

The Real Sate Strange Loop: Evolution and the Uniqueness of the Human Mind Psychological Implications

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Abstract

It has been demonstrated that humans have a far greater amount of association cortex than chimpanzees or other great apes. More association cortex leads to a better endogenous feedback network and better synchronization of neurons. The driving forces behind this greater amount of association cortex should shed light on the hard problem of consciousness. In the evolution of the human brain and mind the anatomically modern *Homo sapiens* predated the arrival of the behaviorally modern human. In the evolution of life it has been observed that simple organisms, such as bacteria, extract latent information embedded in the complexity of their environment and, that more complex organisms with nervous systems, use implicit learning, which is an unconscious cognition capable of performing acts that require intention and deliberation. The nervous system is the place where two important processes take place: gaining and storing information from the environment and from the organism's own body. These processes manifest as two important attractors: the knowledge instinct and the autonomy instinct. The attractors are advanced with respect to the anatomical evolution enabling the emergence of new cognitive realities and this may explain findings that anatomical development predated the cognitive *Homo sapiens*. The autonomy instinct is an attractor that leads to the stability of the Self that has control of some human activities. The negative feedback loop constitutes the basic unit of cybernetic control theory and is fundamental in self-reflection, the basis of human autonomy. Hofstadter considers it as a strange loop, a stable whorl so to speak, and the "I" is only a loop of symbols without any reality. The relationship between reflexivity and eigenform (Heinz von Foerster), has been analyzed. In the world of eigenform (proper form), in perception, the observer and the observed are one in a process that recursively gives rise to each and produces apparent stability of the perception of the object. The simple recursive process, similar to a whorl, carried to its limits, inferior and superior, to obtain the real eigenform permit us to demonstrate that in the *Homo sapiens* during a long process (which explain why human have a lot more association cortex than other primates), an instantaneous feedback, between the "I" (subject) and the "am" (object) emerged through contact with the Absolute infinite (the absolute complexity). This theory supports and is supported by the third Viennese School of Frankl who, from experimental data, demonstrated the existence of a spiritual unconscious of love, art and science.

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1. Introduction

The evolution of human cognition is recorded in more fossils and archeological records than in the case of other comparable primates. Recently, studies comparing humans to chimpanzees revealed that the evolution of the human brain was not merely a matter of enlargement, but involved changes at all levels of organization (Preuss, 2011).

Over the past 20 years, the methods available for studying the brain have improved enormously. Thus, it has been possible to demonstrate that whereas the primary sensory and motor regions of humans are, in absolute terms, very similar in size to those of apes, humans have a far greater amount of association cortex (Preuss, 2011). It is an important fact that humans have a lot more association cortex in absolute terms than chimpanzees or other great apes (Preuss, 2004).

More association cortex leads to a better endogenous feedback network (Augustenborg, 2010) and also to a better synchronization of neurons, which most neurobiologists assume is generated by feedback (Koch and Crick, 1991).

More important is the fact that the driving forces that enabled the emergence of this greater amount of association cortex and the human consciousness must shed some light on Chalmers' concept of the "hard" problem (Chalmers, 1995). The aim of this paper is to discuss this "hard" problem of consciousness and its important implications in psychology and psychotherapy.

Chalmers, based on Wheeler's (Wheeler, 1998) theory that information is fundamental to the physics (it from bit) of the universe and understanding that information has two basic aspects (a physical aspect and a phenomenal aspect), suggests that these two basic aspects explain the emergence of experience from the physical.

According to Chalmers, when in the consideration of the world the intrinsic nature of physical entities is left aside, all is a pure causal flux with no properties for the causation to relate. If it is accepted that intrinsic properties exist, the properties that causation ultimately relates are themselves phenomenal properties. Thus, we may say that phenomenal properties are the internal aspect of information and understand how experience might have a subtle kind of causal relevance in virtue of its status as the intrinsic nature of the physical. These thoughts are considered by Chalmers as metaphysical speculations.

However, we know that all hypotheses have an implicit metaphysics (Yunes, 2005). Chalmers considers that the internal aspects of information could be at the same time the decoder of this information. The internal aspect of information is its meaning, the significance that codifies. If information is fundamental for the physics of the universe and human consciousness is a unity and totality in itself that can decode, interpret and govern this information, with free autonomy, the ontological gap between them is very profound and needs an adequate scientific and metaphysical explanation.

The aim of this essay is to discuss the "hard" problem of consciousness based on: i) an ontological interpretation of the reality considering information fundamental to the physics of the universe and logic-mathematics structures as an important part of this information. Thus, logic-mathematics arguments are fundamental to prove some arguments; ii) theories according to which living beings are dynamic complex systems self-organized by information; and iii) the method that we have

denominated “ontological reductionism” which aims toward coherence between the nature of systems and their parts and between biological systems that are evolutionarily related.

2. The evolution of the human brain and mind

The analysis of the evolution of the human brain and mind permits us to observe some important facts that have not been interpreted adequately in the light of new knowledge. In this context it is possible to note:

- that the emergence of the anatomically modern *Homo sapiens* considerably predated the arrival of the behaviorally modern human;
- that the skull of *Homo heidelbergensis* from Ethiopia shows that it had reached virtually its modern degree, for language, by about 600 kya. Thus, the anatomical structure for language had been achieved half a million years before we had any evidence that the species of the *Homo* genus were using language or speaking;
- and how the large morphological brain, relative to the body size, was formed over a relatively short evolutionary time.

3. The emergence of anatomically modern *Homo sapiens* long before their modern behavior

The end of the Pliocene and the beginning of the Pleistocene was marked by the appearance of the *Homo* clade. This new lineage had a large brain and body with respect to the preceding hominids. The almost complete skeleton of the Turkana boy from 1.6 myr ago, revealed an unprecedented leap in bodily structure (Lee and Wolpoff, 2003; Tattersall, 2002).

Throughout the following Pleistocene period, the *Homo* brain size increased significantly. This increase was not related to a mean change in the body mass and was one of the most significant occurrences in the Pleistocene (Hawks et. al., 2000; Ruff et. al., 1997). The increase was from 600-650 cm³ (1.8 myr) to 1400 cm³ (200 kyr).

Based on different types of experimental data available it is possible to conclude that the brains of our ancestors rapidly increased in size, especially over the last one million years from 500-800 cm³ in the case of *Homo habilis* to 1200-1400 cm³ in modern *Homo sapiens* (Kaas, 2005). Compared with this period the emergent *Homo sapiens* evolved very quickly over approximately 150-60 thousand years.

A clear conclusion that can be drawn from the fossil and archeological records is that the human brain increased by approximately a factor of three without any important change in human behavior. Tattersall(2002) commenting on the predominance of the *Homo sapiens* over the *Neanderthals*, that flourished from something over 200 kyr ago to around 27 kyr ago and had brains as large as our own, wrote: “The conclusion thus seems ineluctable that the emergence of anatomically modern *Homo sapiens* considerably predated the arrival of behaviorally modern humans” and also that “Human beings of essentially modern body structure are presumed to have become established in Africa at about 1.8 myr ago”.

Supporting this opinion the newly excavated *Australopithecus sediba* fossils dating back nearly two million years ago have a mixture of some features of primitives of the genus *Australopithecus* with

others more closely resembling those of *Homo* (Kivell et. al., 2011; Pickering et. al., 2011). Different interpretations regarding this new discovery have been proposed. However, some facts are clear.

The pelvis is short and broad like a human pelvis. Many researchers had previously associated the development of a human-like pelvis with the enlargement of the brain, but in *A. sediba* the brain was still small. The researchers reported that the fingers were curved, as might be seen in a creature that climbed trees. But they were also slim and the thumb was long, more like a *Homo* thumb, so the hand was capable of using tools. However, no tools were found at the site.

Like the pelvis and the hands, the fossilized skull suggests some reorganization in the hominin brain with an expanded part linked to higher cognitive functions in humans, such as the origin of language.

On the other hand, humans have a special anatomical structure for language. In non-human primates the larynx is high in the neck and the pharynx is consequently short, whereas in adult humans, the larynx lies low in the neck lengthening the pharynx and increasing the potential for sound modulation. The skull of *Homo heidelbergensis* found in Ethiopia shows that it had reached virtually its modern degree by about 600 kyr ago. The appropriate structure for language had been achieved half a million years before we have any evidence that the *Homo* were using language or speaking. Thus, Tattersall makes a strong point: “we have to conclude that the appearance of language and its anatomical correlates was not driven by natural selection, however beneficial these innovations may appear in hindsight to have been”.

To summarize, a fundamental question in the human brain-mind evolution is that anatomically modern characteristics preceded modern behavior. This important question needs to be addressed. How could this have come about? What were the driving factors? What relationship exists between the driving factors and the emergence of the human mind?

It is reasonable to interpret these issues in the light of one important factor in evolution, that is, self-organization. The self-organization phenomena can be found everywhere in the world and especially in living organisms which are complex dynamic systems.

4. Self-organization, latent information and implicit learning

It is known that the human brain is a very complex dynamic system with a cerebral cortex of around 10^{11} neurons and 10^{14} synapses and in relation to ontogeny the correct wiring diagram would be almost impossible to arrive at out of all alternatives if all were equally likely. Thus, in the context of ontogeny the self-organization of neural systems must be used to handle their complexity (Mainzer, 1997). To comprehend this process of self-organization it is necessary to observe its long history. Van den Noort et al. (2005) consider that at the elementary level of biological organization, cellular structures appear to have immediate knowledge of remote actions in the system, thereby enabling the emergence of the spontaneous long-range cooperative organization in bio-molecules and membranes, in dendritic networks of cortical neurons and in colonies of single-celled organisms such as bacteria.

On studying the simplest of all organisms, bacteria, Ben-Jacob et al. (2006) report an important finding: some modes of behavior might reflect underlying (primitive) elements of biotic cognition.

Bacteria are not the solitary, simple organisms they are considered to be. Certain bacterial species self-organize into complex colonies of 10^{10} members. The bacteria use several methods of biochemical communication and the colonies can change their spatio-temporal organization to adapt to changes in the environment.

The authors also make an important suggestion: that besides “negative entropy”, organisms extract “*latent information*” embedded in the complexity of their environment. Latent information refers to the non-arbitrary spatio-temporal patterns of regularities and variation that characterize the environmental dynamics.

Ben-Jacob et al.(2006) affirm that the most fundamental aspects of these biological systems is that they can use internally stored relevant information relating to the self-design of their own engineered self-organization.

Hameroff (1996) considers that the cytoskeleton organizes intelligent behavior in eukaryotic cells. The cytoskeleton and its microtubules and other constituents are interlinked by way of a variety of microtubules associated with proteins to form a dynamic network, which defines cell shape and function. Numerous types of studies link the cytoskeleton to cognitive processes.

After several years working on the subject Shapiro (2006) affirmed that cells are cognitive entities possessing great computational power and formulated two important findings: i) that all aspects of cellular biochemistry are subject to computational regulation; and ii) that the molecular interactions (complementarity) relating to genome function are intrinsically computational (i.e., they involve multiple inputs that need to be evaluated algorithmically to generate the appropriate cellular outcome).

These considerations lead Shapiro (2007) to affirm that 40 years of experience as a bacterial geneticist have taught him that bacteria possess many cognitive, computational and evolutionary capabilities unimaginable in the first decades of the 20th century, and to suggest that we revise our basic ideas regarding biological information processing and recognize that even the smallest cells are sentient beings.

Commenting, on recent advances in our understanding of the design principles of biological networks, Alon (2003) states that the discovery of good engineering principles in biochemistry circuitry is surprising. Three of the most important of these are: modularity, robustness and recurring circuit elements.

The findings of Shapiro and Alon demonstrate that the organization associated with cellular biochemistry and the genome is computational or follows engineering principles that signify basically logic-mathematics. This is coherent with the immanent logic mathematics constitutive of the world and the dynamics of the environmental variations.

In more complex organisms Jablonka and Lamb (2006) regarded the emergence of the nervous system as a major transition because it “not only changed the way that information was transmitted between cells and profoundly altered the nature of the individuals in which it was present, but also led to a new type of social and cultural heredity based on the transmission of behaviorally acquired information”.

The capacity of bacteria in more complex organisms was assumed by the nervous system where the existence of *implicit learning* was observed, which is a fundamental process, one that lies at the very heart of the adaptive behavior repertoire of every complex organism (Reber, 1993).

Implicit learning produces a tacit knowledge base that is abstract and representative of the structure of the environment. Such knowledge is optimally acquired and can be used to solve problems and make decisions regarding a novel stimulus (Reber, 1989). It is accepted that unconscious cognition seems to be capable of doing things that require intention, deliberation and conscious awareness and subliminal learning (Seitz and Watanabe, 2003).

Implicit learning is a basic process that has played an important role in the grand evolutionary scheme. An organism that has the facility to extract information from the complexity of the structures and organisms of the environment and use this information to guide its actions is going to have an important advantage over organisms without this facility.

Implicit learning is at the origin of core system 1 which is an approximate representation of numerical magnitude and of core system 2 which is the precise representation of distinct numerical magnitude. Feigenson et al. (2004) provides evidences that these two systems *are present in human infants and in other animal species and therefore do not emerge through individual learning or cultural transmission. These systems account for our basic numerical intuitions and serve as the foundation for the more sophisticated numerical concepts that are uniquely human.*

5. The attractors of the evolution of the human mind

It has been demonstrated that living neural networks do, in fact, organize into a state where many attractors exist. An attractor network is made up of neurons with excitatory interconnections that can settle into a stable pattern of firing. Simulations indicate that attractors can be used to store information. These attractors are important for long and short-term memory, for attention and for decision making.

It has been observed in a previous paper (Yunes, 2005) that the fundamental function of the nervous system is related to two important processes, that is, gaining and storing information: a) from the environment, and b) from the organism's own body.

During evolution it is possible to observe in living organisms that these two processes arrived at a point in which two predominant attractors manifest: one that has been called **knowledge instinct** (Perlovsky 2006), and the other **autonomy instinct**. The first was described mathematically as the maximization of the similarity between concept-models and the world and the second as the maximization of the similarity between concept-models and the self, the identity, the selfhood. It is the principle of identity to obtain a complete autonomy. These instincts are internal forces that stimulate evolution, being **stable attractors** of vital importance to survival.

Interestingly, these two attractors, in a sense, were observed by Jung as **archetypes**: the archetype of the self and the archetype of the smaller numbers. The archetypes are, as such, *a priori* principles of organization, they are self-generating "forces of nature" (McDowell 2001). Supporting our theory is the opinion of McDowell that each archetype-as-such can be defined precisely in terms of mathematics.

The archetype of the self is, according to Jung, the most important of all. The creation of the self is a process of individuation where all the aspects are brought together as one. The archetype of smaller numbers is so ancient that it predates humanity itself, and is carried in the heritage of creatures even as primitive as insects (Robertson, 1995).

The attractors are advanced with respect to the evolution of new anatomical development and organization of the communication in order to enable the emergence of new cognitive realities and so it is possible that the anatomical development predated the behavior of *Homo sapiens*.

Evolution via this mechanism is also clearly observed in human language which was mediated by deep grammatical structures which are inaccessible to conscious introspection (Chomsky, 1975). In this case the brain must contain a recipe or “program” that can build an unlimited number of sentences from a finite list of words. The program is a mental grammar that is innate and the same for all humans. This explains the readiness with which children learn language (Chomsky, 1975).

6. *The big morphological brain formed over relatively short evolutionary time*

Zhang et al. (2011) observed an unexpected accelerated origination of new genes which are upregulated in the early developmental stages (fetal and infants) of human brains relative to the mouse. According to Lahn et al. (2004), the remarkably fast evolution of the human nervous system has a salient molecular correlate, i.e., accelerated evolution of the underlying genes.

The knowledge instinct as an attractor led the hominids, in their effort to survive, to apply their mathematical (arithmetic and geometric) and logic sense while working with the shape, size, distance, motion, constitution and weight of materials. They must have applied some concepts regarding the use of stones thrown as missiles, or bones and pieces of wood used as clubs or simple spears, in the most efficient possible way. Likewise, they must have known how to produce and use stone hammers and anvils as powerful bone-crushers and to gain access to hard-skinned fruits and nuts, and to use stone-cutting tools for the processing of animal carcasses.

All of these activities involve goal-directed cognition, associated with the evolutionary role of dopamine, and according Hills (2006) they are born out of mechanisms initially evolved in the service of foraging-and feeding-related behaviors and are probably an important factor in the relatively fast evolution of the human brain.

7. *The emergence of self-reflection and uniqueness*

An attractor is a state towards which the wholly dynamical system may evolve, starting from certain conditions. The existence of a strange attractor in hominization, starting from 60 million years ago, has been indicated. The autonomy attractor is related to the logic-mathematics structure: “the principle of identity” and leads to the constitution of the selfhood, the identity of a person.

This process of constitution takes place in a conscious mind when it turns to itself. This is a kind of negative feedback that helps to maintain the stability of a system in spite of external changes.

The negative feedback loop constitutes the basic unit in cybernetic control theory. This mechanism of control in physical and biological dynamical systems works by way of the output of information

or a signal that is looped back into the system to achieve some kind of steady state to compute, compare or correct this output.

Feedback is the basis of self-organization and of life. Thus, feedback enables homeostasis which maintains the internal stability of the organisms in relation to changes in the environment. Thus, homeostasis is fundamental for survival. The negative feedback shows clearly that the effects appear before the cause. Some of them must be related to the attractors which can explain the anatomical development prior to modern human behavior.

In the dynamic of the nervous system Freeman (1999) distinguishes three kinds of stable state, each with its own type of attractor: a point, a cycle and a chaotic attractor. However, in order to explain the unity of consciousness, he proposes another level of hierarchy in brain function, the hemispheric attractor, that is, a global operator supported experimentally by the high level of covariance in the EEGs simultaneously recorded from the bulb and the visual, auditory, somatic and limbic cortices of animals and from the scalp of humans.

Interestingly the maximal coherence appears to have zero phase lag recorded over distances of up to several centimeters between sites and even between hemispheres. Freeman affirms that a coherent activity with nearly zero time lag is unknown.

Feedback control in the human nervous system was indicated in the 1920s by Bernstein. Any movement of our arm is guided in its trajectory and speed. This is possible because there is a continuous dialogue, via feedback, between the senses, the brain and the arm, so the trajectory and the speed are adjusted as the motion proceeds.

Feedbacks guided for the two indicated attractors and using the implicit learning could explain the important fact that humans have a lot more association cortex than chimpanzees or other great apes. The negative feedback loop constitutes the basic unit in cybernetic control theory. However, the propagation of the information around the feedback takes a finite time and for this reason a discrepancy always appears between the reference and input values.

Considering the data on primate evolution and the above-mentioned aspects, it is possible to assume the existence of a fundamental stable state toward which is guided by its attractor in the evolution of the human mind ***the autonomy instinct that manifest in the brain as self-reflection or identity attractor***. The different species of the genera *Australopithecus* and *Homo* manifest an evolution process where the zero time lag, the real strange loop, was still not obtained.

Thus, the strange loop is so because it was guided by the identity attractor (the mathematical principle of identity) where the reference perception should be equal to the input reference. The fact that the reference perception should be equal to the input reference requires an instantaneous or similar feedback (loop) between the center that generates the information and the receiver.

The most elemental analogous characteristic, to explain the coherence between the parts and the system, is a single-particle quantum interference. This interference involves a circular feedback where the particle can travel through two slits at the same time and then interfere with itself.

In Wheeler's classic delayed choice experiment the particles seemed to "know" that the second slit was open, or may be said to be "conscious" of the opening of the second slit.

This duality wave-particle, which is strange, could provide some explanation of why objects seem to be in two places at the same time, communicate instantaneously across long distances and appear to the human mind to be subject and predicate at the same time when we say “I know that I know”.

A similar concept regarding the elemental analogies of consciousness was proposed by Reinis (2007) when he explains that the Pauli principle signifies that the electrons “feel” the presence of other electrons at a certain distance and respond to them and, thus, they approach the human subjective feeling of consciousness. The communication ability also represents the most basic unit of consciousness and Reinis affirms that “The explanation of consciousness lies in communication between electrons” and that “Subjective consciousness is a component of the mind and arises from the same electron sensitivity and other functions of the electrons, such as their translocation”.

Reinis et al. (2005) indicated that all electrical phenomena taking place outside or inside the brain cells represent a powerful source of subatomic particles in contact on a quantum level. This whole conglomerate is called RHS and is, perhaps, a non-local phenomenon where all moving electrons interact. Thus, they act as a quantum computer in the interaction of RHS with the brain structure which at the same time creates the RHS.

In this theory the fundamental explanation lies in self-reflection which is, as we will see, analogous to the self-interference that allows for individuality and apparent duality. However, it is clear that the entanglement of photons, electrons, molecules, etc., where they share the same quantum state, is also an important elemental characteristic of consciousness. These aspects satisfy the necessary coherence between the system and its parts as required by the ontological reductionism.

It is very important to note that single-particle two slit interference was demonstrated in macroscopic scale by Couder and Fort (2006). These scientists observed that a droplet of silicon oil of around 1 mm and the surface wave packet it emits, which should be thought of as one entity in an experiment similar to the slits in the original double-slit experiment, interfered with its own reflections.

It was shown by Couder et al. (2005) that a droplet can bounce indefinitely on a vertically vibrated bath of the same fluid. Near the Faraday instability threshold this bouncing becomes subharmonic and the drop emits a localized Faraday wave packet. A bifurcation occurs by which the drop becomes spontaneously self-propelled and moves on the liquid surface at constant velocity. They called the moving drop dressed with a wave-packet it emits a “walker” and it is a “symbiotic structure”.

Interestingly, the above-cited authors noted that a given droplet passes through one of the slits or through the other. However, its associated wave passes through both slits and the interference of the resulting waves is responsible for the trajectory of the droplet. It is important to note that the wave can travel alone without the droplet. The waves which are the bearers of the information may create a special informational field, which we will analyze below. The waves guide the droplet and the trajectory is defined interactively by a type of dynamical echolocation.

Couder and Fort comment “We showed in the simulation how this wavelike behavior of particle trajectories can result from feedback of a remote sensing of the surrounding world by the waves they emit. This phenomenon gives the walking droplet a kind of nonlocality since it evolves in a medium affected by waves it emitted in the past”. This also demonstrates the elemental

characteristics of consciousness as nonlocality, sensing of the surrounding world and interaction with the past.

Tschacher and Rössler (1996) indicate that the self produces order (the experience of “identity”) and thus: i) the self evolves if cognition is applied to cognition, ii) the self as identity of an individual is an attractor; and iii) the self is maintained by continuous recursion. Therefore, according to these authors a structure or entity that we can call “I” does not exist.

Hofstadter (2007) considers a video screen showing itself, showing itself... as similar to consciousness being aware of itself, being aware of itself... and Gödel’s thought that a mathematical formula - a statement about a number - can itself be represented by a number, which is a self-referential capability and signifies that mathematics can say things about its own structure, suggests that this strange loop is similar to what is going on in human thought.

According to Hofstadter, a mind is a near-infinitely extendable self-referential loop of symbols that has the hallucination of being an “I”. Thus, the “I” is only a loop of symbols without any physical reality.

Corballis (2011) considers that recursive thinking is fundamental to define the mind. Recursive thinking is the ability to think about thinking. He indicates mental time travel, to imagine past events within current consciousness as recursive and a basis both of memory and fiction. This permits the ability of imagining the state of mind of others imagining your state of mind. The theory of mind allows the development of language.

Damasio (2012) suggests that when the unconscious mind begins to receive images of disposition and feeling of emotions, it establishes itself self-referentially to make itself a conscious mind.

All of these theories coincide in that some kind of recursive or strange loop, that is self-referential, explains the essence of the consciousness. However, no one explains what could be the basis, the ontology of this strange loop.

However, this kind of reductionism has two problems: i) how can recursion decode the information if it remains within the same level of information? and ii) how can recursion unify, for example, in visual processing, the first step of extraction of the object features, such as color, velocity, size etc., when the extraction occurs in spatially separated populations of neurons in a unique binding in the visual field?

Many lines of logic-mathematics reasoning provide some explanation of these problems. G. Chaitin (2009) speaking about the relation of mathematics with physics and biology stated that *“Normally you think pure math is closer to physics, since they grew together, they co-evolved. But what the bits of the halting probability omega show is that in a certain sense pure math is closer to biology than it is to theoretical physics, because pure mathematics probably contains infinite irreducible complexity (Omega = infinite number of bits). Biology has very high complexity but it is only finite (the most complex biological structure is the human brain, more complex than all the universe).”*

We have analyzed the aspect that in the evolution of the human mind two important attractors existed, the knowledge instinct and the autonomy instinct or identity attractor. The evolution of identity led to a continuous recursive feedback searching for the input “I” to be equal to the perception “am”. That is, subject “I” and object “am”, must be transformed into one and the same

entity. This could be the reason for the larger amount of association cortex that, as we have mentioned, *allows humans to respect other related primates*, considering it led to a better endogenous feedback network and synchronization.

Here, we must return to the thought of Hofstadter: the “strange loop” is an abstract loop which, in a series of stages shifting from one level of abstraction (or structure) to another, feels like an upward movement in a hierarchy. He considers that the current “I”, the up-to-date set of subjective life aspirations, passions, etc., tampering with the external world and other people, has sparked some “rapid feedback” which, once absorbed in the form of symbol activations, gives rise to an infinitesimally modified “I” that after years converges and stabilizes itself.

However, this is not possible. To reach one’s identity (I=am) and to form symbols the “rapid loop” indicated by Hofstadter must arrive at the point of being instantaneous, forming a nonlocal reality. This signifies an upward movement to a superior level of hierarchy that can interpret, decoding the information existent in the input.

Hofstadter explains this process *“It is the upward leap from raw stimuli to symbols that imbues the strange loop with ‘strangeness’. The overall gestalt ‘shape’ of one’s self- the ‘stable whorl, so to speak, of the strange loop constituting one’s ‘I’- is not picked up by a disinterested, neutral camera, but is perceived in a highly subjective manner through the active processes of categorizing, mental replaying, reflecting, comparing, counterfactualizing, and judging”*. However: i) how could there be a stable whorl? and ii) how does the highly subjective manner appear within the same processes?

According to Kauffman (2009, who analyzed the relationship between reflexivity and eigenform (eigenform of Heinz von Foerster), in the world of eigenform the observer and the observed are one in a process that recursively gives rise to each. The notion of a fixed object appears from a process that produces the apparent stability of the object. The stability of the whorl of Hofstadter is apparent. The model of Kauffman examines the results of a simple recursive process carried to its limit, that is, each step in the process encloses the results of the previous step within a box each time smaller. It should be carried to its limit to obtain the stability. The whorl goes down decreasing or goes up increasing the loop.

In the model of Kauffman going down is similar to successively putting a little box within another larger box. At the limit of an infinite number of boxes we find that the infinite set of boxes is an invariant with the addition of one more box. To obtain an invariant it is necessary to go to the limit that is the infinite. The limit of a whorl going down to the infinite is an invariant: a fixed point. It is also the eigenform, its own form or the proper form of the recursion. Mathematically, a point has no parts, it has no dimensions, it is in some concept an infinite (a point is below the Planck length). Similarly, when the human loops, looking for its identity through implicit learning, the difference between input and output times decrease until it disappears, is an instantaneous loop that imbues its ‘strangeness’. Maybe, we can say it is an infinite loop, an actual “relative infinite” (or a transfinite). This infinite will emerge by contact with an absolute infinite or some of its properties as we will indicate below.

Kauffman (1987) writes “Self-reference is the infinite in finite guise!”. However, Kauffman provides a very important response: “How is this formal self-similarity related to our intuition of self within self through introspection?” This suggests that it is via a feedback cycle and seeing the invariance that we come to a reflection of the self. However, the personal process involves the non-mechanical aspect of integration of the parts into a whole. It is not possible to formalize the entire

circumstances of human self-reference in a system of symbols devoid of an observer and ask “Who or what is the observer?” This will be clarified below.

A computer can have a program with the sentence “I know that I know...” It will take a finite time no matter how small to write the sentence. But, it cannot know what it is doing because it can only complete a finite loop not an infinite loop. Evidently, the computer can execute the sentence a finite number of times or an infinite number of times without knowing it. The loop has to be infinite and this must occur in the human mind.

Thinking, when the loop is going up looking for the true, the true of the self or of external world, it will increase until its limit and according to Gödel’s Incompleteness Theorem until the infinite. Gödel’s theorem says that any system that is complex enough to express mathematics cannot prove, by itself, that everything it says is true. It will always rely on something outside the system. Thus, through implicit learning the human mind will continue until contact with the infinite source of information or some of its properties (infinite irreducible complexity).

This process carried out during a long evolutionary period may be the reason of humans have a lot more association cortex in absolute terms than other primates because more association cortex leads to a better endogenous feedback network (Augstenborg 2010) and a better synchronization of neurons to enable the instantaneous feedback, the real strange loop.

The infinite source or its property, as in the case of the loop going down, must be the Absolute infinite of Cantor. *With this contact the human mind, which until that moment cannot interpret itself, by a mechanism of “induction of reflection” considering the known and accepted Reflection Principle, can share every conceivable property of the Absolute (see Rucker, 1982) and so go upwards to a superior level of hierarchy. Thus emerges the decoder, the observer of Kauffman. Rucker quotes Cantor’s important and very strong thought: “The fear of infinity is a form of myopia that destroys the possibility of seeing the actual infinite, even though in its highest form it has created and sustains us, and in its secondary transfinite forms occurs all around us, even inhabits our minds”.*

Furthermore, we can interpret the symbol differently from Hofstadter, because the ceaseless circular process does not transcend to itself and thus cannot create anything. Kauffman (2009) demonstrated that with any transformation T in any domain where an infinite composition of transformations is possible we make $E = T(T(T(T(\dots))))$ and we find that $E = T(E)$ is the fixed point that sometimes corresponds to a stability in the domain of the recursion. He also observed that taking a seed z for the recursion and repeating form: $z, T(z), T(T(z)), \dots$ in a temporal sequence or recursive process, the products can exhibit similarity to the infinite eigenform and can exhibit novelty and creativity. However, in this case the seed z is transcendent information placed in the system. This kind of information is apparently the only way for the human mind to surpass the Incompleteness Theorem looking for the true.

The non-local phenomena of consciousness can be explained in the quantum world. According to Cramer (2009) “The transactional interpretation, a leading alternative to the Copenhagen interpretation, uses an explicitly nonlocal transaction model to account for quantum events”. This model describes any quantum event as a space-time “handshake” executed through an exchange of retarded waves and advanced waves“. He adds “The transaction is explicitly nonlocal because the future is, in a limited way, affecting the past (at the level of enforcing correlations)”.

Vannini and Di Corpo (2011) indicate that the relativistically invariant wave equation of Klein-Gordon is dependent on a square root and yields two solutions: retarded waves which move forward in time and advanced waves which move backwards in time. Advanced waves were considered to be unacceptable because they contradict the law of causality.

Vannini and Di Corpo following the mathematician Luigi Fantappi  noted that advanced waves are governed by a law opposite to entropy which leads to order, differentiation and complexity, named syntropy. The advanced waves are also the basis of attractors. The attractors are situated in the future of the evolution of complex systems.

Thus, the attractor of the human mind identity must be the source of information that guides the evolution by a predominately logic-mathematics structure. This attractor would be the Absolute infinite.

8. This hypothesis and the psychology

It is important to note the relations between this theory and some important psychological schools. This importance is due to the help it can provide in some psychological therapies.

One of these schools is that of C. G. Jung. According to Jung the psyche has three levels: the conscious that is the ego; the personal unconscious, with the memory and emotions; and the collective unconscious that is universal, of all human beings, including the instincts and the archetypes.

Jung distinguishes the ego from the self. The self is primary and the ego develops from it. The self is relational and requires the submission of the ego, a fact that can lead to an individuation crisis. The self is understood as the totality of the body and the mind, the God image (God correspond to our Absolute infinite), and the coincidence of "opposites", our contradictory feelings and impulses. Jung considers the coincidence of opposites to be part of the God and the self-archetypes that enables the individual to transcend and overcome his or her conflicts. We will return to this concept later.

One fundamental concept of Jung's theory is that of individuation. This is the process of becoming a whole identity, a process of self-realization that is to reveal the meaning and purpose of one's life. Individuation is a permanent process that is never completed. There is a circumambulation of the self, everything points towards the center, we could say it is a recursive loop searching for the real identity, the personal realization.

Another important aspect of Jung's theory is to assume intuition to be a normal psychological function. This function permits perceptions to arise from the unconscious with contents as complete wholes.

According Jung (Jung 1969) "it is only through the psyche that we can establish that God acts upon us, but we are unable to distinguish whether God and the unconscious are two different entities. Both are border-line concepts for transcendental contents" and also "The God-image does not coincide with the unconscious as such, but with a special content of it, namely the archetype of the self. It is this archetype from which we can no longer distinguish the God-image empirically".

Jung considers God as an archetype related to man's evolution. According to some authors, he thinks that it is not possible to prove that the God image is God himself or that the self takes the place of God. Others consider that the God of Jung is not a transcendent reality of whom man may achieve some knowledge but rather a basic tendency of human nature (Schmidt 2005).

Another important school is the "Third Viennese School of Frankl" that appeared after Sigmund Freud's psychoanalysis and Alfred Adler's individual psychology, as a humanistic and existential psychology. Freud indicates the pleasure principle, Adler the will of power and Frankl the will of meaning. The logotherapy of Frankl (1955) observes a person's search for meaning. Logos is a Greek word that denotes meaning. Logotherapy is a process which enables a person to become coherent with his main concern: the meaning of his life. There exist in men a will of meaning that is their main motivation force. Life has meaning in all circumstances and in all men is freedom.

As this latter school supports and is supported by this hypothesis of the real strange loop of self-reflection, I will analyze it showing the correspondence:

- i. for Frankl our theory the infinitude of the conscious is revealed in psychology because it is not completely conditioned by the corporeal. Clearly, a residual freedom exists and, thus, a relative independence or autonomy, despite the dependence on the corporeal. The real autonomy of the person is only possible if the person transcends their ego toward an external meaning of their existence.

When the real strange loop emerges the human being obtains its freedom from instinct and impulses. Thus, men need to orient their behavior in life in the face of some contradictory tendencies of both realities. Human beings are permanently questioning regarding their existence and their meaning and they must find the answer in each situation.

- ii. another important aspect is the thought of Jung of Frankl that human conscience is, in some sense, the coincidence of opposites. The unity of the human being, despite the somatic and psychic oppositions, constitutes a "coincidence of opposites". Nicolau of Cusa (2005) taught that, in the infinite, the circle coincides with the line, and thus that the Absolute infinite involves "coincident contradictories". Analogously, a "relative infinite" human conscience must involve the coincidence of opposites and comprehend the paradoxes.

A mind that has the power to comprehend the contradiction of the Liar paradox, a mind that can comprehend the true of the demonstration of the Incompleteness Theorem, derives from a position related to the infinite.

- iii. I consider a fundamental thought of Frankl that there are two forms of the unconscious: one similar to that of Freud, with repressed instincts and desires, and the other that is the source of love, art and the ability to transcend. This unconscious spiritual is the deepest root of the Ego. These two aspects of the unconscious are supported by the hypothesis developed herein: one of them, as Jung suggests, carried in the heritage from our long phylogenetic history and the other related to the emergence of the real strange loop that gives origin to self-reflection and to a special informational field that, nonetheless, needs some material transporter.

The existence of core systems that account for the basic number sense in humans suggested by Feigenson et al. (2004) also supports both our hypothesis and that of Frankl. These core systems, according to the authors, offer a strong case for representational continuity across development and species and are dependent on a mechanism with a long phylogenetic history. Also, these core systems serve as the foundation for developing more sophisticated mathematics, which is uniquely human, and corresponds to our hypothesis of real strange loop and the spiritual unconscious of Frankl.

Thus, the human structure has two aspects of the unconscious forming a unity that cannot be separated, but where each one of them cannot be reduced to the other. Thus, we have two forms of the “I”. One, more superficial and for that easier to follow, which is impulsive, egocentric, aggressive, with an impersonal sexuality tendency which is the heritage of our ancestors (important for survival but the origin of the violence that is the shackle of our civilization) and the second “I”, which is deeper and is a product of the emergence of the real strange loop.

In the conception of Frankl (1987) the real ego appears in the spiritual realm where man is free and responsible. This is the realm of real strange loop. The Ego is a reality that distinguishes man. However, the center of the spiritual person is unconscious. It is a reality inaccessible to the conscious. The reality of the relative infinite of our mind remains unconscious.

Psychoanalysis wants to make conscious the unconscious impulsive while existential analysis wants to make conscious the spiritual, the second “I”.

iv. human mind is open to the world; it is not confined to the environment inhabited by its species as in the case of other animals. The human mind is also open to other persons and to the transcendent. Man, by the real strange loop of his consciousness, is liberated from his impulses and instincts. However, to be autonomous, based on the meaning, especially the ultimate meaning, of his existence he should give value to things. This is only possible if things are considered with respect to an absolute value. The extrapolation to the Absolute, to the infinite, is always necessary.

v. Jung considers intuition to be a normal psychological function, Frankl wrote that intuition is “the wisdom of the heart” and that the conscience is the intuitive capacity of man to find the meaning of concrete situation.

Interestingly, In the field of mathematics it is possible to observe notable cases of intuition as that of Srinivasa Ramanujan, an obscure and poor man of India, that intuitively wrote important mathematics equations without any proofs. Other important cases are indicated for Davis, Hersh and Marchisotto (1995). These facts could be explained by the relation of our relative infinite consciousness and some other infinite.

Summarizing : the logotherapy and existential analysis discovers, in a first phase, that the condition of being human is to be conscious and responsible, in a second phase that a spiritual unconscious that is a source of love, art and transcendence exists and, finally, in a third phase that a latent religiosity unconscious, a state of unconscious relation with God, exists. The relation with God can be unconscious and repressed and thus hidden. However, true religiosity is not impulsive but decisive, because the religiosity is existential or is not absolute.

It is very important to emphasize that Frankl rejected any attempt to subject psychotherapy to religion. Existential analysis and logotherapy lie within the realm of science based on experimental data. Experimentally, Frankl based the reality of the spiritual unconscious on the analysis of dreams and existential analysis which showed that the deepest decisions regarding the human existence are not, as generally believed, conscious, but realized in the unconscious.

This theory of the real strange loop provides scientific support for existential analysis and logotherapy from the point of view of the human mind evolution and of the emergence of the consciousness by some kind of communication with the Absolute infinite (God of Frankl).

Finally, in the present world, with grave crises, we can observe the predominance of the unconscious impulse manifested in violence, different types of fundamentalism, impersonal

sexuality and hedonism, extreme individualism, lack of honesty, white lies, etc. It is clear the fundamental role of that which makes conscious the spiritual: art, science, love, solidarity, etc., first through education at all levels and then via the mass communication media, in order to stimulate the real fraternity that covetousness has concealed.

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References

- Alon U (2003). Biological Networks: the tinkerer as an engineer. *Science*, 301, 1866-67.
- Ben Jacob E, Shapira Y and Tauber AI (2006). Seeking the foundation of cognition bacteria: From Schrödinger's negative entropy to latent information. *Physica A: Statistical Mechanics and its Applications*, 359, 495-524.
- Chaitin G (2009). How Real are Real Numbers? Lecture given at Wilfrid Laurier University in Waterloo, Canada. Retrieved from <http://www.cs.auckland.ac.nz/~chaitin/metabiology.pdf>.
- Chalmers DJ (1995). Facing up to the problem of consciousness. *J. Conscious. Stud.*, 2, 200-219.
- Chomsky N (1975). *Reflections of Language*. NY: Pantheon Books.
- Corballis MC (2011). *The origins of Human Language, thought and civilization*. USA: Princeton Univ. Press.
- Couder Y and Fort E (2006). Single-particle diffraction and interference at a macroscopic scale. *Phys. Rev. Lett.*, 97, 154101.
- Couder Y, Fort E, Gautier CH and Boudaoud A (2005). From bouncing to noncoalescence of drops on a fluid bath. *Phys. Rev. Lett.*, 94, 177801.
- Cramer JG (2009). Quantum nonlocality and the possibility of superluminal effects. *Proceeding of the NASA breakthrough propulsion physics workshop*, 12-14.
- Cusa N de (2005). *Un ignorante discurre acerca de la mente*. Argentina: Bilingüe Ed. Biblos.
- Damasio AR (1992). The selfless consciousness. *Behav. Brain Sci.*, 15, 208-209.
- Damasio AR (2012). *Self comes to mind: constructing the conscious brain*. USA: Pantheon Books.
- Dorus S, Vallender EJ, Evans PD, Anderson JR, Gilbert SL, Mahowald M, Wyckoff GJ, Malcom CM and Lahn BT (2004). Accelerated evolution of nervous system genes in the origin of *Homo sapiens*. *Cell*, 119, 1027-1040.
- Feigenson I, Dehaene S and Spelke E (2004). Core systems of number. *Trends Cogn. Sci.*, 8, 307-314.
- Frankl VE (1955). *La Psicoterapia en la práctica médica*. Buenos Aires: Escuela.
- Frankl VE (1987). *El hombre doliente. Fundamentos Antropológicos de la psicoterapia*. Barcelona: Herder.
- Freeman WJ (1999). Consciousness, Intentionality, and Causality. *J. Cons. Studies*, 143-172.
- Hameroff S (1996). Did consciousness cause the Cambrian Evolutionary explosion? In Hameroff S, Kasniak A and Scott AC (Eds.). *Toward a science of consciousness: the first Tucson discussions and debates*. Cambridge: MIT Press.
- Hawks JD, Hunley K, Lee SH and Wolpoff MH (2000). Population bottlenecks and Pleistocene human evolution. *Molecular biology and Evolution*, 17, 2-22.
- Hills TT (2006). Animal foraging and the evolution of goal-directed cognition. *Cog. Sci.*, 30, 3-41.
- Hofstadter D (2007). *I am a strange loop*. USA: Basic Books.

- Jablonka E and Lamb MJ (2006). The evolution of information in the major transition. *J.Theor. Biol.*, 239, 236-46.
- Kaas JH (2005). From mice to men: the evolution of the large, complex human brain. *J. Biosci.*, 30,155-65.
- Kauffman LH (1987). Self-reference and recursive forms.*J. Social Biol. Struct.*, 10, 53-72.
- Kauffman LH (2009). Reflexivity and eigenform: the shape of process. *Constructivist Foundations*, 4, 121-136.
- Kivell TL, KiviJM, Churchill SE,Schmid P and Berger LR (2011). Australopithecussediba hand demonstrates mosaic evolution of locomotor and manipulative abilities. *Science*, 333, 1411-17.
- Koch C and Crick F (1991). Understanding awareness at the neuronal level. *Behav Brain Sci.*, 14, 683-685.
- Lee SH andWolpoffMH (2003). The pattern of evolution in Pleistocene human brain size. *Paleobiology*, 29, 186-196.
- Mainzer K (1997). *Thinking in complexity: the complex dynamics of matter, mind and mankind.* Germany: Springer-Verlag.
- McDowell MJ (2001).The three gorillas: an archetype orders a dynamic system. *The Journal of Analytical Psychology*, 46, 4.
- Perlovsky LI (2006). Toward physics of the mind: concepts, emotions, consciousness, and symbols. *Physics of Life Reviews*, 3, 23-55.
- Pickering R, Dirks PHG,JinnahZ, de Ruiterdj, ChurchillSE, HerriesAIR, Woodhead JD, Hellstrom JC and Berger LR (2011).Australopithecus sediba at 1.977 Ma and implications for the origin of the genus Homo. *Science*, 333, 1421-23.
- Preuss TM (2011). The human brain: rewired and running hot. *Ann N.Y. Acad. Sci*, 1225, S1 E-182-E191.
- Preuss TM (2004). What is it like to be Human? In Gazzaniga, M.S. (Eds.). *Cognitive Neurosciences.* Cambridge, MA: MIT Press.
- ReberAS (1989). Implicit learning and tacit knowledge. *J. Exp. Psycholog: General*, 118, 219-235.
- Reber AS (1993). *Implicit learning and tacit knowledge: An essay on the cognitive unconscious.* Oxford: Oxford Univ. Press.
- Reinis S, Holub RF andSmrz P (2005). A quantum hypothesis of brain function and consciousness. *CeskoslovenskaFyziologie*, 54, 26-31.
- Reinis J (2007). Can hard problem of consciousness be solved? *CeskoslovenskaFyziologie*, 56, 134-137.
- Seitz AR and Watanabe T (2003). Is subliminal learning really passive? *Nature*, 422, 36.
- Robertson R (1995). *Jungian archetypes: Jung, Gödel and the History of archetypes.* York Beach, Maine: Nicolas-Hays, Inc.
- Ruff CB, TrinkausE and Holliday TW (1997). Body mass and encephalization in Pleistocene. *Nature*, 387, 173-76.
- Schmidt MA (2005). Individuation: finding oneself in analysis-taking risks and making sacrifices. *The Journal of Analytical Psychology*, 50, 595-616.
- Shapiro JA (2006). Genome informatics: The role of DNA in cellular computations. *BiolTheor.*, 1, 288-301.
- Shapiro JA (2007). Bacteria are small but not stupid. *J. Stud. Hist. Phil. Biol& Biomed Sci.*, 38, 807-819.
- Tattersall I (2002). *The monkey in the mirror:Essays on the science of what makes us humans.* USA: Harcourt Inc.
- Tschacher W andRösslerOE(1996). The self: a processual Gestalt. *Chaos, Solitons& Fractals*, 17, 1011-1022.

- Van den Noort MWML, Bosch MPC andHugdall K (2005) Understanding the unconscious brain: evidence for non-linear Information processing.Proceedings of the 27 th Annual Meeting of the Cognitive Science Society. Stresa, Italy.
- Vannini A and Di Corpo U (2011). Quantum physics, advanced waves and consciousness. J. of Cosmology. Retrieved from <http://journalofcosmology.com/Consciousness101.html>.
- Wheeler JA and Ford K (1998). Geons, Black Holes & Quantum Foam. USA: W.W. Norton Comp.
- Yunes RA (2005). The evolution of the human mind and logic-mathematics structures. J.Theor.Biol., 236, 95-110.
- Zhang YE, Landback P, Vibranovski MD and Long M (2011). Accelerated Recruitment of New Brain Development Genes into Human Genome. PLoS Biol., 9, e1001179.