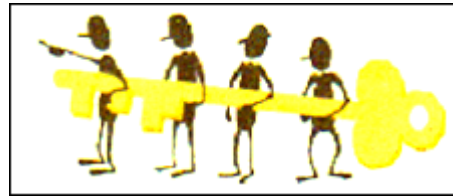
Already **in mammals** they are spread over six different biological areas. RD1S and RD1M as primary domains are in mesencephalon, diencephalon and telencephalon. RD2 is an associative (= higher) area in cerebral cortex, hippocampus and amygdala (1, p 4, 5).

In **human brain** this mammal-brain is even very much more differentiated. These basic two functions (sensual and motoric) are evaluated to more senses. These are spread over very much more biological areas in different specializations (6). The sense of touching for instance is thinkable as a finer evolution of motion and so on.

A lot of combinations of all our five human senses are really existent in our human brain. To the area for cognition has come the area of communication and speaking. Last not least we have got the self-consciousness, creativity and intelligence. All together is the significant research area of the now about 100 to 150 years old sciences Neurosciences and Neurobiology. For ISc it would be too complex. ISc can only take out logical structures and significant biological connections.

But now let us follow this evolution up to our human state in great steps. We can confidentially start with our found **Minimum Brain** (MB) of animals with nervous systems (1, p 5 ff).

What we definitely can say is: this MB is still a part in our brain. It is a part of our evolutionary background, our **phylogenetic properties**. We can imagine how we have been reacting in the time as we haven't yet got our self-consciousness and our subjective personality. We had only **reflex, instinct and drive**, which mean **subconsciousness**.



How did we learn to see and hear, think and speak and to react in many very much more variability's of situations? Only by **recognizing and learning** new situations and accidents.

An **alarm call** is a Sign for other members of a group if enemies appear. The **image of a possible predator** is a definitive Sign; it is based on typical characteristics of a typically dangerous new object.

These signs promote motoric reactions, if they are recognized and known; or bring no reaction, if the object seems to be no danger. In an interpreting area (RD2) in this MB all stimuli and signs which were accepted by ears or eyes are actually compared, combined and evaluated to a PIERCE's Sign. The living animal has got already this new possibility to store info's in his brain. If a new sign comes in the brain (MB) of the animal it can compare this and get a Meaning about his value. Only if the sign is known as dangerous the motoric flight area (RD1M) gets an impulse and a reaction is starting.

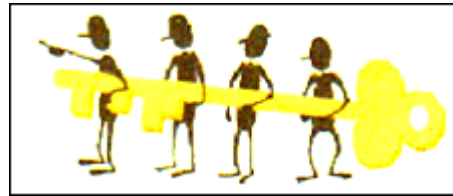
It's remarkable:

- a) a certain amount of stimuli is coming from the surrounding world and is combined by the Object to an incoming Sign and
- b) a lot of corresponding stored impressions of a Sign are stored in RD2, they are stimulated now

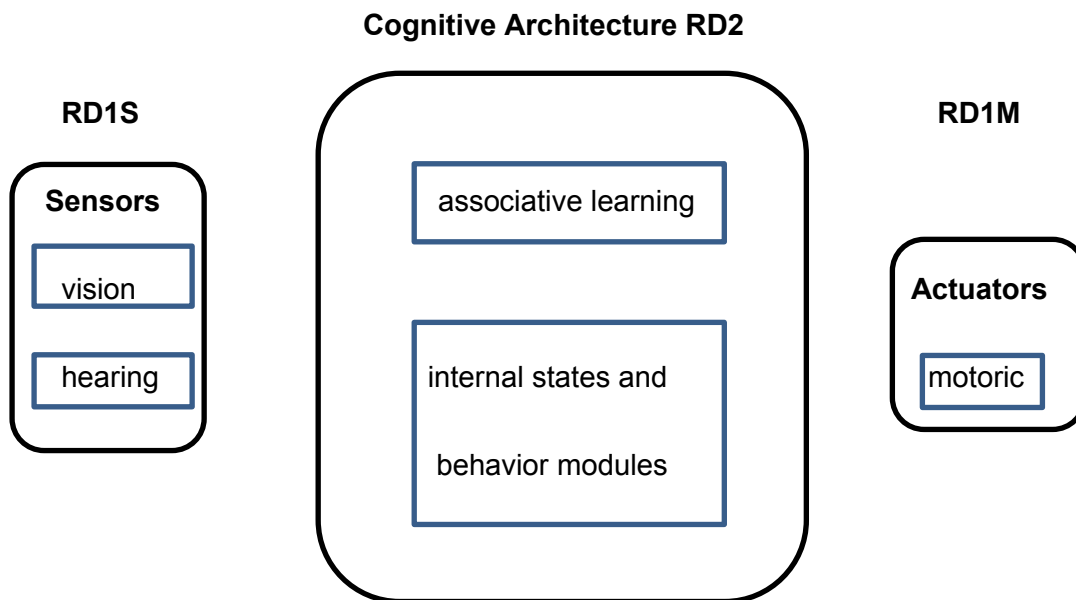
So we have two "Signs":

- a) the Sign which comes to the MB by senses and
- b) the Sign which is stored in the memory of RD2

If they come to a corresponding equity a reaction in RD1M is stimulated or not. That decides the RD2.



RD1x-Areas are primary representations. RD2-areas are developed a little bit higher, more differentiated and interpreting, so called **secondary representations**. See following graphical reduction:

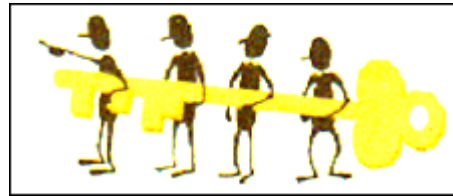


Picture 2

The **Cognitive Architecture** of RD2 combines one or more neuronal representations in the brain (Sensors) to a coactivated biological ensemble. One or more Signs are the mental representations of all different activated neurons in different regions of the brain, stimulated by different Sensors. They are the **recognized information** in the brain. This Sign correlates really to an Object outside - in the real world. It stimulates in a primary way neuronal Actuators to a correlating **behavior** (= combination of different motoric reactions).

The flow of **recognized information (=Signs)** comes from Sensors, stimulates the Cognitive Architecture and perhaps Actuators. **Cognition of Signs** is separated in two main steps, the **associative learning** and the **memory** with internal states and stored behavior modules.

The learning area is the only one, which has a **backflow of energy** to the Sensors in order to compare some characteristics between already stored Signs and possible new Signs, properties found by Sensors.



From the Sensors flows the stimulated electro-chemical energy in a neuronal way to the Cognitive Architecture and perhaps to the Actuators, in our special case in one direction only. In RD2 the decision is made, if or what danger exists and what reaction in RD1M has to be made.

If there is no RD2 we can speak from a classical **reflex**.

Here we come to new problem. We have to ask: What is the difference between an electro-chemical energy (= living data) and a Sign? Therefore look down to chapter 5.

3.3. The differentiation of PEIRCE's Signs

Now we can use the up to date version of PEIRCE's Signs in our evolution-thread. Joao QUEIROZ and his science-friends (1, p 9 ff) made a useful differentiation. They use the terms as follows:

a) **Icon:**

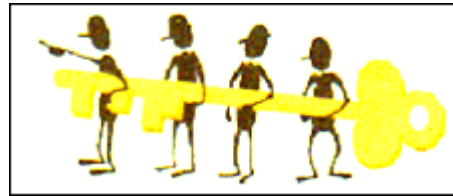
is the first Sign as it comes to the MB. It is an acoustic call or a visual image. The using of the Sign-class Icon shows a similarity to something – that is stored in the MB-Memory.

A local impulse from an Object is real, but not yet enough for a definitive decision: enemy or not.

So more stimuli from the brain and from the external Object have to be compared till a definitive correlation to a known Sign can be made and a definitive reaction follows.

b) **Index:**

The Sign-class Index is usable if enough stimuli from outside and insight of the MB are valid (= are connected by "firing"). After reconnections to the RD1S for comparing - a definitive decision gets possible. A definitive reaction or not in RD1M is following immediately.

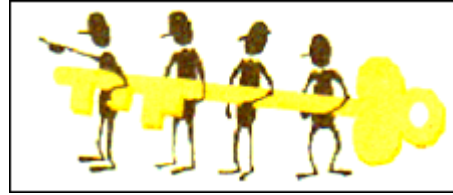


c) **Symbol:**

Is the traditional and most-used type of a Sign. Joao QUEIROZ et alias use it in connection to an in the memory known Sign but also existing different active stimuli. So a clearing recursive comparing of all other stored data in all involved neurons is necessary. The way to a decision is possible by enforcing ore suppressing of special stimuli. If a special level of energy is reached a decision can be made and a consequent following action is stimulated. If the congruent stimuli are not enough nothing is happening.

The difference to the Index is that a stored possibility of solution is relevant, but some other stored stimuli are not congruent, so a definitive solution would be possible but is not yet satisfying. More differentiated knowledge like laws and habits have to be searched and then a decision can be made.

For defining a Symbol much involvement of the Cognitive Structure RS2 is necessary, especially the Associative Learning area. That's the way of more differentiation of knowing about incoming new data. The further evolution of our brain is initialized. In the Memory new stored Signs can be created.



4. R.O. HEBB and following Neuroscientists

A remarkable scientist on the way of the evolution of our brain is Donald O. HEBB (1904-1985). He postulated 1949 after decades of leading research very much biological facts of our human brain. He formed really the new sciences Neurosciences, Neurobiology or Neurophysiology. Most of his postulates could be verified by other following neuroscientist in the years after his population of 1949 (7). His theories got valid and he is still important in his science.

The most famous one is **“The HEBBian Learning Rule”** (7, p 62):

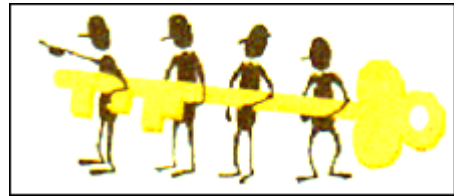
“A neurophysiological postulate: Let us assume then that the persistence or repetition of a reverberatory activity (ore trace) tends to include lasting cellular changes that add to its stability. The assumption can be precisely stated as follows: When an axon of cell A is near enough to excite a cell B and repeatedly or persistently takes part in firing it, some growth process or metabolic change takes place in one or both cells such that A’s efficiency, as one of the cells firing B, is increased.”

Today we can say that his theory has got real seeable in natural science by electronic instruments and is still valid. The human brain, one main step in evolution of complexity of live is a very complex and not yet clear network of biological neurons with dendrites for energy of other neurons and axons with synapses for energy to other dendrites or even terminal activators of muscles or glands.

We understand now: The basic kernels in the beginning of evolution of our brain are

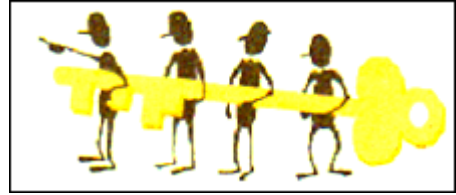
- a) a sensoric and
- b) a biological connected motoric area and
- c) a more and more developing and growing area for storing of knowledge and learning of new situations between a) and b).

These new cognitive, more and more differentiated structures for creativity and intelligence (RD2) got control over the two basic elements (RD1S and RD1M). Sometimes no reaction to



RD1M was necessary, sometimes variations of reactions where the best connections; more differentiated knowledge about external facts prevented decision-errors. Before an action more communication with and about the subjective knowledge brought advantages, it “made sense” to send a sound - not only to hear. The RM2 with learning area and memory found a new type of Signs, the combination and direct response of acoustic calls – the area for acoustic communication and language. **Speak and language** was the consequent new ability after seeing and hearing.

The theories of D.O.HEBB are the scientific background of the MB by Sidarta RIBEIRO, Angelo LOULA, Ivan de ARAUJO, Ricardo GUDWIN and Joao QUEIROZ (1).



5. HOP-IT and Conclusions

5.1. What is HOP-IT?

In HOP-IT (Human Orientation Paradigm for IT) an actual new thinking for IT is just in investigation status. In a Dissertation of F. PLOCHBERGER, the author of this paper (3) this paradigm is treated. In (2) F.PLOCHBERGER defines **axioms** in ISc to get scientific usable terms for

- a) **Data**
- b) **Information**
- c) **Knowledge.**

To get a nearly final solution for worldwide broad discussions and definitions for those terms he names his definitions by using the word “axioms”. They are based on real historical and actual using in ISc, they don’t need logical deduction, real originally defined axioms.

5.1.1. Data

Data is an amount of stored Information about Objects of our human surrounding.

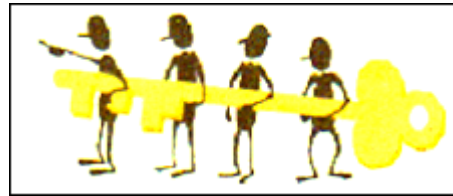
Two main groups can be separated:

- a) **stored, dead, materialistic or written down data**

Carrier is a not living material (paper, electronic artifact, video, IT-data ...)

- b) **living data**

Carrier of these data is a living subject (plant, animal, human)



5.1.2. Information

is an extraction or abstraction of living or materialistic (= not living) data by a subject, mostly human. In a primitive form also plants or animals can be such (living) subjects.

Only a living subject is able to create Information – direct from object or out of data about an object. So Information is a property of live. A living object is able to store Information, to correlate it, think, speak about it and communicate it. Finally only a living subject is able to create, produce and give Information to other living subjects.

5.1.3. Knowledge

is the information, which is stored in living subjects. On paper stored Knowledge is also very much used but is – a form of data. Unconsciousness of subjects is a form of permanent living data transport.

5.2. What bring these terms of HOP-IT for understanding our brain?

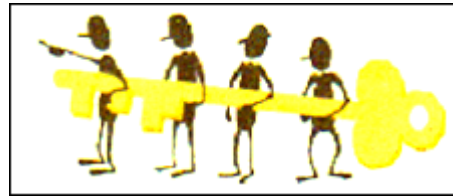
It brings a possibly structural way of thinking in connection of investigate our brain.

Neuroscientists only use biological facts. The human being is not only a biological organ. It is a “subject” with self-consciousness, free will, individual habits and feelings.

For understanding our brain we find a new border. We have to ask: When starts a PEIRCE’s Sign (further on called only Sign)? Or in terms of HOP-IT we can ask in the form: When starts the term Information, when stops the term Data?

In understanding of evolution of our brain, we can definitely say: A Sign is real Information.

When started the Sign in the evolution of our species in our evolution? Surely before we have got self-consciousness. On the level of our MB from above we can ask: How can we define the **First Sign** in our evolution? Is it the same as the **moment**, when we learned, that we are a human person with body and mind?



ISc is sometimes called the modern maidservant of philosophy. So it is possible to extend the HOP-IT to all living subjects in an adequate form. A MB is no Human Brain. But we can understand now, the origin of mind or higher – not only biological – properties of living organism. First step is the possibility of living subjects to recognize Signs.

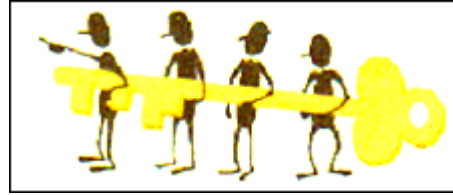
So we can say:

- a) A Sign is the first step in evolution of our mental possibilities
- b) a Sign is the first evolutionary appearance of Information (HOP-IT)
- c) the step from living data to Sign or Information is a step in evolution
- d) this step is correlated with first appearance of the RD2 (Cognitive Structure), a secondary domain in our MB, defined above

So we can define in a clear structural way the difference between data and information in HOP-IT by:

A Sign - as first evolutionary form of Information - is definable by its first appearance in our evolution: as we got the ability to decide - to set a motoric action or not - we got the second level in our mental evolution. Since that moment we can manage Signs.

To stay on good scientific level it is to say, that this moment seems not yet to be the moment of knowledge of a human, that he has an own person, of the ability of self-control in the sense of Humberto MATURANA et alias. It must have been earlier in our evolution.



6. Involved Literature

- (1) Sidarta RIBEIRO, Angelo LOULA, Ivan de ARAUJO, Ricardo GUDWIN and Joao QUEIROZ, Symbols are not uniquely human, 2006, Universities in USA and Brazil, [Symbols are not uniquely human](#) or search by GOOGLE
- (2) Franz PLOCHBERGER, Informationswissenschaftliche Grundlagen und Termini, 2011, Eigenverlag, <https://www.triboox.de/buchladen/produkt/ingeniosus/informationswissenschaft-grundlagen-und-termini/ebook/4HpCA5QXRScA/>, please join
- (3) Franz PLOCHBERGER, Humanorientierung der IT, ein Paradigma, 2012, Eigenverlag, [Homepage HOP-IT, Human Orientation of IT](#), please join
- (4) WIKIPEDIA, 2011, [http://en.wikipedia.org/wiki/Semiotic_elements_and_classes_of_signs_\(Peirce\)](http://en.wikipedia.org/wiki/Semiotic_elements_and_classes_of_signs_(Peirce))
- (5) Internet <http://www.philognosie.net/index.php/article/articleview/349/>, Stand 3/2009, Eine Zusammenfassung des Buches von Humberto Maturana : „Die Organisation und Verkörperung der Wirklichkeit – lebendige biologische Systeme“
- (6) SCHMIDT.SCHAIBLE (Hrsg.), Neuro- und Sinnesphysiologie, Springer-Lehrbuch, 2000, ISBN 3-540-41347-2, 4.Auflage
- (7) D.O.HEBB, Organization of Behavior, A neuropsychological Theory, 1949, John Wiley & Sons, Inc.
- (8) R.E.BROWN, P.M. MILNER, The legacy of Donald O.HEBB: more than the Hebb Synapse, Nature Reviews, Volume4, December 2003, <http://www.nature.com/reviews/neuro>