

# The transformation of neuronal activity into conscious experience: the synergetic theory

Jacobo Grinberg-Zylberbaum

*Facultad de Psicología, Universidad Nacional Autónoma de México and  
Instituto Nacional para el Estudio de la Conciencia, México*

'Reality' can be conceived of as an undifferentiated energetic matrix. By means of the brain, this matrix is converted into neuronal activity and experience. This paper explores the manner in which human experience occurs by analyzing the characteristics of information present in space, the events associated with brain activity, and the interaction between the two. Human experience is considered to constitute or 'exist in' a dimension different from that which is related to the localized physiological activity of the brain. Between cerebral electrochemical changes and the experiences themselves of light, sound, love, fear, etc., energetic transformations of a qualitative nature must take place. These postulated transformations are discussed and a new theory (the synergetic theory) concerning the creation of experience is presented.

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## 1. Introduction

The way in which neuronal activity is transformed into conscious experience is the most elusive problem facing the field of biology today. There are at least four different though interrelated theoretical approaches that have been applied to this issue:

- (1) Emergent properties approach. According to this set of ideas, conscious experience appears when neuronal activity reaches a certain level of complexity. A dimensional change is postulated involving the transformation of neuronal energy into another energetic state more related to consciousness (Grinberg-Zylberbaum, 1976*b*).
- (2) Psychoneural identity approach. Partisans of this view hold that experience and neuronal activity are identical. Since a neuronal pattern is a pattern of experience, there is no necessity to propose any type of energetic transformation (Fernandez Guardiola, 1979).
- (3) Independence approach. This position maintains that the brain is merely a tool used by the 'real observer' to make contact with physical reality. This observer (being) transforms neuronal patterns into experience but is itself independent of the process. Consciousness is considered to be independent from but interrelated to neuronal activity (Don Lucio, 1980).
- (4) Unity approach. Following this line of reasoning, the individual brain is conceived of as a part or an element of a larger brain—that which really experiences. The individual brain only focalizes experiences (Cooke, 1976).

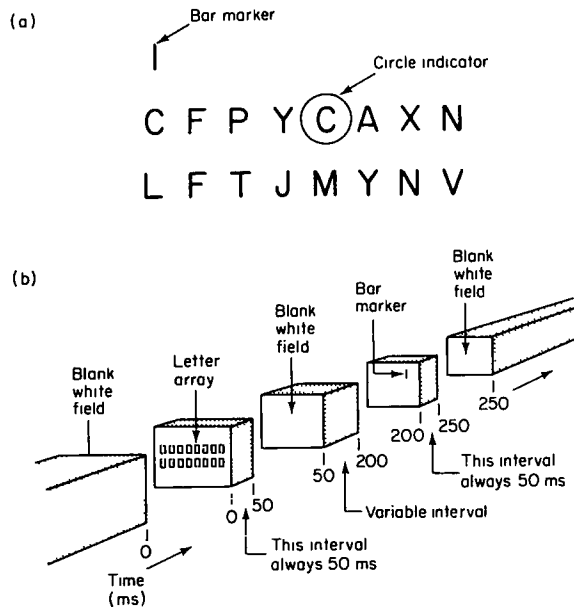


Fig. 1. The experiment of Averbach & Coriell (1961). (a) Typical stimulus pattern; (b) procedural outline (Neisser, 1967)

My own position with regard to this problem has moved from the first to the last approach over time. As will be elucidated in this paper, I now conceptualize conscious experience as an interaction between an energetic field (neuronal field) activated by the individual brain and the structure of space. The analysis begins with a discussion about a phenomenon (iconic phenomenon) that suggests some very interesting neurophysiological possibilities.

In 1961, Averbach & Coriell demonstrated that a visual pointer (bar marker) presented after a display of letters had been removed permitted selected portions to be 'looked at' by subjects. The interval between the presentation of the display and the pointer could be varied from tens to hundreds of milliseconds without disturbing this phenomenon. During the interval, the information contained in the original visual display (see Fig. 1) is transduced by the retina, transmitted through the optic nerves, and activates the thalamus, visual cortex and related structures. The bar marker presented after this series of events is able to retrieve the image of an absent and predecoded letter. Furthermore, if a circle is presented instead of the marker, the icon (visual image of the letter) is erased (Neisser, 1967). This retroactive masking effect blocks the conscious experience of the visual icon even though it has been almost completely physiologically decoded and processed.

It has been postulated (Grinberg-Zylberbaum, 1976a) that one of the basic operations performed by the visual system is the inclusion of information in neuronal hierarchically-ordered convergent levels, each one of which has the capacity to unify information that is dispersed at lower levels. The operation of unification involves the extraction of 'neuroalgorithms'—logical structures of complex neuronal patterns—and the activation of new dimensions of functional activity, such as the 'neuronal field' which will be discussed later. Each neuroalgorithm conveys information about form, position and meaning in its neurological structure.

The retrieval of visual information takes place after part of the neuroalgorithm is

stimulated: divergence circuits reactivate the original cortical neuronal population that was activated when the stimulus was initially presented. This retrieval involves the excitation of the visual system by means of a triggering stimulus either similar or related to the original one.

In Averbach & Coriell's experiment, the visual icon of a letter is seen when a bar marker occupying the same position in space is presented. It is proposed that the neuronal codification of a letter involves the activation of a neuroalgorithm which is represented in a hierarchically convergent polysensorial population of neurons as a complex pattern of neuronal discharges, containing in its structure the form, level of illumination, position, etc. of the letter. The bar marker is also codified as a neuroalgorithm having at least its position in common with the one representing the letter. This shared feature is able to activate the entire neuroalgorithm of the letter, and thus to stimulate divergence circuits which effect the corresponding cortical neuronal activation. Therefore, subjects see an absent letter when a bar marker occupying the same position is presented.

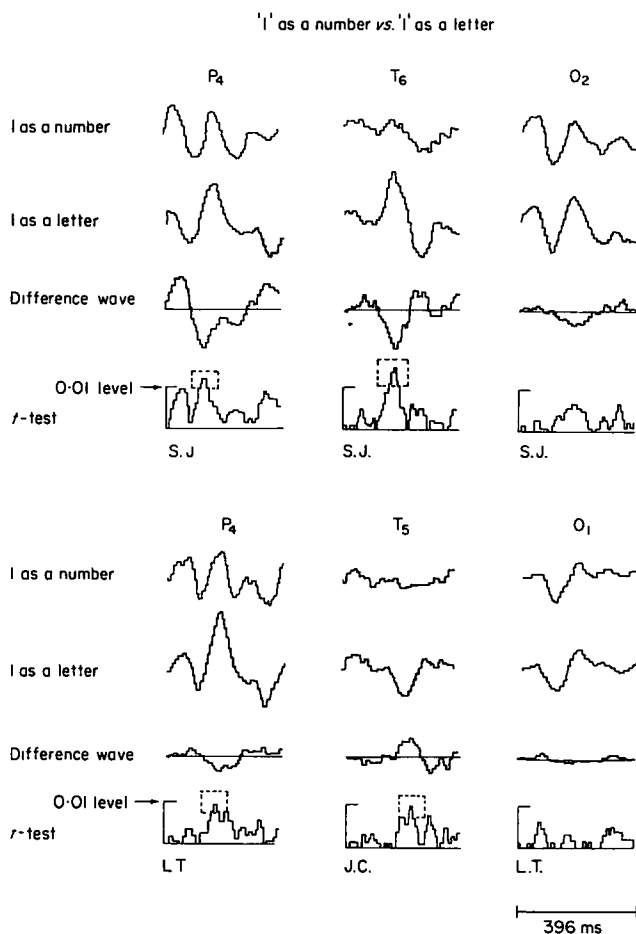
The retroactive masking phenomenon has a similar physiological basis except that a new factor—the complexity of the neuroalgorithm representing a circle—is introduced. The visual icon is lost due to the complexity of this neuroalgorithm which competes with that representing the letter. In this case the divergence circuits are not able to convey any organized information and retrieval does not take place.

## 2. The transformation of neuronal patterns into experience

Studies concerning the characteristic electrophysiological responses that are evoked in the visual system as a result of the presentation of a stimulus have shown that their morphology and even their temporal features are dependent upon at least two types of processes which can be typified as exogenous, representing the physical form, and endogenous, representing the meaning of a stimulus (John, 1972; John, Bartlett, Shimokochi & Kleinmann, 1973). Moreover, it was demonstrated in 1974 that the form of a letter and its meaning are processed in different cerebral locations (Grinberg-Zylberbaum & John, 1979). This was accomplished by recording and averaging potentials evoked by an identical stimulus that could be placed in two different meaningful contexts (the letter 'l' and the number '1') and two different stimuli that have a single meaning ('capital A' and 'small a', varying in size).

The results show that similar averaged evoked potentials (AEPs) are recorded in the occipital cortex when the letter 'l' and the number '1' are presented, while dissimilar AEPs are recorded in the parietal cortex under the same circumstances (Fig. 2). The differences in the morphology of the AEPs registered in the parietal cortex appear 150–190 ms after the stimulus is presented, indicating that the decodification of meaning has taken place by this time. In contrast, the potentials evoked by the 'capital A' and 'little a' differ significantly only in the occipital cortex (Fig. 3). Thus, it has been concluded that the form of a letter is processed in the occipital cortex while its meaning is processed in the parietal cortex. It can be postulated that the perception of form is the outcome of the activation of an extensive population of neurons located in the occipital cortex, while the cognition of meaning arises from the activation of 'neuroalgorithms' which have the power to unify poly-sensory, highly convergent populations of neurons into a neuronal pattern.

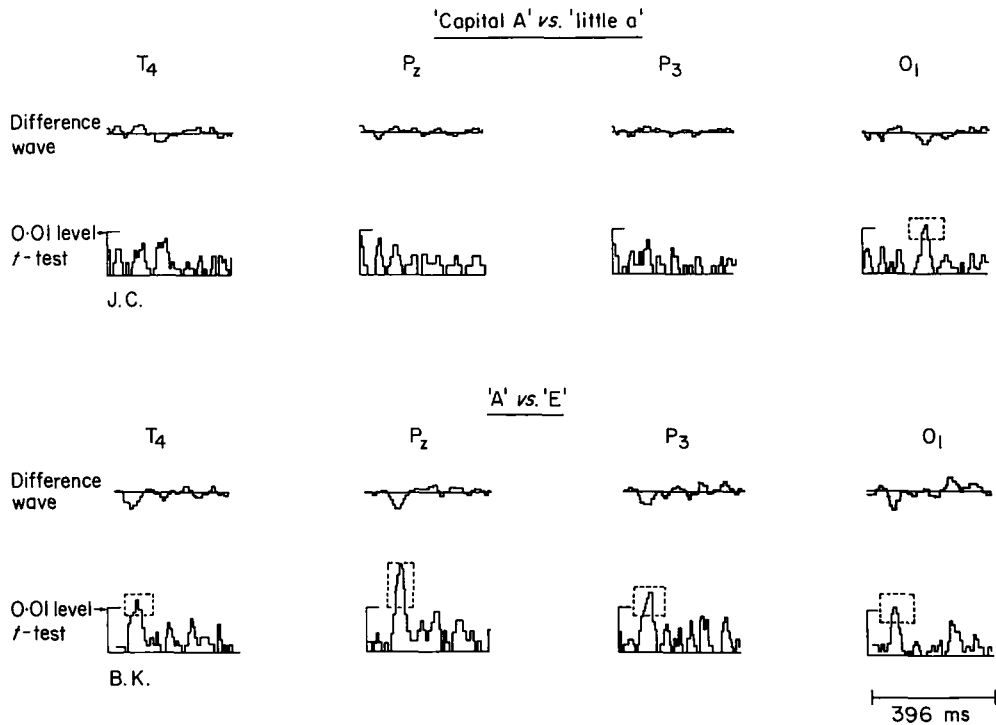
The above-mentioned concepts and their derivatives describe some of the neurological correlates of the visual perception of form, position, etc., and the attribution of meaning. Theoretical models which describe the processes of logic and language in terms of neuro-physiological events as well as neuroalgorithms have already been formulated (Grinberg-Zylberbaum, 1976*b*).



*Fig. 2. Averaged evoked potentials (AEPs,  $n = 100$ ) elicited by a vertical line presented in a numeral (lines 1 and 5) and in an alphabetical (lines 2 and 6) context. They were recorded in three subjects (S.J., L.T., J.C.) in different areas of the brain ( $P_4$ , parietal;  $T_{5,6}$ , temporal;  $O_{1,2}$ , occipital). Statistically significant differences were obtained in the parietal and temporal AEP components located between 150–190 ms of latency. The difference wave and  $t$ -test were calculated using a PDP-12 computer (Grinberg-Zylberbaum & John, 1979)*

A completely different inventory of concepts must be developed in order to attempt to explain the foundations of conscious experience, since this phenomenon takes place in a dimension distinct from that of neuronal activation. Thus, in endeavoring to understand conscious experience as an experience in itself, the consideration of neural events and neuroalgorithms is pointless. In other words, the experience of light as light, of sound as sound, and even of meaning as meaning cannot be located *per se* in the activity of any neuronal population which has been described so far.

The dimension of experience is different from the dimension of neuronal activity. Nevertheless, it is possible to measure the interval after which the conscious experience of a stimulus 'occurs' by means of recording the evoked potentials (Cansesco, Torres, Riefkohl & Grinberg-Zylberbaum, 1978). In our laboratory, this interval has been found to be about 100 ms.



*Fig. 3. Upper tracing, difference wave (line 1) and t-test (line 2) obtained from averaged evoked potentials (AEPs,  $n = 100$ ) elicited by a 'capital A' and 'little a' in one subject (J.C.). The response is statistically significant only in the occipital ( $O_1$ ) location. Lower tracing, similar calculations applied to AEPs recorded in one subject (B.K.) in response to capital letters 'A' and 'E'. Statistically significant differences were found in AEPs recorded in the temporal ( $T_4$ ), parietal ( $P_{2,3}$ ) and occipital ( $O_1$ ) regions. The difference wave and t-test were calculated using a PDP-12 computer (Grinberg-Zylberbaum & John, 1979)*

What are the processes during that 100 ms after stimulus presentation which result in a conscious experience of the stimulus? In order to answer this question, two concepts will first be introduced that must be taken into account: the 'synergic' organization of space and the 'neuronal field'.

### 3. Synergic organization of space

We don't perceive objects; rather, we perceive information located in space in the form of energy patterns. The 'synergic' (derived from the words synthesis and energy) organization of space is defined as the organization of information located in space in the form of complex patterns of energy. One of its most interesting features is the concentration of information at each point. For example, large amounts of information can be received and visualized when an observer looks through a pinhole made in a piece of paper. What the eye 'sees' is the space of the pinhole. However, if the pinhole is oriented towards a star-studded sky, information emanating from thousands of stars is concentrated in the form of complex energy patterns in the space of that pinhole.

The quantity of information concentrated in a point of space depends, among other variables, on the position of the point relative to the source(s) of information. For example,

if the pinhole is located a meter away from a star, the quantity of information concerning the star concentrated in that space will be less than if the same pinhole is located light years away from the star. In this latter location with a sufficiently powerful telescope (for the purposes of illustration), we could see all the features visible in the former location and much more besides. Therefore, all the information concentrated at the pinhole at a meter's distance is also *present* at a pinhole light years away.

Obviously, the extent of space from which information is gathered increases with the distance of the pinhole from the source(s) of information. In other words, the source(s) of information and the point of reference that intercepts the dimension of space in which that information is concentrated as energy patterns could be visualized as describing a cone. A high synergetic space is differentiated from a low synergetic space on the basis of the amount of information in a given segment of space (the greater the amount of information and the smaller the space, the higher the 'synergy'). Thus, a high synergetic space has a large amount of information concentrated at each point.

The space-matter continuum can actually be conceived of as a synergetic continuum in which one extreme (matter) concentrates less information (is less convergent) and the other (space) more information (is more convergent). The property of redundancy is associated with that of convergence, such that a high synergetic space is more redundant (different portions contain similar information) than a low synergetic space. Redundancy of information increases as a direct function of the distance between the source of information and a point of reference.

The following common situation is a good example of redundancy: If an observer is travelling on the surface of the earth and looks towards the moon, he will notice that the moon 'follows' his movements. At the same time, the objects near his path appear blurred and are swiftly left behind. The only explanation of this amazing fact is that information about the moon is found in redundant form in the many portions of space through which the observer passes. Each point in space (at the distance from the moon to the observer) contains similar information and so the observer sees the same image, independent of the speed at which he travels. In contrast, objects located near him are not found in a redundant form in the space that is traversed, and so they appear blurred.

The two synergetic properties mentioned so far, concentration-convergence of information and redundancy, are interrelated in the sense that as one of them increases, so does the other. As the synergetic continuum can be considered to be synonymous with the space-matter continuum, other properties can be deduced as well. The first and most mysterious of these are gravitational forces. Whenever an observer approaches a high synergetic space, that is, a space in which there is a high concentration and redundancy of information at each point, the gravitational force diminishes with respect to a low synergetic space. It is interesting to speculate that what we call gravity might only reflect a change in synergetic organization.

Physical time is also related to the synergy of a space: time 'goes faster' in a low synergetic space and 'slower' in a high synergetic space. It is proposed that time can be measured only when changes in the organization of information in space are taking place. Thus, physical time will 'go faster' in a space in which pronounced organizational changes are occurring. For instance, it has been shown that physical time as measured by initially synchronized atomic clocks passes more quickly in the proximity of a large as opposed to a small gravitational mass. A high synergetic space characterized by a high level of redundancy is relatively more homogeneous than a low synergetic space; therefore, time will pass more rapidly in the latter situation. The fact that time slows down as the speed of light is approached, as predicted by Einstein, is in accordance with these theoretical concepts.

A maximally high synergetic space would be equivalent to a space traversed at the speed of light.

There is also a correlation between synergy and speed: an observer moving at high speed is 'equivalent' to a stationary observer located in a high synergetic space, in that each interacts with a large amount of information in a small measure of time. This phenomenon brought to an extreme is found at the speed of light, when time disappears and the degree of redundancy is infinite.

It can be said that a perceptual image is a phenomenological unity in which is concentrated all the time-related neurophysiological processes which were previously activated. In an analogous manner, a portion of a high synergetic space can be said to concentrate information in a single energetic unit that has travelled different times before reaching that particular region. It is therefore possible to speak of the 'concentration' of time in portions of space. Each point in a high synergetic space can be conceived of as concentrating both time and information: originally located in an enormous expanse of space, they are found in a minute sector of it. The great concentration of information at each point gives rise to a highly complex organization.

We shall see that the brain is synergetically organized as well. If the complexity of the synergetic organization of space exceeds the 'neurosynergetic' organization of the brain, that space appears to be transparent. If, on the other hand, the latter is more complex than the former, then the space (its content) becomes 'materialized' to perception. Matter and transparent space are ultimately a creation of the brain.

In conclusion, what has been defined as high synergy within the space-matter continuum is characterized by:

- (1) high concentration of information,
- (2) high redundancy,
- (3) concentration of time,
- (4) great complexity,
- (5) reduced gravitational forces.

Finally, it can be postulated that a high synergetic space is also a densely algorithmized space in which the information in each of its portions is shared with the others, such that each point contains information about the whole.

#### **4. Synergetic organization of the brain**

The characteristics of the synergetic organization of space that have been presented are also observable in the brain. In an earlier article, I have described the convergent organization of the neuronal circuitry of the brain (Grinberg-Zylberbaum, 1976a). One of its most interesting properties is the convergence of information. Ascending levels of convergence can be postulated which contain ever larger amounts of information (similar to space).

Convergence and different levels of convergence are terms which refer to two different processes. One is the concentration of information by means of complex neuronal circuits. At each level, an algorithm of the former levels is produced. These algorithms can be used by the system to reconstruct the details of the original information but they don't contain the details in themselves. The other process is the concentration of information, also in an algorithmical form, by means of dimensional transformations. An example of this type of process, which will be discussed later, is the formation of a 'neuronal field' from the local activity of components of the nervous system. This neuronal field would have coded in its morphology all the information previously contained in the separate elements.

What is called abstract thought and conceptualization must involve the integration of

information of varying orders of complexity (convergence codification). The neuronal information at each level of the 'convergence tree' must be organized in a very complicated manner and is surely associated with the activation of a myriad number of cells. Thus, convergent codification involves the general activation of neuronal populations. As in space, each increasingly convergent level contains a greater redundancy of information.

A neurosyntergic organization of the brain as well as a neurosyntergic continuum (high to low) can be theorized, such that a brain functioning in a high neurosyntergic mode would be better able to integrate information in a unified and abstract manner, while a low neurosyntergic mode would involve a more concrete perception of reality. Furthermore, a neurosyntergic/syntergic ratio can be proposed: if greater than 1 in reference to some space, that space would be perceived as containing matter ('materialized') and thus a concrete object would be seen, while if less than 1, perception would be disorganized and visual transparency would be the result. The development of neurosyntergy can be postulated as proceeding parallel to phylo- and ontogenetic development, giving rise to the perception of more and more complex patterns of information in increasingly evolved forms of life.

### **5. Neuronal fields**

The activation of neuronal populations of cells involves highly complex interactions. If each neuron is conceptualized as an emitter and receiver of electrochemical discharges, and if the transmission of each electrical charge between cells creates a local energetic field, then a global energetic field must be formed as a result of a population response. The field associated with each neural level of convergence would be incorporated into an even more inclusive field arising from the holistic activity of the entire brain. This field is called the 'neuronal field' (Grinberg-Zylberbaum, 1978).

Although the nature of this field is unknown, there is no reason to suppose that it behaves differently from other fields which have been described. Thus, the neuronal field would expand into the space surrounding the brain and interact with the syntergic organization of that space. The greater the neurosyntergic organization of a brain, the more similar the neuronal field would become to a high syntergic space. Theoretically, at some level of development the neuronal field could become identical to the morphology of the syntergic space. In this event, it is probable that the experience of the observer would be unified with the whole information field.

I propose that what is called experience is precisely the interaction between the neuronal field and the syntergic organization of space. The time required to activate a fully operational neuronal field would be experienced as the duration of the present moment. This varies accordingly to the modality of the experience and is positively correlated with the level of the neurosyntergic organization of the brain. Therefore, there is a direct relationship between the experienced duration of the present and the level of neurosyntergic functioning.

### **6. Gravitational changes and the neuronal field**

The interaction between the neuronal field and the syntergic organization of space could result in mutual alterations. A neuronal field from a high neurosyntergic brain might increase the syntergy of the surrounding space, while a change in the syntergic organization of space might alter the morphology of the neuronal fields located within that space and thus activate different modalities of experience.



If gravitational forces reflect changes in the synergetic organization of space, then it can be postulated that gravitational shifts would occur in the proximity of a brain in the process of a neurosynergetic change. It was recently demonstrated that an increase in brain coherence as measured in EEG recordings alters the gravitational field, thus supporting the existence of a neuronal field and its possible interaction with the synergetic continuum (Grinberg-Zylberbaum & Tabachnick, 1979).

### 7. Localization of experience

If experience is the interaction of neuronal fields with the synergetic organization of space, experience can 'occur' at any location where this interaction takes place. Human beings are accustomed to consider the body as the origin and the center of experience. I propose that with adequate training in the attainment of certain mental states (neurosynergetic modalities), the site of experience could appear outside the human body.

The focusing of experience must be regulated by an additional factor besides the interaction of fields since our experience is localized in space and time. This can be called the 'directionality factor' and must be related to changes in the energetic morphology of the interacting fields. Research on the characteristics and modes of action of the directionality factor are needed in order to demonstrate its existence and properties.

Thus, the interaction between neuronal fields and the synergetic organization of space constitutes an event that we sense as experience. Different modalities of experience would depend on the energetic, situational and morphological properties of the interacting fields.

### 8. Interactions between neuronal fields

It is proposed that what is called reality or experience is the interaction between our neuronal field and the synergetic organization of space and other neuronal fields. Reciprocal influences can be postulated, such that a single neuronal field could affect and be affected by the morphology and energetic organization of the fields with which it interacts.

Techniques are now being developed for the stimulation of what could be called 'direct communication' between subjects, thought to be made possible by an interaction between individual neuronal fields. The simultaneous EEG activity of subjects has been recorded during intervals in which this sort of communication has been attempted (Grinberg-Zylberbaum, Cueli & Szydlo, 1978; Grinberg-Zylberbaum, Cueli, Szydlo, Villanueva & Tabachnick, 1979).

We have found that there is a high degree of correspondence between the level of communication attained and the coherence of the subjects' EEG recordings. It is possible to define two types of communication: 'symbiotic' and 'mature'. The former is characterized by an apparent loss of identity or ego-independence and is associated with the EEG patterns of the subjects being 90° out of phase, with respect to coherence. That is to say, when the coherence of one EEG increases, the other diminishes. At the same time, the morphology of the EEG patterns recorded in zone T<sub>5</sub> of both subjects are correlated to a high degree.

In mature communication, both subjects share common feelings, images and thoughts but without losing their individuality. The EEG recordings show that during this type of direct communication, both brains undergo a simultaneous increase in coherence.

It is important to remember that according to the ideas presented in this paper, an increase in redundancy (in this case, an increase in coherence) is related to an increase in neurosynergeticity, such that the neurosynergeticity/synergeticity ratio becomes smaller. It is logical that two subjects could establish direct communication under these conditions since in some sense they have become more unified with the structure of space.

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