Cortical and Subcortical Mecchanisms that Underly Consciousness

Jerome Liss, M.D.
j.liss@fastwebnet.it

Part I: A Single Moment of Consciousness
Part II: How Stimuli Enter the Field of Consciousness
Part III: Brain Mechanisms of the Stream of Consciousness

Laboratory and Clinical Research on Brain Mechanisms of Consciousness

This article will present two directions of research regarding the brain mechanisms of consciousness. The empiricial starting point for these two directions is different; the challenge is to integrate the theoretical models.

Laboratory research has made vast progress in recent years due to neuroimaging, including magnetic resonance, tomography, and so on. This allows for very **precise correlations** on the observational level. Images of brain activity can be correlated with the **precise input stimuli,** on one hand, and subject reports and behavior, on the other hand. For example, simple words, numbers or images may be flashed on a screen at intensity levels that are just below or above the threshold of consciousness, and then patient reports and behavior can indicate which stimuli enter consciousness, despite masking stimuli, while the brain imaging shows the corresponding brain mechanism activation. The great scientific advantage of this approach is the precision of the empirical data. The **disadvantage** is the **distance** of such registered "moments of consciousness" from the "**natural system**" (Hempel,1952) of consciousness in everyday reality. In other words as a study of human experience – passion, fear, drive, turmoil, conflict, anxiety, happiness, and so on – such experimental work, for the moment, does not seem to have **direct relevance**.

Clinical research regarding "the stream of consciousness", that is, the consciousness that we experience alone and with others in everyday life, might seem too ambitious in today's early period of scientific research regarding the brain and consciousness. However, this article proposes that some initial steps are justified. Therefore this article uses, as its starting point, six previous articles regarding "the stream of consciousness" as observed from patient's oral and written reports. (Liss, 2007-2009) The focus is on **"the impasse in solitude."** This is **the conscious sequence that will be repeated** by patients who are anxious, depressed and suffering from trauma.

Although some researchers might say that the empirical basis is too difficult to register, the first article in the series faces this dilemma and explains how the patient's verbal and written reports, despite significant distortions and simplifications, has sufficient connection with the "real event of the natural system" to be treated as the observational grounding for generating theoretical models that will then be corrected in the future.

One important point: **Designs will be used to illustrate the basic mechanisms.** Designs contribute to the articulation of brain mechanisms, allow growing complexities to be understood in simple ways, and encourage comparison among theoretical models.[1]

One of the goals of this article is to create "a bridge" between laboratory and clinical research. In other words, just as the author of this article has profited from laboratory research models of brain mechanisms, it is proposed that laboratory researchers can be stimulated to integrate clinical perspectives regarding their own brain studies.

Neural Correlates for Three Times of Consciousness: Access, a Moment and the Prolonged Stream

Laboratory research usually focuses on the single moment of access to consciousness and a single moment of consciousness itself, that is, of consciousness regarding an outer stimulus. Thus the time element in both cases regards a single moment. Very often, there is a measure of how such **outer stimuli** reach consciousness by means of **cortical and subcortical** brain processes. The first two parts of this article treat these two moments of consciousness. (Of special interest is the research of Dehaene and Changeux, 2003)

The third part treats the clinical question. Few empirical examples will be offered in this article, since these have already been presented in the previous works already cited. The accent in the third part will be upon extending the model of brain mechanisms in order to explain the great complexity and force of "the stream of consciousness." For example, how can we explain the strength and tenacity of the conscious stream when we are continuously worried, anxious and overwhelmed by unhappiness? "Vicious cycles" within **unconscious subcortical mechanisms** are correlated with the "vicious cycles" in the **stream of consciousness**. (See "A Tank in the Garden of the Mind," Stream V, for a more detailed presentation of this brain mechanism.)."

In addition, the Self-Other Locus theory (of Trehub and others) will be presented. It is hypothesized that this structure of consciousness will be an important aspect of future brain research. In addition, while laboratory research focuses on responses to an **outer stimulus,** clinical research focuses on how the "stream of consciousness" in solitude is continuously under the influence of **inner forces.**

Although these last themes that interest the clinician still create little interest for the researcher in the laboratory -- or perhaps they are too complex for the researcher to handle – the clinician would nevertheless like to know the brain processes that are going on "behind the scenes."

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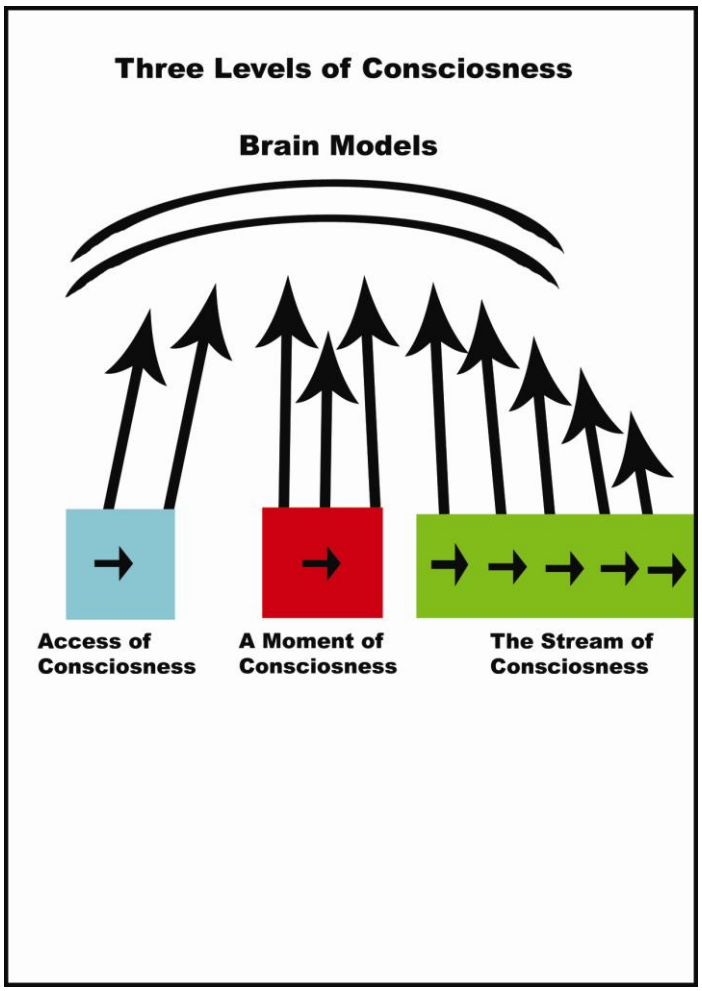


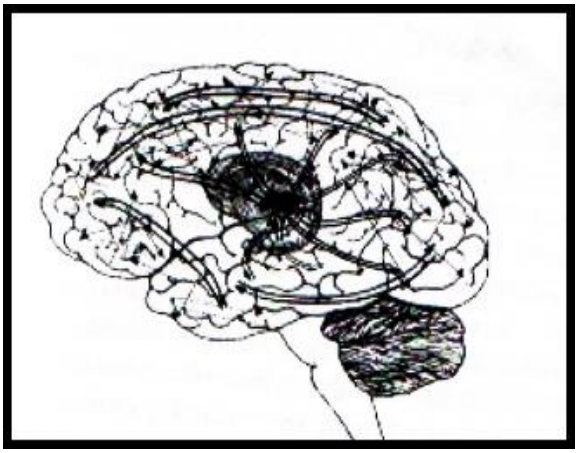
Part I: A Single Moment of Consciousness

The "Dynamic Core"

Gerald Edelman proposes that consciousness is organized by the thalamo-cortical circuit, which he calls **"the dynamic core."** (Edelman,1989,2000,2004) The **thalamus** receives ascending input from the perceptual world (**the ascending reticular system**), the subcortical system of motor coordination (**the basal ganglia**) and the emotional world (**the amygdala**). Excitatory neurons from the thalamus shoot upwards to the cortex, lighting up many cortical areas and their neuronal circuits. There is always "feedback" or "reentry" from the cortical circuits back to the thalamus, so that they are in reciprocal interaction. It makes a lot of sense to envision the thalamus-cortical interaction as a mechanism of consciousness, since the thalamus is receiving inputs from at least three major sources that merit attention: **external stimuli** from the ascending reticular formation, **motor programs** from the basal ganglia, and **emotions** from the amygdala. But it is not only stimulus intensity that determines what inputs the thalamus will then send upwards to capture our attention. The cortex sends down messages to the neuronal net that surrounds the thalamus, opening up or closing down this net-gate, and this

mechanism also determines what information the thalamus will send up to the cortex. This is how the cortico-thalamic "dynamic core" orients our attention.

The Cortico-Thalamic "Dynamic Core"

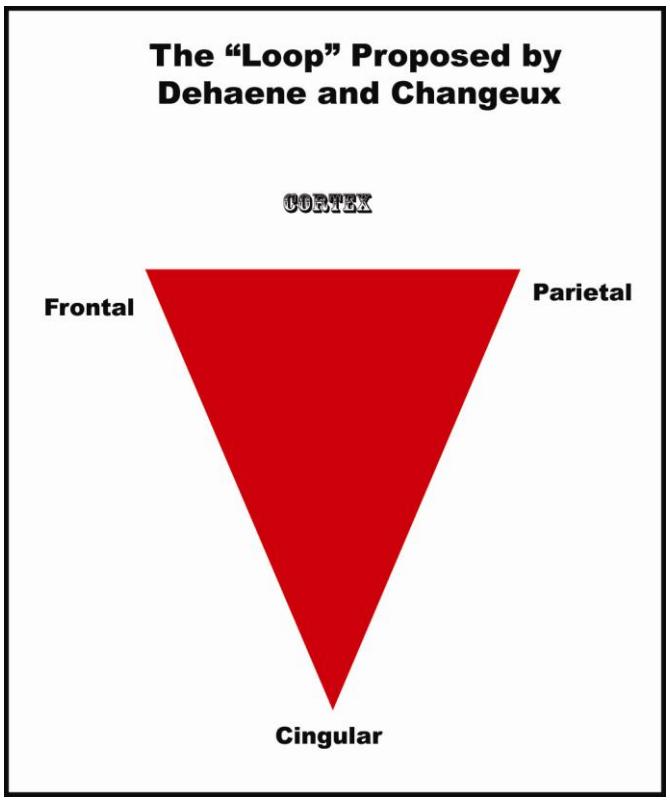


Design from Edelman "Wide as the Sky"

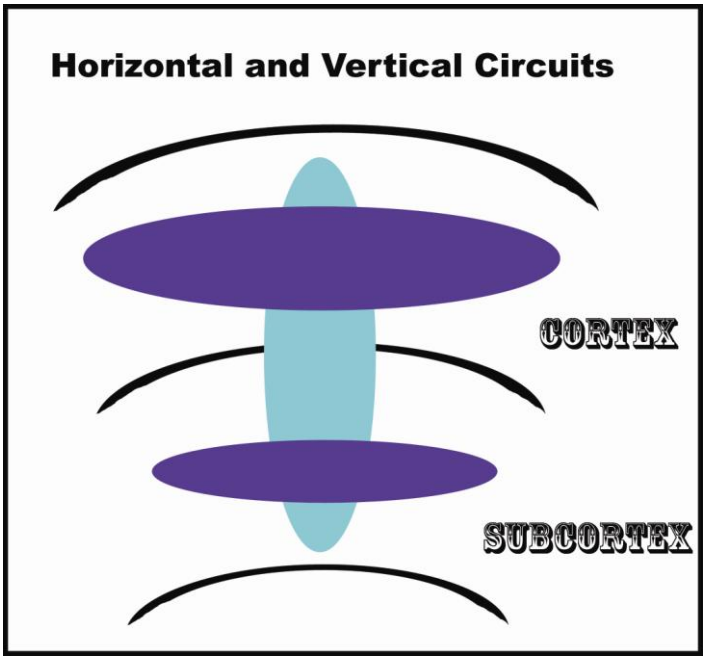
An important feature of this model is the top-down/down-up **vertical mechanism** of consciousness. In other words, the upper brain cortex is the brain's physical substrate for consciousness, while **the lower brain subcortex is absolutely necessary to carry forward consciousness,** even though this part of the brain does not have the complex neuronal architecture that is required to make a neuronal event conscious.

The Frontal-Parietal-Cingular Loop

Dehaene and Changeux (2003) go beyond Edelman's "dynamic core" and propose another brain mechanism of consciousness. They hypothesize that **every event of consciousness must also involve a loop connecting the frontal lobe, the inferior parietal lobe and the cingular gyrus.**



This circuit then "broadcasts" its messages both **horizontally** to the other cortical areas and **downwards** to subcortical regions.



The authors say that this mechanism gives a neuronal basis for the most well-known theory of consciousness, **Bernard Baar's "Global Workspace Model."** More specifically, Baar (1988,2003) proposes that a fundamental process of consciousness involves neurons that "broadcast" to all parts of the cortex. And what is sent out also returns by means of "reentry," so that consciousness has the capacity to pull into its repeating and expanding circuits vast regions of the cortex. More specifically, as said above, this integrates within the focus of consciousness **posterior lobe** perceptions, **temporal lobe** memories, **parietal lobe** spacial structures derived from mathematical space-time calculations, **frontal lobe** action plans and **cingulate-orbitofrontal** self identity needs. (Heilman,2002) Dehaene and Changeux give physiological support to this cortical-cortical horizontal interaction, showing that the cortex has bundles of **long-range neurons** that link up the separate cortical regions; thus studies of brain anatomy supports this neuronal model that explains the frontal-parietal-cingular loop for the "broadcasting" of central consciousness processes, as well as for the feedback that makes all parts of the system reciprocal.

Phonological Loop and Visual Sketch Pad

One feature of consciousness is that we think with words and images. The research of Baddeley (2003) can be summed up as a model of working memory that involves three distinct subsystems. Baddeley writes, "The best described is the **'phonological loop',** a system that draws upon speech resources. For example, if I wanted to remember a set of numbers, I might catch myself whispering to myself -- it turns out that speech systems are an integral part of working memory. The second component is the **visuospatial sketchpad,** a parallel system akin to an artist's sketchbook for stimuli that cannot be verbalized, such as spatial information."

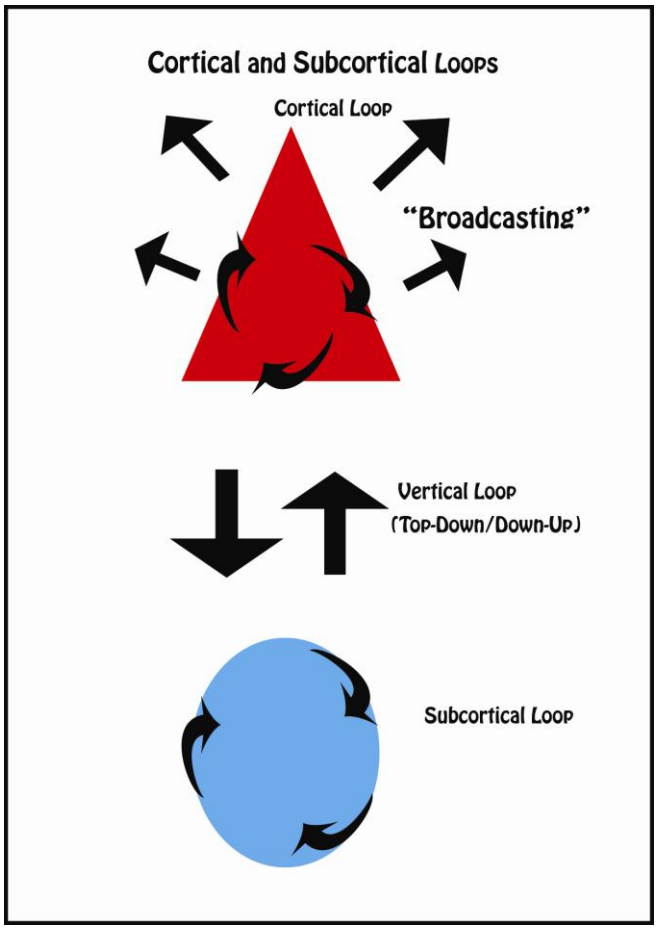
We can keep in mind that each conscious thought process – word or image – involves several circuits working in an integrated way. For example, the experience of **language** integrates Wernicke's area language lexicon, Broca area's language motor output, the motor cortex and also (see Lieberman,2000) the subcortical basal ganglia. Then, when we talk about **visualisation**, we must keep in mind two basic components of what is seen: The **"what"** of the visual image (posterior lobe of visual receptivity to the temporal cortex), and the **"where"** (posterior lobe to inferior parietal cortex), in other words, **"object"** and **"context."**

Baddley also suggests a third loop: "The third main unit is the central executive, a system responsible for supervisory attentional control and cognitive processing. This last system, though poorly defined, is most alluring because it represents the very stuff of thought." When we treat the Stream of Consciousness in Part III, several more systems will be proposed to explain thought sequences in everyday life, and these systems will include emotional dynamics, time and space dimensions, and the Self-Other locus. (See also Crick,2003)

Horizontal and Vertical Loops

Using the research of Edelman as well as Dehaene and Changeux, we can take a step further, integrating the above **cortical-cortical horizontal** processes with **subcortical-cortical vertical** interactions. To repeat the main idea: We have both **lateral** long-range neurons in interaction pulling into consciousness diverse cortical regions, and **vertical** long-range neurons that give an excitatory effect which is absolutely necessary for consciousness. Without these **vertical** cortical-subcortical loops, the **horizontal** cortical processes will not have sufficient intensity to be accessed by consciousness. This is demonstrated by Dehaene and Changeux's research. The two authors call this process "top-down and bottom-up" activated brain circuits. (See Stupiggia for clinical examples, 2009).

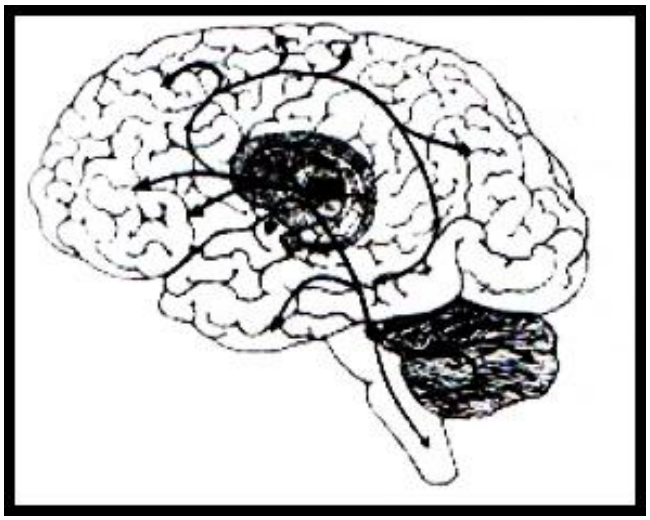
But at this point the brain system begs completion. We must add the logically predictable mechanism of **subcortical-subcortical loops**. There is abbundant evidence for their presence. We have mutually intensifying interactions between the substantia nigra and the globus pallidus (Edelman,1989), between the amygdala and locus coeruleus (Berridge,2003), between the nuclus accumbens and the amygdala (Kelley,2004), etc.



The Activating Subcortical Neuromodulators

The brain is constantly being washed by four "activating" chemical neuromodulators: dopamine, noradrenaline, serotonine and acetylcholine. These originate in the neuromodulator production areas in the base of the brain and "wake up" the brain in various ways. Edelman gives a design which demonstrates their widespread distribution.

Neuromodulator Distribution in the Brain



Design from Edelman "Wide as the Sky"

Given that these "jets" of activating chemicals reach both subcortical and cortical levels, we can understand how consciousness can vary according to their intensity. What do these four activating neuromodulators do, and where do they come from? The following Table gives a summary.

Lower Brain Region	**Neuromodulator**	**Functions**
Tegmentum	Dopamine	Action for Reward
Raphe Nuclei	Serotonin	Bonding, Visceral Feeling
Locus Coeruleus	Noradrenalin	Vigorous action, mental focusing
Pendulopontine Nuclei	Acetylcholine	Learning, memory

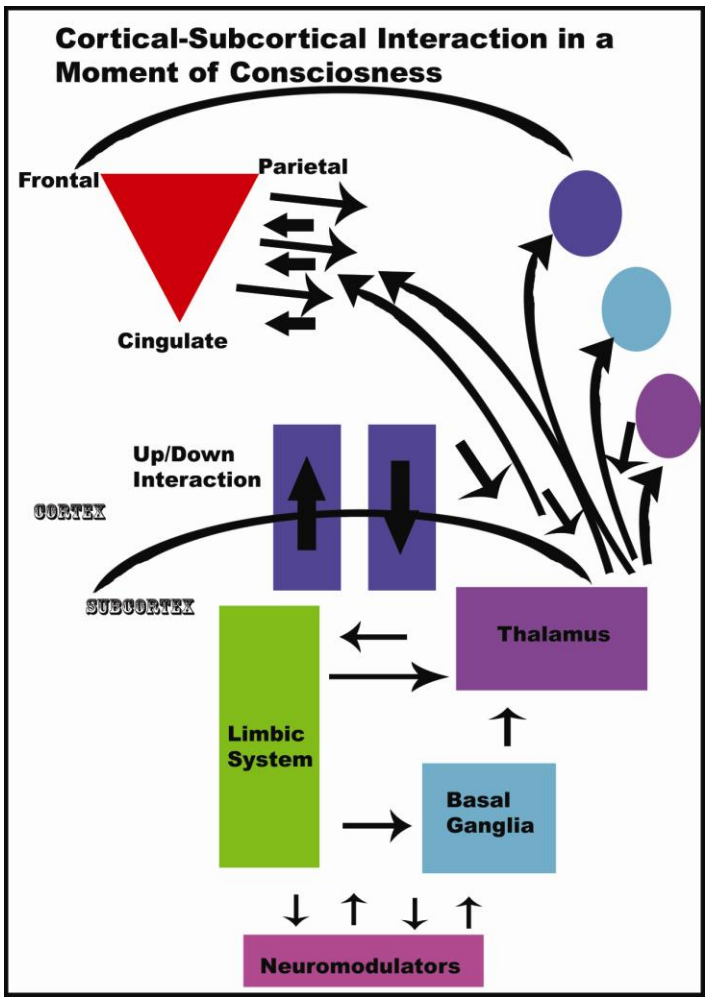
Design from Stream V

It has been suggested that these neuromodulators produced at the very base of the brain influence, predominantly, **the intensity** of cortical brain processes. In contrast, other subcortical regions that are situated higher up in the subcortex – amygdala, hippocampus, thalamus – send upwards messages to the cortex that can influence, predominantly, **the patterns** of the cortical processes. (Liss, Stream V)

We can imagine consciousness riding on these jets, like the white foam on top of dynamic waves, the waves being the underlying subcortical force, with the lower brain activating neuromodulators energizing the spray.

Great Wave of kanagawa Hokusai

At this point we will give a schematic design to integrate these various mechanisms of consciousness.



Part II: How Stimuli Enter the Field of Consciousness

Sufficient Circuit Intensity Required for Consciousness

The research of Dehaene and Changeux presents specific experimental observations that describe the **intensity requirements** for a visual stimulus to go from the unconscious subcortex to the conscious cortex: "A brief thalamic stimulation could lead to the **ignition** of a large set of distant cortical areas, which remain active by **self-sustaining reverberatory loops** for tens of milliseconds beyond the initial stimulus duration. This establishes a clear link between the content of working memory and of consciousness, and may explain why the maintenance of active information over a short delay is only feasible when the information is conscious."

This mechanism will be applied in the next part when we describe how certain peripheral streams of consciousness can enter the central stream. Their research demonstrates that a reverberatory loop that is too brief for consciousness to access will immediately die down. Consciousness is needed to "ignite" (intensify) the neuronal loop; otherwise it will disappear.

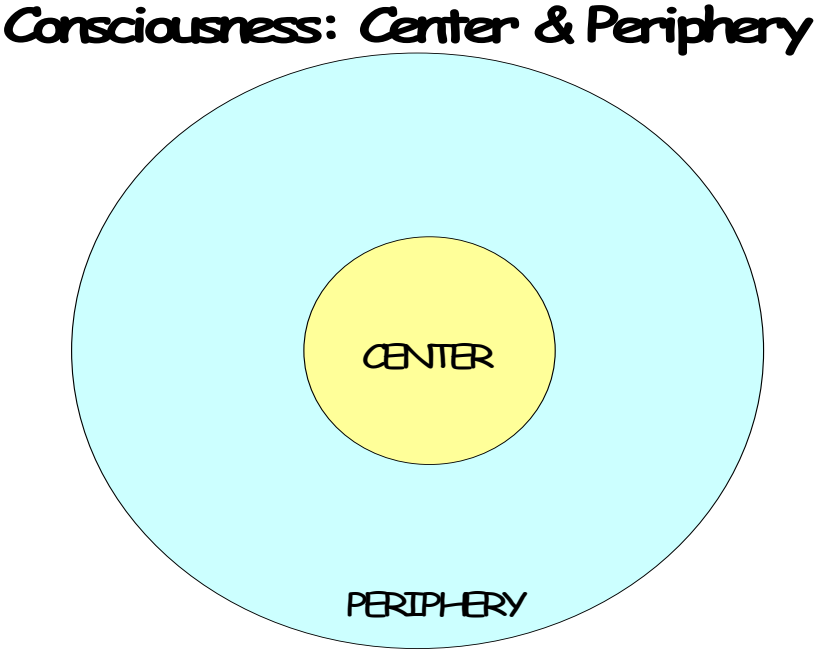
Part III: Brain Mechanisms of the Stream of Consciousness

From Single Moments in the Laboratory to the Stream of Consciousness in Daily Life

One of the goals of this article is to show how the **models of consciousness** stemming from laboratory studies are quite insufficient for explaining human consciousness as it takes place in everyday life. A general thesis is that scientific theories explain evidence. But if the "evidence" used is the reported perception of a word written on a screen, then our scientific understanding need only explain that very limited evidence. This does not say very much about the mechanisms of consciousness in everyday life. In other words, the cerebral mechanisms of consciousness presented in Parts I and II are quite valid for explaining a very limited moment of consciousness that takes place in the laboratory setting when the Subject responds to an external stimulus -- a word or an image – that is presented so briefly that it may or may not become accessed at a conscious level. But if we wish to explain **the complex events of the "natural system,"** that is, of consciousness in everyday life when we are talking with a friend, or making plans for the weekend with the family, or mulling over a quandary in solitude, then **our hypothesized brain mechanisms must become correspondingly more complex.** We may call such everyday events that take place in our awareness "the stream of consciousness."

Central and Peripheral Experience

How can consciousness be sliced up in order to be studied? This is not an easy question. Our starting point will be the division of consciousness into "central and peripheral" experience. What is the difference? **Central experience** means the focus. It is more or less clear cut, precise, transmittable and memorable. It is **explicit**. **Peripheral experience** is located **around** the center. It is rather vague, "almost there", difficult to describe, impalpable, imprecise and difficult to transmit with language. It is **implicit**. (See Stern, 2004) For example, while our "central attention" at this moment is taken up by the meaning of the words we are reading, our "peripheral attention" involves our position while sitting, the sensations of our skin, our breath movements, noise from outside the window, the sense of time passing, etc., These can all be present as "almost thoughts" in the periphery of consciousness. (See **Gestalt Therapy** (1972) by Perls, Goodman and Hefferline for the first clinical presentation of this distinction between central and peripheral experience; their basic exercise of "here and now" attention involves this constant movement "from the periphery to the center" of consciousness.)



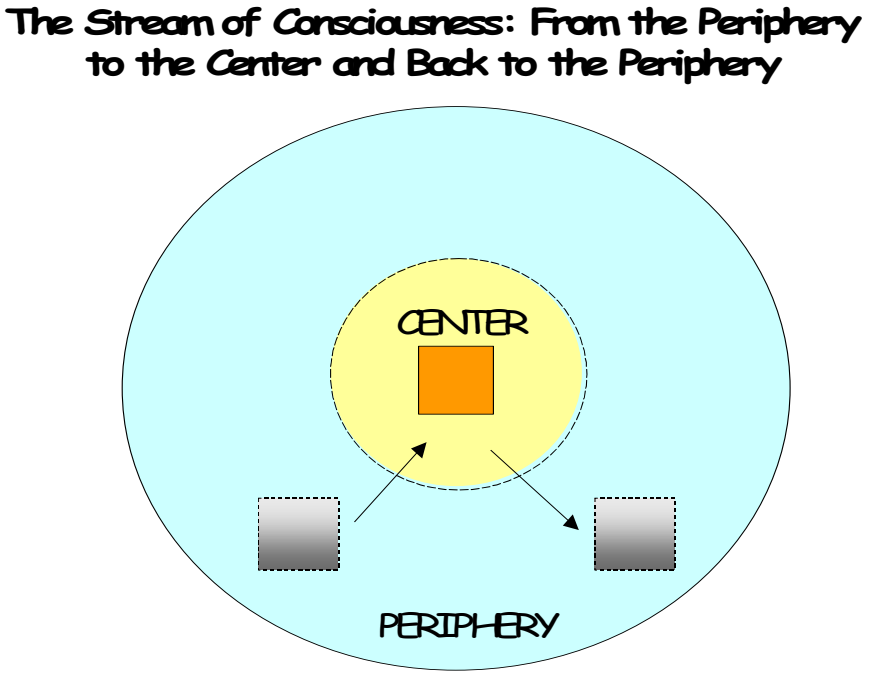
All these "peripheral streams" and many others are flowing forward in a parallel form "next to" the explicit central stream," They have the potential to enter the center of consciousness. This experiential phenomena corresponds very closely to the research conclusions of Dehaene and Changeux (2003). They postulate "the existence of distributed specialized processes that, most of the time, process information nonconsciously."(p.9) (One difference: They say "nonconsciously," while we propose that these neuronal events emerge both nonconsciously and also **in the periphey of "barely aware" consciousness.**) The two authors also say, "Out of the multiple active cortical representations that could become conscious, only one will receive the appropriate top-down amplification and be mobilized into consciousness. The other representations are temporarily nonconscious."(p.4) In their article of 2008, they also write, "The entire workspace is globally interconnected in such a way that only one such workshop representation can be arrived at any given time (citing Sigman and Dehaene, 2006). This all-or-none invasive property distinguishes it from peripheral processors in which, due to local patterns of connections, several representations with different formats may coexist." (Changeux and Dehaene, 2008, p.736)

In the clinical research of Stream I, the very same process is proposed, based on studying the "stream of consciousness." Certain "almost thoughts" of the **peripheral stream** can be "ignited", one by one, and thereby enter the center of consciousness. After entering the **explicit center** of consciousness, each thought will then return to the **implicit periphery**.

This mapping of explicit and implicit consciousness will help us avoid the typical mistake of thinking that the verbal recounting of consciousness, which is explicit, is a representation of the entire field of consciousness. Why is this a mistake? Because **the words are not taking into account the implicit experiences in the periphery,** although in emotional moments these implicit experiences will influence explicit verbal language. In addition, there are many implicit experiences, or currents,

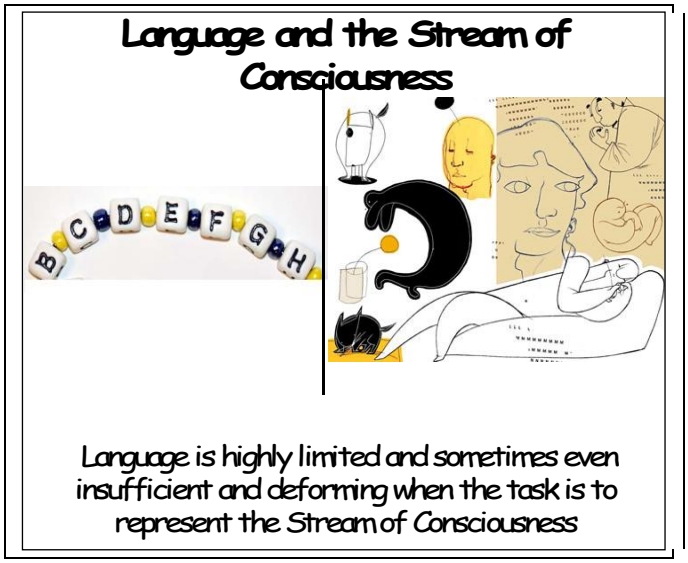
running through the mind at one time, especially after an important and traumatic event. Changeux and Dehaene give a neuronal map for this situation of peripheral consciousness. They declare, "There is a vast array of unconscious specialized processors running in parallel." We are adding here that such parallel processes can be totally **unconscious**, especially when they are situated in the **subcortex** (see below), but some can also be in the **periphery of consciousness**, that is, in the **cortex**.

Let us take an example that frequently occurs in psychotherapy. A patient feels hurt and desperate after a separation from her husband. The first words, "I feel abandoned, lost...," gives the essential meaning of the event, but do not communicate the rich variation of sensations in the periphery of experience. Nevertheless, as the person continues to share details of the event, talking about the feeling of surprise, the sense of injustice, the fear for the future, the reactions of the children, economic fears, loss of self-esteem, all these and many other "peripheral" currents come to the surface, one by one. But "access to consciousness" means only one peripheral input at a time.

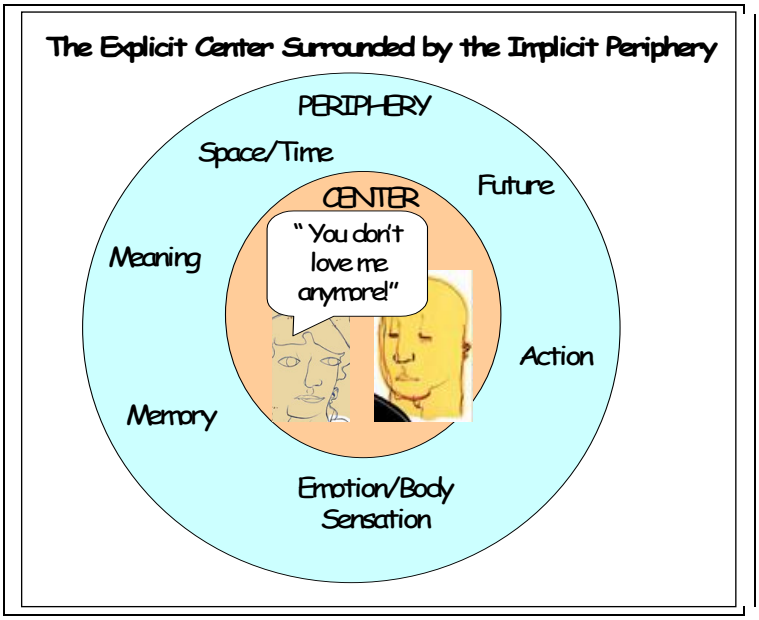


Design from "Stream of Consciousness I"

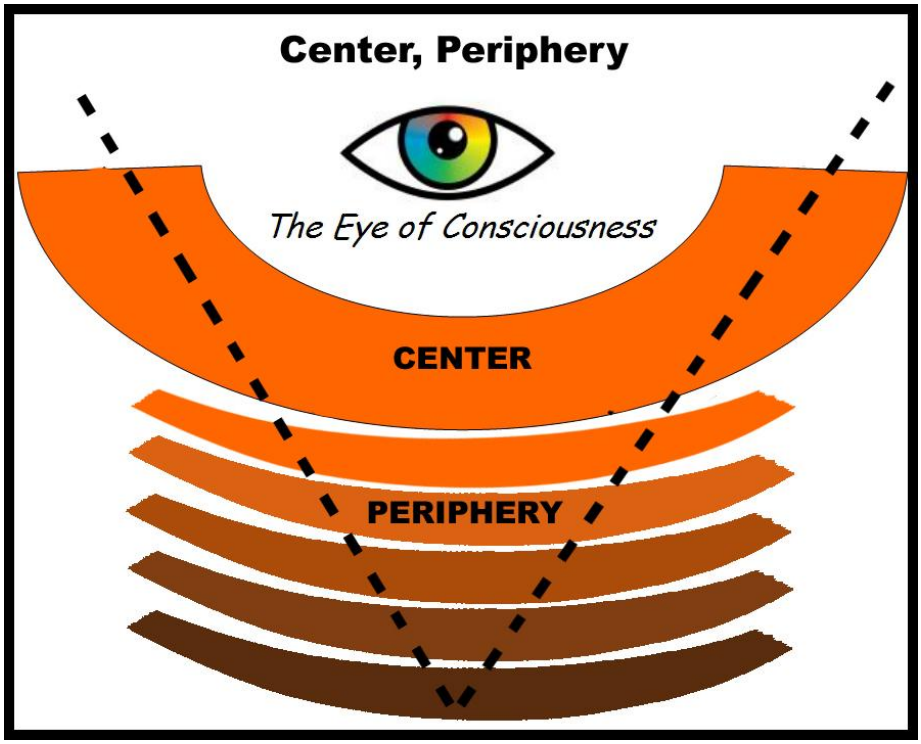
Another fact to bear in mind is that surrounding the verbal description there are the many peripheral currents that are non-verbal and therefore **cannot be said.** To illustrate this relationship between the explicit word and the implicit background within consciousness, we can refer to Steven Pinker's metaphor. He calls **explicit word sequences,** "pearls on a strings." (Pinker,2007) The background has a great deal that is elusive, indescribable, impalpable. Here is a design from Stream III.



In summary, if we combine this law regarding **the intensity of loops required for the entry into consciousness** with the model of **parallel unconscious currents continually flowing,** we can have a basic model for central-and-peripheral consciousness. This model can overcome simplications. For example, Gerald Edelman talks of "the unity of consciousness" with all its components integrated as a "seamless" whole. In regards to "the stream of consciousness," this can correspond to what happens in certain moments. "I feel very much together." "I feel calm and present." But clinical work can reveal other realities in which this "unity" is not experienced. People can feel "intrusive" thoughts and "impasses" that fragment the sense of unity and keep returning against one's will. "It keeps tormenting me." "I'm being pulled in every direction," "Something feels broken inside." These experiences occur much more often than people admit. (Design from Stream III)



Therefore, profiting from Dehaene and Changeux's studies, we can say that **behind this seamless and seemingly indissoluble whole we have countless subterranean undercurrents,** none of which will enter consciousness unless it reaches the threshold intensity necessary to **ignite** that particular circuitry. Once ignited, the circuit can remain in consciousness as a self-sustaining reverberatory loop.



Dehaene and Changeux also make another important point: They say that consciousness is **"a single limited-capacity serial workspace."** This means that **only one of the parallel process peripheral currents can enter consciousness in one moment.** One might say, "One song at a time."

Self-Other Locus Model

A very important theory for understanding normal consciousness is the Self-Other Locus model. First, let us try to understand **why** this theory has been somewhat neglected by those doing laboratory research. The Self-Other Locus highlights the fact that each moment of consciousness is based on **an individual point of view,** and this difference in perspective, as we go from person to person, **has very little relevance** when each Subject is looking at a screen with words and nonsense syllables flashing for brief moments. But if the example to be studied were to be a normal human event, such as one person saying, "You really made a fool of yourself last night," and the other responding with, "But how can you say that? Everyone laughed at my jokes!", then **we must introduce the concept of Self-Other Locus, or "point of view," or "alternative position," in order to explain such different experiences that arise in each person's consciousness when faced with a common situation.**

What is the Self-Other Locus model? This notion is based on the research of Trehub (1991,2006), Revonsuo (2006) and Metzinger (2003), among others. First presented by Trehub as the "Retinoid Model," this concept highlights the fact that just as the retina of the eye picks up the object attended to **from a single and localized point of view,** so too every moment of consciousness involves the Self localized in the center of consciousness, while the Other (other people, physical reality, outside world) is localized around this center point.

Trehub presents a very useful concept in his "retinoid model." He describes the perception of an outer object as containing too planes. One plane contains the horizontal x- and vertical y-axes that represent the width and height of the object. He then shows how the Z-plane of object "depth" represents a second plane of perceptual experience in our neuronal geometry. Trehub was talking about the experience of an object visualized **outside** of ourselves.

We can now apply this geometric topology to the stream of consciousness when alone, that is, to our **inner world**. When a person thinks of a disappointing event of the past, or a menacing possibility in the future, it is as if **the "outside world" is collapsing down on the "inner world."** The person can say, "I feel 'overwhelmed,' 'attacked,' 'oppressed,' 'drowned,' 'crushed,' 'caving in,' etc. At this moment we can imagine **a collapse of the geometric scaffolding created by the Z-plane of depth,** that is, the distance between Self and Other is lost. Although the person is focusing on the nature of the threat, in the **periphery** of consciousness there is a sense of this **collapsing distance** between Self and the outer world. Verbal psychotherapy can help re-establish some degree of differentiation between Self and the Other, but when the problem involves intense emotions and painful situations (with all the neuromodulator alterations this entails), we can understand the difficulty encountered and the inevitable slowness when working for therapeutic change.

Clashes Between Self-and-Other Perspectives

Let us return to the Self Locus model. Anil K. Seth (2007) recapitulates the argument, saying that in every moment of consciousness we have a **"self locus"** of the **"core self"** which results in the experience of **"egocentric space."** Seth writes, "A phenomenal self model cannot exist without the prior existence of the *self locus*, a neuronal entity constituting the *core self* which is the innate origin of our *egocentric space*... This means that we have a neural implementation of Baars' global workspace with additional emphasis on perspectivaleness (the unique spatiotemporal *origin* of all of one's phenomenal experience."

This idea is evident when we go beyond the restricted laboratory situation and think of how things really happen in everyday life. We are always experiencing events of the world from our own point of view. "That was a beautiful play." "For me, it was totally without interest." "She's a wonderful teacher." "I didn't learn anything in her class." In **solitude** as well, our thoughts keep churning away with memories, plans and wishes, all emerging into consciousness **from our own point of view.** (See examples in Stream I-VI)**.** We can also take an example from couple therapy: "Why does he treat me so badly? He's growing so indifferent to me lately." While from the other' s point of view, "Damn it! I have to stay late every night in the office. This financial crisis is an inferno! But she doesn't understand this reality." She replies, "But you're the only one in the office sacrificing their family life." And so on, as "points of view" clash, **each one speaking from a Self-Other Locus that clashes**

with the other' s experience. If models of brain mechanisms don't include this fundamental aspect of experience, "the subjective perspective," then human differences in a single and particular situation cannot be accounted for.

Some Observed Examples: Self-Other Locus in Ordinary Consciousness

Clinical work in psychology requires the notion of the Self-Other Locus in order to help people overcome the limits of their emotional subjectivity. For example, here are phrases from the Stream of Consciousness coming from patients in psychotherapy. "Susan didn't come to the appointment. I was crushed." (Unknown to the Subject, she was delayed in traffic.) "If he dies, my life is over." (The importance of all other relationships and of all other aspects of life is totally forgotten.) "To speak in public makes me feel panic. All those eyes that pierce through me and see all my defects." (In a moment of performance anticipation, the Self is felt as transparent and the Other is seen as totally threatening.)

Let's take a typical example of **a collision between two perspectives.** The father has one point of view, the son feels "oppressed" by this (Self-Other collapse) and has another point of view. The father says, "If you go to art school, you'll be ruining your life. In today's world, you need to study Business Administration to get a job. Or else become an engineer." Reply: "But you don't understand anything. I have talent in art, and nothing else interests me!" The argument can circle round and round, each feeling "right" and offended by the other's point of view.

The School of General Semantics that was originated by Korzybski in the 1930's and then developed further by Hayakawa in the 1940's, presented a clear-cut framework for overcoming this problem. They clarified that every idea, perception, belief, feeling or plan comes from our Self Locus. Others can experience the situation differently. Therefore, we must clarify our Self-Locus when we communicate an experience with another person whose Self-Locus brings them to another point of view. "This is my opinion," "I have another perspective," "I'd like to say how I see it," and the two people should be ready to accept this difference in order to dialogue fruitfully. Unfortunately, such "relativism" or "contextualization" often does not take place. Each person experiences what is "out there" in an absolute way without taking into consideration that another person, whose Self-Locus is different -- this can easily happen between child and parent, husband and wife, boss and employe, etc. -- will **necessarily experience the situation in another way**, having a history of learning and a series of priorities that are different from oneself. Therefore to understand the other, within one's own Self-Other Locus perspective, requires two different thoughts: First, "I see the object." Second, "I see it from my point of view." To neglect this second point of "locus" or "perspective" can explain the many needless and interminable clashes that people experience every day when each one bashes the other over the head, verbally, to prove his point and show that he is "right." (Korzybski,1933); (Hayawaka, 1941)

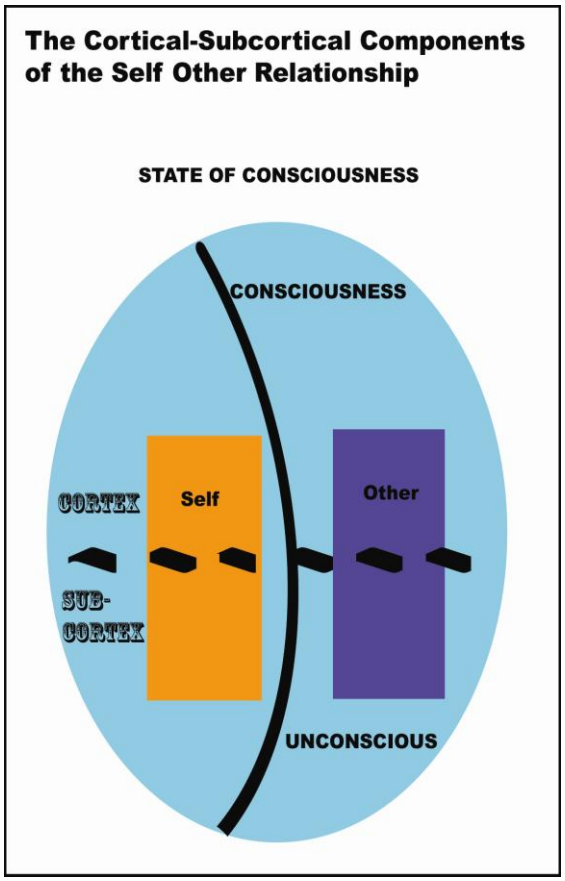
Self-Environment Distinction

The relationship between Self and Other can also be conceptualized as "differentiation." (This concept is implicit in the above analysis of the geometrical matrix that allows for "distance.") Metzinger (2003) writes, "A distinction must be drawn between **environment-related signals and organism-related signals**, which in turn allows the organism itself to model the intentional relation between subject and world." However, we all know how this distinction between Self and Other can break down, for example, when "projecting" on the world our own ideas, or when aspects of the Other "get under the skin."

Self-Other Neural Correlations in Clinical Studies

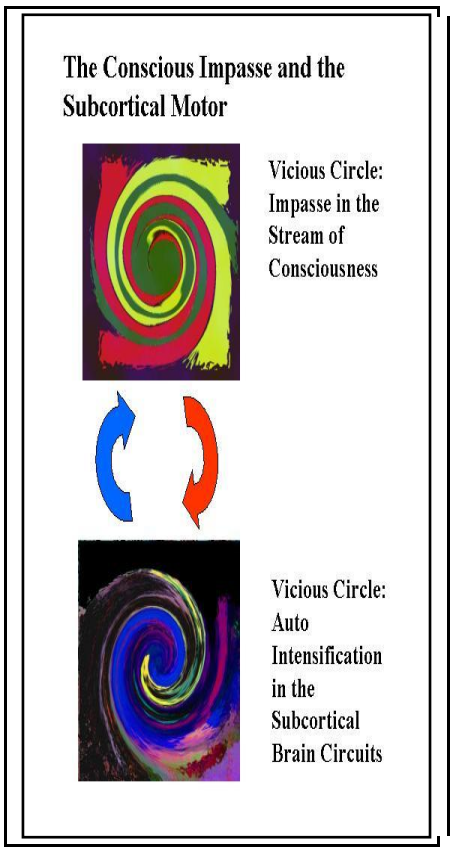
While the laboratory setting has the great advantage of studying **specific moments** of consciousness, there is a vast literature regarding **general aspects** of consciousness and behavior that correspond to **clinical phenomena** seen in psychotherapy. The most noteworthy review comes from Louis Cozolino's study, **The Neuroscience of Human Relationships** (2006), with more than 1000 references. The clinical framework involves the study of mother-child disregulation and its effect on child disturbance, all this leading to adult pathology. Mothers who are anxious, negative, depressed, invasive and disorganized induce severe disturbances in their infants. Years later the child-turned-adult will often still manifest this disorder with out-of-control emotional outbursts, abuse of substances, chaotic and irresponsibile behavior, depression, mood disturbances, and so on.

Cozolino's study touches all brain levels. Most interesting is his discussion of the insula for body schema, the distinction between amygdala-based fear and the stria terminalis-based anxiety, sympathetic-attacking styles against parasympathetic-avoidence styles, hippocampus self-other location maps, anterior cingular self-other re-orientation, orbito-frontal and dorsal frontal influence on empathy, hypothalamus-pituitary axis prolongation of stress states, and neuromodulator abnormalities such as the decrease of serotonin. As specific states of consciousness will be investigated in the future, studies like those of Cozolino can serve as a background, pointing to the vast number of subcortical changes that are underlying any moment of consciousness. Perhaps his diagram showing **seven cortical and subcortical regions**, each one in interaction with the others, and all working together during a single moment of **perceiving a face** (p. 179), can serve as a model of the "multiple systems" interaction that must underly any study of consciousness.



The Power of Subcortical Impulses

In Stream V, "A Tank in the Garden, The Subcortical Power that Drives the Stream of Consciousness," the clinical picture of the inescapable and frequently tormenting impasse is outlined. The enormous instinctual force that overrides our rational thoughts in solitude is correlated to **subcortical brain mechanisms** that create "vicious circles." For example, we have the study of Berridge (2003) on amygdala – locus coeruleus interaction**.** The excessive production of noradrenalin (stimulated by amygdala messages to the locus coeruleus), increases still further the amygdala emotion of fear or rage, while inhibiting the hippocampus and anterior cingulate gyrus, which normally "contain" the amygdala. Therefore, Berridge gives us an example of a subcortical – subcortical "vicious circle," that we propose acts as one of the neural correlates for "vicious circles" in the cortical-based stream of consciousness.



Design from Stream V

Such neural mechanisms are of help to the clinician. The therapeutic dilemma is as follows: **"Why can we not change our thoughts and feelings by means of a more rational perspective when we feel assailed by a series of negative and self-lacerating thoughts that keeps returning when we are alone, and that make us feel imprisoned within a cage?** This inner "stream" can repeat itself for weeks, months or even years. The fact that the **subcortical circuits** are a combination of **neuronal and chemical processes** makes it more clear why the power of the subcortical bottom-top impulses cannot be contained by the rational cortical-based top-down contextualization.[2]

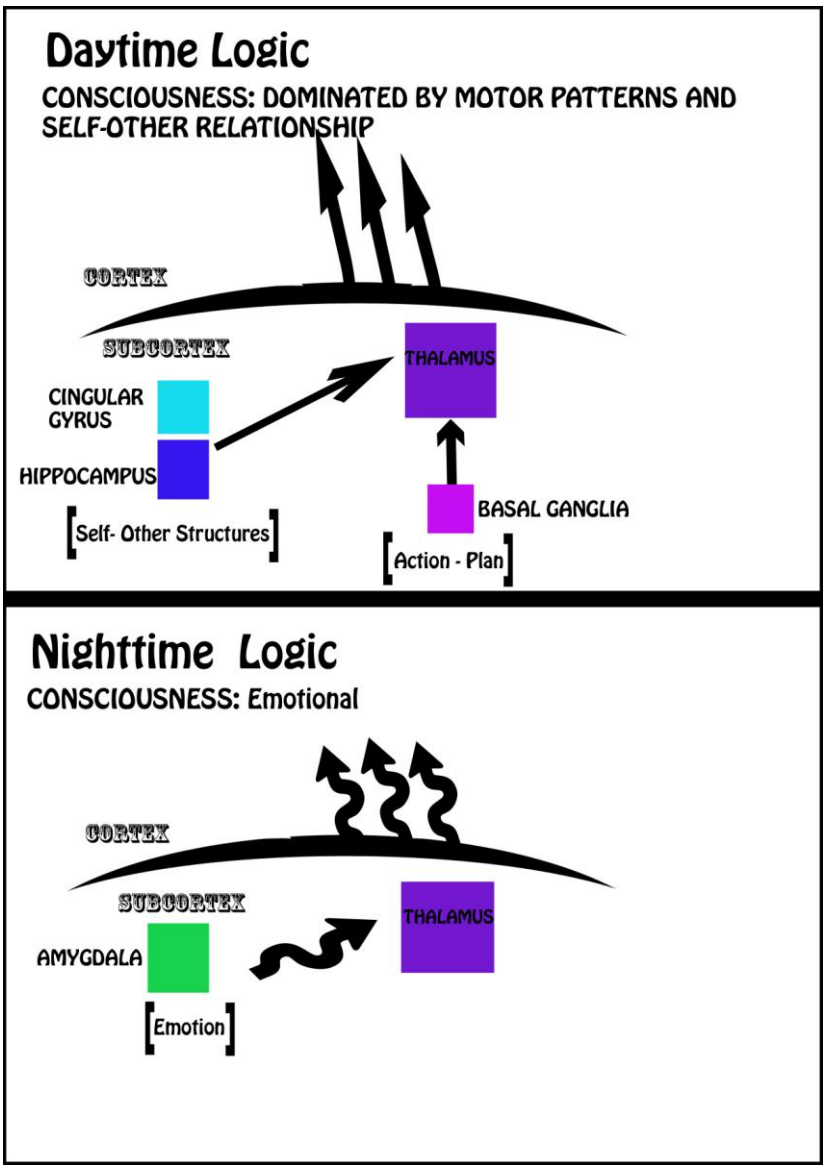
From Day-Time to Night-Time Consciousness

Let us continue our exploration with **everyday life examples of conscious experience**. Why is it that in **daytime** circumstances of normal activities and social relationships, the inner mind processes of anxiety, fear, desperation, etc., do **not** overwhelm our consciousness? In contrast, when we spend extended periods alone, and if we avoid the distracting effects of mass media, we can become assailed by "the logic of the **night."** Thoughts become more extreme, logic becomes confused, the Self Locus dominates yet more intensely the Stream of Consciousness, and we can easily – some say, all too easily – become submerged by the the obsessions and self-attacking thoughts of the psychological impasse. How can all this happen?

2

Reponse: In the article Stream II, the difference between the rational-oriented **"logic of the day"** and the emotionally-laden **"logic of the night"** is clarified with clinical examples. Our brain map shows us that the **thalamus** can be under the influence of the **basal ganglia action system** during the logic of the day, when consciousness must follow the motor-predominant unconscious stratetegy of this subcortical system. In addition, the thalamus receives messages from the **subcortical "Self-Other relationship" systems** involving the cingulate gyrus, the hippocampus and the neuromodulator sertonine. (See Louis Cozolino, **The Neuroscience of Human Relationships,** 2006) This too will "contain" thalamic processes and their impact upon cortical consciousness.

In contrast, when **nighttime solitude and non-action** stop such beneficial input, the **thalamus** then receives a greater input from the emotional **amygdala**, and **our emotional tank grinds forward to roll through the garden of the mind.** There is crushing, pounding, annihilating, exploding and breaking of walls, which is how we feel when the subcortical limbic system forces are no longer contained by action plans and supportive relationships.



Summary and Conclusion

In summary, the first part of this article presents neural correlates of access to consciousness and of one moment of consciousness, relying especially on the work of Dehaene and Changeux. The second part raises several aspects of the "stream of consciousness" as it happens in daily life, with special emphasis on central-peripheral dimensions, the repetitive impasse that causes disturbance, and the Self-Other Locus Model. The neural correlates of these dimensions are proposed.

The goal of this study is to create a bridge between studies of consciousness in the laboratory setting, and the "stream of consciousness" in daily life. This suggests that greater dialogue in the future between those doing precise research in the laboratory, but limiting their observational base to what can be studied in this restricted setting, with clinical researchers who have only imprecise means of study, but whose observational material regards "the natural system" of consciousness, can become a fruitful enterprise.

Footnotes

1: Articles with visual designs that reproduce the essential ideas of a written work help the reader grasp the essential model in an instict. Many people can "see" a complex interaction more readily with a spacial representation than if the material is presented exclusively as a linear verbal text. In addition, the spacial design is often remembered more easily than the verbal text. Comparisons among theoretical models is facilitated by using designs. Finally the use of Internet permits the composition and communication of designs, while the traditional publication on paper limited that opportunity. Therefore, we can expect an expanding use of spacial designs as science advances, since this will be useful for a dialogue among colleagues and for teaching students.

2: The Epistemological Basis of this Article: It is important for the reader to understand that the author of this paper does not "believe" that these correlations between the specific brain mechanisms cited and phenomenal experience are correct or accurate. All of these models and correlations are presented as **hypotheses**. The goal is to create useful and simplified patterns that will then be corrected in the future, as laboratory science and clinical science advance hand in hand.

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