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# Francisco Varela's neurophenomenology of time: temporality of consciousness explained?

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This article attempts to clarify Francisco Varela's proposal of a neurophenomenology of time consciousness in the light of distinctions based on the philosophical literature of phenomenology and recent advances of neurobiology. The analysis is carried out considering three aspects. In the first of them, we discuss the phenomenological aspect of consciousness, accessible in first-person, which describes time as a structure with three inseparable moments (past-present-future) and three levels of temporality, and not merely as the chronometric time or clock time. In the second one, we analyze the neurobiological aspect of consciousness that tends to "explain" the phenomenological time in terms of three possible levels of neuronal integration. Thus, we propose a correspondence between the levels of phenomenological time and neural integration processes. Finally, we try to analyze this "correspondence" and the issues that follow from this by considering that the notion of time in this correspondence is, in essence, the clock time and not the phenomenological time consciousness.

**Keywords:** Consciousness, Time, Neurophenomenology, Neural synchrony, Francisco Varela

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## Neurofenomenología del tiempo según Francisco Varela: ¿la temporalidad de la conciencia explicada?

En este artículo se intenta esclarecer la propuesta de una neurofenomenología del tiempo de la conciencia de Francisco Varela a la luz de distinciones asentadas en la literatura filosófica sobre la fenomenología y desarrollos recientes en neurobiología. El análisis se lleva a cabo considerando tres momentos. En el primero de ellos se analiza el aspecto fenomenológico de la conciencia, accesible en primera per-

sona, el cual muestra al tiempo como una estructura con tres momentos inseparables (pasado-presente-futuro) y tres niveles de temporalidad, y no meramente como un tiempo cronométrico o del reloj. En el segundo de ellos se analiza el momento neurobiológico de la conciencia que tiende a "explicar" el tiempo fenomenológico en función de tres posibles niveles de integración neuronal. Se establece así una correspondencia entre los niveles del tiempo fenomenológico y los procesos de integración neuronal. Por último, se intenta analizar tal "correspondencia" y los problemas que se siguen de ello planteándose que el tiempo que se piensa en esta correspondencia es, en el fondo, el tiempo del reloj y no el tiempo fenomenológico de la conciencia.

**Palabras Clave:** Conciencia, Tiempo, Neurofenomenología, Sincronía neuronal, Francisco Varela

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## INTRODUCTION

The notion of time has become a major revolution to our era. Although it is difficult to define time, as suggested by Augustine<sup>1</sup> centuries ago, this has not prevented from trying to decode some of its characters. In our era, for example, the physical science led by Einstein<sup>2</sup> intended to understand time not as something independent from the bodies but as a function "measuring" the correspondence between the "occurrence" of phases of a physical process and the clock (p. 24-26). Time starts to be understood as something *relative* to the bodies and not as *absolute* running independently from them. Such conception of time as a "measure of occurrence", already rooted in the thought of Aristotle<sup>3</sup>, was generally presented as the sole plausible conception of the notion of time. Biology, for example, still borrows this conception in its studies, there being other biological conceptions in itself such as age, evolutionary time, ecosystem time<sup>4</sup>, among others, which cannot be reduced to clock time. Now, in this same era some philosophers have questioned this exclusive physical conception of time. The most paradigmatic case was indeed

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time of consciousness. Bergson<sup>5</sup>, for instance, established the time of consciousness is something lasting without any phases'. Husserl<sup>6</sup>, on the other hand, intended to describe time as it is presented to us. Time for him is shown at a certain level as something continuous, without the familiar cuts of "past, present and future" generally shown at the physical time, where "past and future" are ultimately mere "denials" of the present. Thus, two apparently irreconcilable traditions were originated: that conceiving time as a quantifiable physical concept and, therefore, measurable and the other understanding time of consciousness as a continuous experience, only accessible for a description in first person. It is associated to such juncture that Francisco Varela's thought (1946-2001) is presented with unusual relevance. This remarkable Chilean biologist suggests a research program he calls "neurophenomenology", intending to unify the scientific and philosophical positions as per specific and determined topics<sup>7</sup>, which could haltingly be approached on other research programs. Indeed, Varela's program intends to show results precisely in relation to the complex issue of time.

Therefore, such an approach should, on the one hand, think of time in "scientific" terms (e.g. through neurobiology methods), where time must be "measured"; and on the other hand, to consider time not from an external observer perspective but as "it is presented" or "appears". As set out above, time is not a pure concept but something apparent, a kind of phenomenon that can be also and primarily accessed in the first person, although, recalling Augustine's warning, undoubtedly remains something quite difficult to conceptualize.

Varela's neurophenomenology proposal to the presented problematic involves incorporating all vital descriptions on time and being able to scientifically (neurobiological) "explain" them. In this sense, neurophenomenology unifies two knowledge that disconnected would not bear fruit. Thus, neurobiology with its methods would not be able to assess the time of consciousness in all its scope and complexity, which as we have outlined will only be accessible to a first person description. Without a phenomenological study of time, such "neurobiological" explanation could assume time is nothing more than a "succession measure". Moreover, phenomenology can "describe" time of consciousness but is unable explain it, if we understand here by explanation a description under certain formal scientific standards. Neurophenomenology of time then intends to scientifically describe and explain the time of consciousness.

That being said, one must consider there is currently a relative diffusion of Varela's neurophenomenological program<sup>8-10</sup>, but strictly speaking there is still not a critical evaluation of the program in terms of one of its critical topics: the time of consciousness<sup>11,12</sup>. In order to address this issue, we will firstly assess what neurophenomenology means in general terms for Varela. Then we will establish how the time of the consciousness can be explained according to this research program. Finally, we would like to address some problems of this conception of time.

## WHAT IS NEUROPHENOMENOLOGY?

Varela's neurophenomenology<sup>7</sup> shows three indissoluble moments to be approached. First, the "phenomenology" moment consisting basically in the description of acts conscious to humans. It is a phenomenology of consciousness. Secondly, the "neurobiology" moment that must explain "how" the brain processes promoting consciousness occur. Finally, a third moment responding to the "unity" of the precedent moments. These three points will be briefly developed below.

## Phenomenology of consciousness

A phenomenological study of consciousness or conscious acts generally consists of an experience-based analysis of consciousness, i.e. a description in *the first person* of the "awareness" character of the experienced acts. Thus, Searle for example establishes that consciousness "*is an inner, first-person, qualitative phenomenon*" (p. 5)<sup>13</sup>. The latter means such phenomenological description is reported in first person through whom lives it, making it "immediately" inaccessible to any external agent wanting to perceive such description\*\* in third person. Thus, when a person affirms being aware of something is because he or she is really

\*\* The first and third person can be distinguished in many ways, which leads to much confusion in the use of these terms. We will distinguish them in this paper by the "access mode" in which a person perceives or feels something. So, the first person refers to the way of access to our "own" apprehensions as tastes, sensations, etc. This mode of access is "immediate", it is not accessible, for example, by reasoning. For example, I know a delicacy is tasty by just testing it. The third person, however, is the access mode to the apprehensions "of others". This mode of access is not immediate. I do not feel, for example, the taste of something when somebody else tries it. To access this apprehension we must, for example, listen to what the other person says, study his brain, etc. This distinction is not related to the classical duality between the subjective (first person) and the objective (third person). Subjective is that which depends causally on a subject. We are not saying here the taste of something, while the first person, depends causally on me and, therefore, is a unique flavor. This is a theory that should be demonstrated. Our claim is that "access" to the flavor, in the first person, is to immediately apprehend through our senses and, in the third person, is to apprehend indirectly through language, etc. Although the subject is extensive, we believe this explanation would be enough to clarify in what sense we use these terms in writing.

<sup>5</sup> Bergson expresses: "For our duration is not merely one instant replacing another; if it were, there would never be anything but the present—no prolonging of the past into the actual, no evolution, no concrete duration. Duration is the continuous progress of the past which gnaws into the future and which swells as it advances. And as the past grows without ceasing, so also there is no limit to its preservation" (p. 24)<sup>5</sup>.

aware and no external observer can deny this fact. Now, first-person phenomenological or descriptive studies may approach, on the one hand, all conscious acts as acts of a *content* or quality (*qualia*) of which we are conscious. Moreover, we can describe as being conscious of the red color, a sound, a smell, etc. This is what we can denominate an easy phenomenology, although critical. On the other hand, we could describe not the "content" of what is being presented but the "mode" it is being presented. This is even harder to describe. A good example to understand all these distinctions is the absence phenomenon. In order to illustrate this, let us image the situation where a friend has recently lost a dear family member. The observation of such feelings by an external agent (e.g. ourselves) represents a description in third person. The experience-based description made by our friend of his own sense of absence, by contrast, constitutes a description in the first person. Let us briefly analyze this from both perspectives. As far as we are concerned, the absence in third person is presented as something *negative*. Thus, we mean the absence is shown as some type of "spatial emptiness" left by the disappearance of our friend's relative. The absence then for a third person simply means the absence of something *that is no longer present*. Our friend "is not" with his relative the same as he "is not" in Poland, etc. However, from an immediate first person perspective, such absence is something completely different. Indeed, from a phenomenological perspective, the absence is established as a fact of a *positive nature* in the sense the absence is shown, for the first person, as "present". The absence is not just the lack of something, but the "presence" of such absence. For this same reason, someone's absence may hurt. The absence, therefore, is not merely negative, but is something present. But this *presence of absence* is not a present as a sensitive "quality" such as color, taste, etc., but a very special presence, it is a "mode" of presence. These "modes" are the most difficult to describe, but represent a significant part of our experiences. This is in fact what phenomenology has intended to describe. That would be the case, for example, of the absence phenomena, the silence, and consciousness in general, and that most concerns us here, time. As we will see, time is a "mode" of special presence.

## Neurobiology of the consciousness

A second moment of the neurophenomenology is the study of consciousness from a neurobiological perspective. Here, a critical aspect for Varela's *embodied idea of cognition*, or *enactive approximation* of cognition<sup>11,14,15</sup>. In the words of Varela:

*"My overall approach to cognition is based on situated, embodied agents. I have introduced the name enactive to designate this approach more precisely. It is comprised of two complementary aspects.*

*(1) On the one hand, the ongoing coupling of the cognitive agent, a permanent coupling that is fundamentally mediated by sensori-motor activities.*

*(2) On the other hand, the autonomous activities of the agent whose identity is based on emerging, endogenous configurations (or self-organizing patterns) of neuronal activity" (p. 116)<sup>11</sup>.*

Thus, the word "enactive" is coined by Varela to conceptualize two related ideas: first of all, to describe the *autonomous* characteristic of an organism, that is, the intrinsic capacity to generate and maintain its own somatic identity and, therefore, to define its own cognitive domains; and second, to specify that these cognitive structures emerge from the recurring coupling among the body, nervous system and environment of the individual. In this sense, the enactive approach fits more naturally into the dynamics of cognition approaches<sup>14</sup>, which does not assume *a priori* only a predetermined relationship between components and system input and its internal dynamics<sup>15</sup>, thus differentiating enaction from other approaches to the study of consciousness, such as computationalism<sup>16</sup> or connectionism<sup>17</sup>. In short, the enactive approach emphasizes the individual defines its own "point of view" of the world embodied in the dynamics of its operation, and not through static rules that define such operations (i.e. connectionism) or the ability to extract and process abstract symbolic information of the environment (i.e. computationalism).

A second critical aspect for the neurobiological study of consciousness in Varela is known as the *neurodynamics approach* of consciousness<sup>18</sup>. It is there argued that any cognitive act in the brain requires the simultaneous coordination of multiple functionally specialized regions, capable of interacting with each other<sup>18-22</sup>. For the neurophenomenological program, a moment of consciousness should incorporate transient self-organization of the components mentioned in order to produce a unified brain activity<sup>18</sup>. The basic idea is that the relevant parameter describing the interaction within neuronal groups is not the individual or local activity of its component neurons, but the *dynamic* links established *within* neuronal groups<sup>23</sup>. A candidate for this functional dynamic relationship is the "temporal code" established by neuronal groups in terms of their simultaneous discharge activity. This mechanism is known as *neuronal synchronization* and it currently has a broad empirical support<sup>24</sup>. The neuronal synchrony corresponds to a phenomenon occurring in brain at multiple scales, from local functionally specific neurons (e.g. the visual) to distant brain neuronal groups that present global or long-scale synchrony during the emergence of a cognitive act<sup>25</sup>. In the case of consciousness, the most studied is the synchronization of the long-scale neuronal activity in gamma frequency band (40-60 Hz), having recently been correlated with conscious visual perception<sup>26</sup>.

## The unity of two moments. The neurophenomenology

A third moment of the neurophenomenology is the "unity" of the phenomenological moment of the first person and the neurobiological moment of the third person. This unit has been conceptualized in many ways. First, Dennett<sup>27</sup> argues these moments are not different, but one (the neurobiological moment) in a way, explains and annuls the other (the phenomenological moment). Consciousness, as a phenomenological moment, seems to be somewhat subjective, valid only in the first person, but when scientifically explained in the third person, its subjective reality is "nullified", as the character of gold gilding is canceled when gold is explained atomic terms. Second, the unity of these moments can be understood through a "correlation", which means finding a relation in the variation of a moment relative to another. For example, Crick<sup>28</sup> thought to find a correlation between the visual consciousness of an object and the synchronized neuronal shots in approximately 40 Hz. Third, we may assume that the unit is a "causal relationship" of the brain (cause) towards the consciousness (effect), but not vice versa<sup>13</sup>. To that end, we should determine not only the "correlation" between brain and consciousness, but also that the relationship of the brain towards consciousness is "necessary and sufficient", i.e. it is actually causal. Not all correlation is causal. Causation is conceived here from the bottom (brain) up (consciousness). This does not mean that consciousness as an effect is something *different* from the brain for Searle, but is rather a "state" of it, just like the liquid state of water is an effect of the structure of its molecules, without such a liquid state is something other than its cause. Finally, we must consider Varela's concept of "unity". Varela, assuming these two moments are real (against Dennett), argues there is a unity between these two moments, although such unity is not a "correlation" (Crick), because that assumes the first correlated elements are what they are and then enter into a kind of *extrinsic* relationship. Nor is "a causation from the bottom-up" as that would mean that consciousness is a mere brain "effect", even when understood as a "brain state" (Searle). Varela assumes this as a *reciprocal causation* relationship, circular, where consciousness is determined by the brain and the brain is determined by consciousness. For Varela, this unit is more of a "co-determination" (p. 343)<sup>7</sup>, an "active link" (p. 137)<sup>11</sup>, a "reciprocal causation"<sup>14</sup>. The study of this unit is precisely what constitutes the work hypothesis of neurophenomenology. So, Varela says: "*Phenomenological accounts of the structure of experience and their counterparts in cognitive science relate to each other through reciprocal constraints*" (p. 343)<sup>7</sup>. Thus, brain (studied by neurobiology) and consciousness (studied by phenomenology) are mutually determined, mutually restricted in their actions. Then, the unity here is much like to a cause-state relationship, as theorized by Searle.

## THE STUDY OF TIME IN VARELA

### Phenomenological analysis of time

This analysis attempts to describe time as "manifest" and not how "it emerges" in consciousness. It is not about studying, for example, how images get to the brain and then how to succeed one another "to" consciousness. This is a third-person study of time to which we have no immediate access. Neither time is what is usually understood as physical time, clock time. This time is thought *in the third person* relating the simultaneity of the moments of a physical event with times infinitesimally continuous and equidistant from a clock. This makes time something "objective" and independent of consciousness. This is the time Varela tries to overcome and therefore tells us:

*"In fact, we have inherited from classical physics a notion of time as an arrow of infinitesimal moments, which flows in a constant stream. It is based on sequences of finite or infinitesimal elements, which are even reversible for a large part of physics. This view of time is entirely homologous to that developed by the modern theory of computation. [...] This strict adherence to a computational scheme will be, in fact, one of the research frameworks that needs to be abandoned as a result of the neuro-phenomenological examination proposed here"* (p. 112).<sup>11</sup>

Now, how does Varela describe time? Varela receives mainly the influence of Husserl fine analysis that essentially were exposed in his *Lessons On the phenomenology of the consciousness of internal time*<sup>29</sup> (hereinafter simply *Lessons*), among other readings that complement his views. As we know, the traditional representation of time as a "now series" has been an influential mold in the representation of science on the notion of time. An important fact to be considered in this regard is what Martin Heidegger himself points out, who in *Sein und Zeit [Being and Time]*<sup>30</sup> describes this traditional representation as the "vulgar understanding of time" (*vulgäres Zeitverständnis*) acknowledging the break with the philosophical tradition that *Lessons* meant. Husserl called this now series as "objective time" and contrasted this target time in the *Lessons* with what he called the "consciousness of internal time" In the manuscripts of the thirties this "consciousness of internal time" was named as "living present" (*lebendige Gegenwart*)<sup>31</sup>. The access to this internal time, mentioned by Husserl in the *Lessons*, is essentially a description of the experience of the objective time in the first person. Phenomenologically speaking, time is not a content or quality perceived as color, taste, shape, etc. It is much more difficult to describe, it is a presentation "mode" having at least two essential properties:

First, time has a triple "structure" (past, present, future). If time is studied only in the third person, of these three

structures, two (past and future) are conceived as something purely negative. From this perspective, only the present, the now would really be the only thing susceptible to objective measurement compared to a clock. But from the careful description in first person, past and future are a "special presentation mode", similar to the phenomenon of absence. Then, for example, the past is not the mere "re-presentation" of an already past present being recreated by the secondary memory, as stated by Husserl, but a primary retention of the lived present. Husserl characterizes it "as a comet's tail that attaches itself to the perception of the moment" (p. 57)<sup>29</sup>. The past is formally a "retentional mode of the consciousness", not a content. We remain open to the past, even if we do not remember any "content" of it. This is what happens when we have some "lapses" where we know that something happened, but we do not know what exactly. Meanwhile, the future is a "protentional mode of consciousness" by which we are always open to what is going to happen, but do not possess any content of what is to come (p. 73)<sup>29</sup>. The future is not, strictly speaking, "that" that can happen, but to be "already" opened to what is going to happen, although we do not know exactly what will occur. Retention and protention are two "modes" of the consciousness in the present time. Past-present-future are three inseparable moments of the structure of time.

Moreover, the time to Varela has three levels of temporal consciousness or temporality.

The first level is the time of consciousness of objects and events, the physical time. The time measured by the clock, what is often understood by time. Thus, for example, in the fall of an object, we have a "same" body "passing" from one place to another. This "passing" of the body is set to "correspondence" in the consciousness of an observer with a clock process and gives us the time as clock time. Thus we say that it took, for example, three seconds. It is not, then, the idea to eliminate this conceptualization of time, but to place it as a level of consciousness of temporality, among others.

The second level is the time of the acts of consciousness, immanent or internal time. The idea is to address not the duration of physical bodies of which we have consciousness (first level), but the time of the "conscious acts themselves". Thus, in the above example, we were to ascertain a falling body in an act of consciousness we call perception. The idea is then, in this case, to consider the presence of time on consciousness and not the duration of the modification of the position of the perceived<sup>\*\*\*</sup>.

<sup>\*\*\*</sup> Another example, perhaps, can help us to understand this level of temporality. Let us suppose we see a body, we close our eyes for a moment, open them again and see "other" body in another position. Can we here measure the travel time of the body, the physical time? Of course not, because it is not the "same" body. But in this example, could you say you have no presence of the time passed? No. This example shows us, not

Finally, the third level concerns the absolute flow of consciousness. This is the most difficult level to ascertain. This is not to analyze the duration of an "object" (first level) or the time of an "act of consciousness" (second level), but the consciousness itself. It includes the levels thereof. We all seem to have the feeling that "we remain fluent" in an absolute independently form from what we perceive, imagine, etc. This level aims to our linguistic ability to behave as an "self" with some personal identity. In short, these three levels of temporal consciousness are given inextricably<sup>\*\*\*\*</sup> linked and only the phenomenological analysis can conceptually distinguish them.

### Neurobiological analysis of time as "scientific explanation" of phenomenological time

The phenomenological analysis of time showed at least two properties of time, namely, its structure and temporal levels. Varela tried to "explain" such temporal properties under the biological paradigm of self-organization, neuronal synchrony and nonlinear systems. This will be discussed briefly below.

#### *Explanation of the structure of time*

To explain the *past-present-future* structure we will use the neuro-phenomenological study Lutz *et al.* as an example<sup>32</sup>. There, the EEG activity was recorded during the presentation of a point pattern with depth information called auto-stereogram. Each subject had to press a button when he or she achieved to clearly observe the three-dimensional figure and make a report of the experience. According to the descriptions, two preparation states were identified experienced by subjects at the time of auto-stereogram: non-prepared and prepared. According to these phenomenological categories, EEG records were classified and subsequently the patterns of phase synchrony in the gamma band were determined. The results showed differences, both behavioral and neuronal dynamics, according to the phenomenological category. First, prior to the presentation of the visual stimulus, we observed a large-scale pattern of phase synchrony in the frontal brain region in prepared subjects but not in unprepared subjects. Second, we observed the degree of phase scattering recorded in the back electrodes was also modulated by the degree of preparation, i.e. the lower the degree of preparation the greater dispersion phase. Third, we observed an earlier large-

the duration of the consciousness of the movement of the body (since no body remains the same), but the time of our consciousness. We feel that there is a time horizon regardless of whether the perceived objects vary or not.

<sup>\*\*\*\*</sup> For Varela, the three levels of temporality are embodied; for example, they are modulated by our emotions (p. 300)<sup>12</sup>. We will see this below.

scale pattern of phase synchrony in prepared subjects (300 ms) than in the no-prepared subjects (600 ms) for the motor response.

As seen before, the present, according to the neurophenomenology, should be understood as a moment of the *past-present-future* structure. In this sense, the retention and protention character of the lived present must be somewhat linked to the neural activity. Thus, on the one hand, the retention understood in neural terms could show if some aspect of neuronal group activity (associated with the cognitive act immediately previous to the current) is *retained*, i.e. if the previous activity remains part of the present neuronal ensemble<sup>9,12</sup>. As interpreted by Lutz<sup>9</sup>, some local neuronal groups can keep oscillating after the disappearance of a globally synchronous assembly, which may be re-enslaved by the synchronous formation assembly. Thus, some of the recent past would be present at the time of actual consciousness. On the other hand, the protentional character (future) of the lived present is understood by Varela as a form of opening to the next moment of consciousness or "disposition for action" (p. 298)<sup>12</sup>. This is where, for Varela, the affective tone plays a crucial role in acting as a modulator of the stream of consciousness, enabling its stays and breaks. In neurodynamic terms, the emotional tone accompanying the subjects trained for the previous task is interpreted as a parameter that rearranges the phase space of the neural dynamics, thus creating the conditions for the emergence of a fast motor coordination after the stimulus emerges. This will be evidenced in the shortest reaction time and the appearance of a pattern of earlier phase synchrony in prepared subjects (300 ms) rather than no-prepared subjects<sup>9</sup>. Similarly, the emotional tone of surprise described by subjects during the unprepared states would maintain the system in a region of phase space, where the appearance of the visual stimulus would cause the reorganization of the system, on a new neuronal pattern, to take more time to materialize in generating a motor response<sup>9</sup>. This will be evidenced in the increased reaction time and the massive phase scattering pattern (reorganization) observed in subjects in the no-prepared than in the prepared state.

### *Explanation of temporal levels*

a) **Relationship between the first level of Husserl and Varela's "1/10" scale:** The first level of temporality described by Husserl time would correspond to the time of objects and events in the world (p. 269)<sup>12</sup>. As mentioned in the previous section, this level of description of time is used by physics and experimental psychology: the physical time. The neurobiological basis of this time level would be given, according to Varela, by the neuronal activity that occurs within the scale "1/10" (p. 273)<sup>12</sup>. This level, Varela thought, for

example, from the so-called apparent motion or phi phenomenon<sup>33,34</sup>. In this phenomenon, when two lights are displayed successively at an interval lower than 0.1 seconds, then they are perceived as simultaneous. As this range increases, then the stimulus is perceived, first as a quick movement and then as a sequential movement<sup>33</sup>. One group of subjects was asked to discriminate the temporal sequence in which two lights were presented in order to evaluate if this interval correlated with brain alpha rhythm phase (i.e. 7-13 Hz). The alpha brain activity was recorded such that the beginning of the presentation of light patterns was initiated either in the positive or negative alpha cycle phase. The results showed that there was a high probability for the discrimination of lights as simultaneous when the stimuli were shown in the positive phase of the alpha cycle, or as sequential, when they were displayed during the negative phase of the alpha cycle.

b) **Relationship between the second level of Husserl and Varela's scale "1":** The second level of temporality described by Husserl is *the acts of consciousness* that represent the objects-events (p. 269)<sup>12</sup>. This level shows the *internal or immanent time* of the acts of consciousness, as seen in the previous section. This level of phenomenological description is that Varela attempts to ground using the scale "1" of neuronal activity *integration-relaxation* (p. 273)<sup>12</sup>. A study that may illustrate this point belongs to Cosmelli et al.<sup>35</sup>, in which phase synchrony patterns were analyzed by MEG during a task of binocular rivalry. The binocular rivalry arises when two unmergeable images are presented, one to each eye. Instead of perceiving both overlapped images, such stimulation results in the alternate perception of the image displayed to the right and left eye<sup>36</sup>. The subject task was to indicate by one of two buttons when the complete dominance of some of the stimuli was perceived. The activation of a widely distributed brain network was determined during the period of observation of both stimuli. Significantly, it was demonstrated that the conscious perception of one of the stimuli was correlated with the time course of a synchronized cortical network in the frequency band of the presented stimulus (5 Hz).

If we analyze this experiment we may be able to realize why Varela associates the second level of temporality with the scale "1" of the duration of acts of consciousness, a scale understood as a pattern of long-scale synchronous activity observed during the perceptual dominance of one of the stimuli. Indeed, since the two images are always invariably present throughout the experiment, changes in perception over the leaps between dominant images are given by *the acts of consciousness* and not by the variation of physical objects. Thus, the duration of the phase synchrony

pattern can be matched with the period of dominance of one of the images. For example, images originating multi-stable perceptions can be placed in the same case<sup>12</sup>. Although the picture does not change physically, our perception of them varies. The perceptual image, as an act of consciousness, *lasts* a certain period of time without physically changing the perceived object. This is what should be measured and explained with the theory of scale "1".

- c) **Relationship between the third level of Husserl and Varela's scale "10":** The third level of temporality described by Husserl corresponds to the "*absolute time constituting flow of consciousness*" (p. 269)<sup>12</sup>. This level includes the two previous periods. The neurobiological basis of this time level would be given, according to Varela, by the neuronal activity occurring within the scale "10" (p. 273)<sup>12</sup>. This duration scale attempts to explain descriptive-narrative statements related to our language skills<sup>12</sup>. This level of temporality would correspond to the experience of "continuity of self" or the "flow of time related to personal identity"<sup>12</sup>. According to Varela, it is this experience of continuity of the "self" that would precisely lead to pathologies such as schizophrenia<sup>12, 37</sup>. The reason is some of the so-called positive symptoms of schizophrenia include reports of insertion of thoughts or control delusions. In such patients, the thought generation or control of some of their movements are attributed to the action of an external agent<sup>37</sup>. However, what seems to be affected in these patients is not the sense of "ownership" of the consciousness flow, but the feeling of "agenciality" of the contents of such consciousness flow. Thus, for example, some thoughts are experienced by patients as *their own*, but not as if they were *the authors*, but as introduced, somehow, in *their* consciousness. In summary, patients with schizophrenia experience a consciousness flow that they identify as their own, but where thoughts and movements are introduced, for which they have no sense of agenciality.

Now, it should be noted that while Varela does not explain the type of neural mechanism involved in the emergence of the scale "10", he indeed suggests it would be related to how the cognitive moments of the scale "1" are capable of being integrated and "*linked together to form a broader temporal horizon*" (p. 277)<sup>12</sup>. Accordingly, one could hypothesize the alterations in this neuronal integration level would be associated to changes in the sense of agenciality experienced by schizophrenic patients, which associates with a loss of the protentional or future character. The fact these patients lose their *protentional* character prevents them from having the feeling of being "*brewing*" their thought ("where it goes") and they only assume them *retentionally* as a thought that has crossed their mind but do not perceived themselves as managers. Thus,

according to this model, these patients would break the continuity of the time structure and, with it, the absolute time as an "self"<sup>37</sup>. In this line of thought, it has recently been suggested that the prefrontal cortex would play a central role in the body temporal integration by linking working memory (past), the interference control (present) and preparation (future)<sup>38</sup> and this view may shed light on the structural alterations of temporality in schizophrenia<sup>39</sup>. Be it true or not, this is the line drawn by the research program, where answers to the anomalies produced in the consciousness of time must be sought.

## CRITICISM TO VARELA'S IDEA OF TIME

Finally, we would like to present some problems of Varela's neuro-phenomenological proposal in relation to the concept of time there included. Neurophenomenology, as we saw, involves three moments, and we can consecutively classify the problems, in turn, into three groups. We will critically analyze each of them; however, we will focus on the last problem.

- 1) First, let us say something about the "phenomenological" moment of time. This raises some problems: is it right or at least relevant Husserl's phenomenological analysis to describe the time? Although Varela has naturalized Husserl's description (besides receiving other influences in his phenomenological conception of time), it essentially retains its description of the levels of temporality, for example, where the third level is hardly a pure phenomenon. Besides, is it possible to describe purely reducing or bracketing any explanation? That is a problem that affects all phenomenology. We generally assumed Varela's thesis at this point.
- 2) Second, the "neurobiological" moment of time. This moment aims to scientifically explain time. As we have seen, the phase synchrony in the gamma band is the neural model used by neurophenomenology to explain the temporality of consciousness. However, synchrony *per se* appears to be *necessary* but not *sufficient* to explain consciousness<sup>40-43</sup>. For example, it has been reported that the neuronal synchronization in gamma band is even wider in anesthetized animals (i.e. unconscious) than in alert animals<sup>43</sup>. Furthermore, in binocular rivalry experiments have shown that synchronous patterns in gamma band disappear *before* the end of the presentation of a visual stimulus, although the subject continues to perceive the displayed image<sup>44</sup>. Thus, it seems the phase synchrony in gamma band would explain the initial emergence of consciousness, but not its prolongation over time (e.g. see discussion of Melloni et al.<sup>26</sup>). In this regard, reports of gamma band synchrony show the *discrete* temporal

nature of these patterns<sup>25,26,32</sup>, leaving the temporarily *continuous* character of conscious experience unexplained. Finally, evidence on the role of the gamma-band synchrony is only a mere correlation; there is no experiment to date proving that selective disruption of neuronal synchronization causes temporal changes in consciousness. Moreover, recently Merker<sup>45</sup> presented detailed evidence of children *without* cerebral cortex (and therefore structurally incapable of presenting patterns of synchrony), who seem to show clinical signs of consciousness, such as alertness, selective reaction to environmental stimuli, emotional expression of joy, etc.

3) Finally, let us see the unity of these two moments, the neurophenomenology of time. Here the main problem is to ask ourselves: what is the concept of time operating in the "co-determination" or relation between these two moments? For more clarity, let us see this problem in the phenomenological description of the three levels of temporality and its neurobiological explanation.

3.1) The first level is the physical time of objects and events. It involves studying the consciousness of the duration or temporal distance of the movement of a body. From this level, Varela aims to study the neurobiological or scientific explanation of this level. But, in fact, what he ends up studying is the biological foundation required to become conscious of the duration of the motion of a body, i.e. he studies the "minimum temporal distance" needed to become *conscious* of two events as different. This is what can be studied, for example, in the phi phenomenon. Different time intervals are controlled and it is intended to be correlated with the consciousness of perceiving or not two events as successive. This level is what Varela seeks to explain through the scale "1/10". Now, absolute and real time is here understood as that shown in a clock. The consciousness of discrimination of two events may vary and be subjective; it is time which is "assumed" to remain the same. Thus, the time operating in the *unit* in both aspects is the clock time.

3.2) The second level is the time of conscious acts. This is what Varela has placed in co-determination with the level "1" of neuronal synchrony. In order to study the time of an act of consciousness, such as perception, and not from physical objects, an unchangeable object is required. This applies, for example, for the pyramid as a multistable figure<sup>12</sup>. The figure does not physically change (at least that is what we state in the third person), what is perceived is the change from a percept (face up) to another (upside down) and vice versa. The duration

of each percept is what we want to measure with a clock and relate that to the neuronal synchrony. Here, two problems must be approached.

First, we should ask ourselves whether it is possible to "measure" how long a perception lasts. Therefore, we require the act of perception to manifest a beginning and an end in order to put such act in correspondence with a clock. This can be done, for example, when we measure the time in which a body moves (as in the phi phenomenon), for here what is being measured is the physical time of the body, not our perception, i.e. the consciousness of the time of duration of the movement of a physical object. But can the time of the act of perceptual consciousness be measured? Time was measured in the experiment of the pyramid, but what was measured, in reality, was the duration of the "perceptual shift" and not the "perception consciousness" of the pyramid. The act of perception *has never ceased* in such experiment, since the change of percept was noted by "perceiving it". Therefore, we have never failed to perceive, what has changed is the perceived. Would you say, then, we have measured the time of the perceived act?

Moreover, there have been attempts to relate this level to the neuronal "synchrony". But synchrony means here simultaneous neural events for an absolute clock. And here again time is conceived as physical or chronometric. The same should be said of the "simultaneity" to be found between what one observer describes in first person and what neurobiological instruments indicate. There is an external observer or a machine that establishes, watch in hand, the synchrony between that expressed phenomenologically in the first person and the scientific results in the third-person. In explaining this level of temporality we find, basically, two synchronicities: one, the neuronal and the other that relates the phenomenological events with the neural. These two synchronicities are always understood under the concept of clock time in the third person.

3.3) The third level is the absolute time of consciousness. This is where Varela seeks to explain this level with the scale "10" of neuronal synchrony. Consciousness has generally been described as a flow, as a continuum that "lasts". Philosophers like Bergson<sup>5</sup>, James<sup>46</sup>, Husserl<sup>29</sup> and Zubiri<sup>47</sup>, among others, showed the character of consciousness as a flow without beginning or end. Zubiri<sup>47</sup>, for example, noted that the duration was irreducible to clock time. The time of physics, the clock time "freezes" the continuity of a psychic process, reducing it to dots of a line that can later be divided infinitesimally.

It is a kind of spatialization of time, the time reduced to a line like the one used in the graphs. This is just what cannot be done with consciousness, precisely because it is a flow without parts or points. Furthermore, there is a major difficulty. It is very difficult to determine the *neural correlate* of the absolute time of consciousness, as this aspect, somehow, is always present in the first person. While there is description there is consciousness. No one can describe its unconsciousness in first person, i.e., no one can say "I am totally unaware"\*\*\*\*. Only the unconscious character can be detected from the outside, in the third person, when we postulate, for some *reason*, there is no consciousness. How can absolute time be measured and explained? This difficulty could be solved in two ways:

- On the one hand, one could study the cases where, because of illness, the "self" is *completely lost*, the absolute consciousness, whether in a short period of time or indefinitely. The loss of this absolute consciousness is correlated with the neuronal processes. But this study is something that is done in the third person. It is us who, from the outside, *assume* a break in the continuity of consciousness of a sick person. In some cases this may be an incorrect assumption, because the conscious acts are not defined by what someone *does* (third person) but by *how* something is felt (first person). The fact that someone does not do "what is usually done" when conscious does not give us irrefutable evidence of loss of consciousness. Moreover, at this point we must avoid the mistake of thinking that the continuity of the "self" emerges from unifying by memory all past experiences. This would again be seeing things from outside. The person, in the first person, seems to live a certain continuity of past-present-future, although it lasts, as clock time, a few minutes or seconds. The absolute time continuity of consciousness does not then refer to live, as clock time, as a single "self". It means we perceive ourselves in a "past-present-future"

\*\*\*\* It is true that in some cases there is some perceptual unconscious through which the person says he has no consciousness of "something" very specific, that we, from the outside, in the third person, "postulate" that person perceives. In that case is, for example, the so-called blind eye, where the person says he/she does not see an object, but acts dodging it as if he/she sees it. However, in these cases unconsciousness is, first, partial, as the person has consciousness, he/she reports, for example, on what we believe he/she does not see. Moreover, its unconscious character is appointed from external observers. It is we, in fact, who tell him/her what he/she does not see. We are not conscious of being totally unconscious.

temporal continuity although this is, in relation to a clock, something very fleeting. Although consciousness lasts only a moment in a clock, we live it in temporal continuity, open back and forward, even when we have no memory of the past. The time of consciousness is a mode of presentation, not the union of a series of perceptions. This is what the philosophers mentioned have suggested, according to our interpretation.

- On the other hand, a case where the "structure of temporal continuity of the self" is lost can be studied, for example, its protention. This applies to some type of schizophrenia, as seen above. But here, even if the explanation is correct, the protentional consciousness referred to a certain type of thinking has been *partially* lost. Not all protention has been lost. The person keeps its "continuity", it would only be lost for a special point in time within the field of consciousness, similarly to the person with blind look who *partially* loses its consciousness.

In short, the claim of Varela's neurophenomenology to co-determine or actively linking phenomenological data of the first person to the scientific studies of the third-person inevitably sets in the third person. In this case we ask again: what is the idea of time behind the neurophenomenology work as a bond science? In our view, here we are working with physical or chronometric time. That is the time that can be measured and be correlated between neuronal processes and phenomenological descriptions of an observer. In all these experiments there is an external observer functionally relating what a person declares (phenomenological moment) and shows "according to a certain interpretation" of scientific instruments (neurobiological moment). The co-determination is not then an immediate phenomenological datum and, therefore, is always subjected to discussion. Ultimately, Varela seems to fall back, at this point, in the physical or chronometric time from which he eagers to distance. All this, however, is not intended to invalidate his work, but, on the contrary, it tries to give a chance to the theoretical proposition of Varela to rework himself bringing forth his problems.

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