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Neuro-phenomenology and neuro- physiology of learning in education

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Abstract

Contemporary research on neuroscience and neuro-phenomenology opens in new and more complex models of interpretation regarding the phenomena that govern the development of knowledge and consciousness. In an interview with "Le Monde" in February 1999, Varela said, "from the age of 9 or 10, just one question nagged at me: how to understand the relationship between the body, so physical, so heavy, and the mind perceived as ephemeral, almost atmospheric". This question is still recurrent and is expressed as a new paradigmatic model, able to explain, in terms of knowledge, the connection and the relation between the neuronal structure and the procedural knowledge; in other words, between neurophysiology and neuro-phenomenology. Which are, in this prospective, the interpretative approaches and the speculative developments?
Besides, moving from these approaches, what kind of problem we will have to consider from a didactic point of view? Which relationship exists between the encephalic reality and the phenomenological living body?
These considerations, that investigate about the understanding of the relational nature of neural processes which regulate the evolution of human consciousness/knowledge, find their roots and justification in the studies of J. Z. Tsien (in the neuro-physiological field) and of Varela & Thompson (in the neuro-phenomenological field).
Tsien and his team, in a biomedical field and through combined and complex experiments, have developed an interesting theory on the basic mechanism by which the brain would be able to transform experience into memory. Clans of neurons involved in coding, they say, make a selection of experiences stored, giving a sense at the experience and transforming it into knowledge.
From a different perspective, called Radical Embodiment, the problem of the relational nature of consciousness/knowledge is investigated by Thompson and Varela. Their position is considered as a new approach to the study of neuroscience.

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Keywords: Neuro-phenomenology, Neuro-physiology of learning, Radical Embodiment, Neural code, Memory code.

1. Introduction

Many seem to be the points of contact that relate the analysis of studies on the neuro-phenomenological vision of knowledge (and the occurrence of states of consciousness in relation to the act of knowing) and further studies phenomena related to bio physical and neuro-logical that govern and influence the physiology of learning. A study conducted by several parties on the subject show that individual neurons are able to recognize people, landscapes, objects and even written and names. The finding suggests the existence of a consistent and explicit code that could play a role in the transformation of complex visual representations into long-term memories.

This conception of individual neurons as 'thinking cells' - says the neuro-surgeon Itzhak Fried - represents an important step toward deciphering the code of the cognitive brain. If we can understand this process, maybe one day we will be able to build cognitive prostheses to replace functions lost due to brain injury or disease, and perhaps even to improve memory. The theory developed by Itzhak Fried and his research group at the University of California in Los

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Angeles is based on a new conception of the mode of storage of memories, stating that encode memories are small sets of neurons located in specific regions of the brain. These small clusters of neural cells simultaneously represent many aspects of the same thing.

This statement leads to the conclusion that each neuron has its own memory and that groups of neurons fire selectively to images of faces, animals, objects or scenes. In this perspective are here analyzed two different areas of research that are based on two different approaches: one referring to the neuro-phenomenological studies (total embodiment of Varela and Thompson), and the other in reference to the neuro-physiological and bio-medical studies (neurophysiology of learning of Zhuo Joseph Tsien).

But as you can remember the mental states activated by past perceptions and refer back to an object in the world, even when it is not present or does not exist? How is it that a model of external reality emerges in the physical system, which is the brain? What role has the intentionality and the emergence of consciousness in this process? The answers to these problems are numerous and controversial and detection of connection points difficult and problematic (hampered by the differentiation of the areas of inquiry: Philosophy of mind, Philosophy of language, Cognitive science, Neuroscience, etc.). This basically means that "Philosophy" speaks little of "Biology" and "Biology" of "Philosophy" speaks even less.

2. Comparative Analysis of Two Models Of Research in Neuroscience: A Meuro-Phsiological Analysis of The Thought of J. Z. Tsien and The Radical Embodiment Of E. Thompson And F. Varela.

2.1 The Neuro-physiological Analysis of Thought of Joseph Zhuo Tsien

Tsien founded the Shanghai Institute of Brain Functional Genomics at East China Normal University and is now director of the Center for Systems Neurobiology at Boston University. His studies are focused on the search for a neural code that can explain the experience phenomenologically lived through the observation of specific biological processes.

For a long time research of the neural mechanisms by which memories are stored in the brain has been studied by neuroscientists. Learning and memory are very important in the structuring of knowledge: learning is the process by which one acquires knowledge and memory is the process by which knowledge is preserved in time. For many years we have tried, therefore, to investigate the intricacies of cellular memory and to understand the functional basis for action at the neural level.

Tsien and his team, in a biomedical field and through combined and complex experiments, have developed an interesting theory on the basic mechanism by which the brain would be able to transform experience into memory. Clans of neurons involved in coding, they say, make a selection of experiences stored, giving a sense of the experience and transforming it into knowledge. This extraordinary research could allow, in the near future, to decipher the neural universal code allowing the reading of the memories of a human being by monitoring brain activity.

Interesting observations are:

a) the nature of the mechanisms of action and the behavior of neural cells,
b) the sophisticated mechanism of action research (covering the area CA1 of the hippocampus).

In this theoretical model each event is represented by a group of neuronal clans that encode different characteristics; a clan is represented by a set of neurons that responds in a similar manner to each stimulus, working in harmony in the encoding of events. It is believed, therefore, that it is the clan to generate neural memories, acting in unison on the information conveyed phenomenal experience. Does this mean that behavior is also the derivation of genetic relational nature of man and his predisposition to the “lineage"? (Maturana Dàvila, 2006)

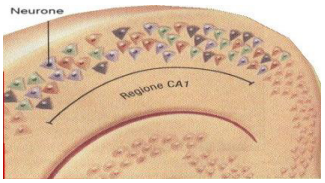

Fig 1. Schematic view of cliques encoding the earthquake experience (each color represents one clique)

Fig 2. Startling event polyhedron. Any given pyramid can be a component of a polyhedron representing all events of a given category, such as “all startling events.”

The brain is, in this perspective, the clan for neural discrimination of events encoded in memory. In a three-dimensional view, each experience is represented on a pyramid at various levels; each pyramid is considered an integral part of a polyhedron which, in turn, represents the category common to all the pyramids. This model represents a consolidation of memories in a clear and inconceivable way and demonstrate the dynamic nature of the human brain and its extraordinary ability.

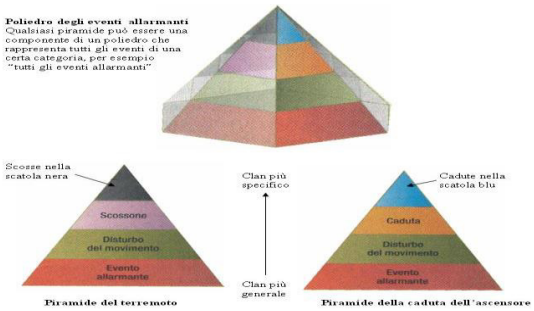

Fig. 3. This analyses showed that each clique encodes a different aspect of an experience, ranging from the general to the specific. The author conceives of this hierarchical organization as a pyramid with the most general clique at bottom, as is shown below for two events. (The sizes of the pyramid “layers” do not signify the number of neurons in the cliques.)

The idea that the action patterns of perception and memory are regulated and controlled by neuronal clan is not new for neuroscientific research, Tsien has provided, for the first time, corroborated experimental data on the hierarchical

organization and on the categorization as universal principles of the functioning of our brain. In the case of memory these properties allow you to create an unlimited number of patterns of neuronal activation (corresponding to the number of experiences that an organism can live).

In this perspective, Tsien and his research team in a recent article say "The ability to learn and remember conspecifics is essential for the establishment and maintenance of social groups. Many animals, including humans, primates and rodents, depend on stable social relationships for survival. Social learning and social recognition have become emerging areas of interest for neuroscientists but are still not well understood. It has been established that several hormones play a role in the modulation of social recognition including estrogen, oxytocin and arginine vasopression. Relatively few studies have investigated how social recognition might be improved or enhanced. In this study, we investigate the role of the NMDA receptor in social recognition memory, specifically the consequences of altering the ratio of the NR2B:NR2A subunits in the forebrain regions in social behavior. We produced transgenic mice in which the NR2B subunit of the NMDA receptor was overexpressed postnatally in the excitatory neurons of the forebrain areas including the cortex, amygdala and hippocampus. We investigated the ability of both our transgenic animals and their wild-type littermate to learn and remember juvenile conspecifics using both 1-hr and 24-hr memory tests. Our experiments show that the wild-type animals and NR2B transgenic mice preformed similarly in the 1-hr test. However, transgenic mice showed better performances in 24-hr tests of recognizing animals of a different strain or animals of a different species. We conclude that NR2B overexpression in the forebrain enhances social recognition memory for different strains and animal species"(Jacobs,Tsien, 2012).

2.2. The Radical Embodiment - E. Thompson e F.Varela

From a different perspective, the problem of the relational nature of consciousness/knowledge is investigated by Thompson and Varela, as neuro-phenomenological approach called "Radical Embodiment". Their position is placed as a new approach to neuroscience.

Here, neuro-phenomenology becomes "methodological proposal" that seeks to study, to observe, to understand and to analyze brain activity (description in the third-person) without neglecting the subjective experience (first-person).

What is, in this perspective, the relationship between neuronal structure and lived experiential? How to put together the subjective knowledge and objective knowledge? Varela and Thompson explain it in terms of enactive emergentism highlighting the presence of a twofold action of causality (bottom-up and top-down), which is clearly evident from the resonance that is established between groups of cortical cells in some given moments of the life of consciousness.

The consciousness identity has, in this perspective, a relational meaning and exists only as a relational pattern (consciousness is not smoke coming out of the brain). That is shown through a synchronized rhythmic discharges synaptic well highlighted in the dual pattern of causation. If mapped to the level of individual neurons, the electrical-chemical interactions do not occur in a precise direction and do not have an overview of organic and represent, however, the minimal units necessary for the emergence of a higher level of organization, expression of a state of consciousness that are well-defined and organized and that, once emerged, conditions the functioning of each single neuron synchronizing and ordering the action.

The emergence determines the crystallization of a circle of local-global causal dependencies. For Varela this circle of dependency is found in a neuro-physio-anatomical level, where to each bio-chemical and physiological structure corresponds another structure in the opposite circle. This approach, therefore, aims at mapping the neural substrates of knowledge/consciousness as emerging dynamic patterns and transient brain activity on a large scale, rather than at the level of particular circuits or classes of neurons. Varela's theory is fascinating and considers the emergentism positions as co-determination of reciprocal causes, including, in a auto-referentiality circle, "mind, body, world".

Our identity, says Varela, has a peculiar nature, although there is a kind of interface connection with the world, which gives the impression of a certain level of identity and existence at the same time (like all emergent processes) this identity can not be placed in a specific location; its existence has no locus or a specific space-time. It is, says Varela, a relational identity, which exists only as a relational pattern, but there is no substantial and material. The thought that everything that exists must have substantial and material existence is an old way of thinking that belongs to the Western tradition.

Fig. 4. The shadow of a perception. Average scalp distribution of gamma activity and phase synchrony. EEG was recorded from electrodes at the scalp surface. Subjects were shown upright and upside-down Mooney figures (high contrast faces), which are easily perceived as faces when presented upright, but usually perceived as meaningless black-and-white forms when upside-down. The subjects' task was a rapid two-choice button response of whether or not they perceived a face at first glance. Color coding indicates gamma power (averaged in a 34–40 Hz frequency range) over a given electrode and during a 180 ms time window, from stimulation onset (0 ms) to motor response (720 ms). Gamma activity is spatially homogenous and similar between conditions over time. By contrast, phase synchrony is markedly regional and differs between conditions. Synchrony between electrode pairs is indicated by black and green lines lines, corresponding to a significant increase or decrease in synchrony, respectively. These are shown only if the synchrony value is beyond the distribution of shuffled data sets ($P < 0.01$; see methods, Ref. 18). Modified from Ref. 18.

Varela and Thompson, in a volume of the journal Cognitive Science, regarding this question say: "The most plausible mechanism for large-scale integration is the formation of dynamic links mediated by synchrony over multiple frequency bands. Neuronal groups exhibit a wide range of oscillations (in the theta to gamma ranges, 6–80 Hz), and can enter into precise synchrony over a limited period of time (a fraction of a second). Synchrony in this context means precise phase-locking as directly quantified by novel statistical methods (rather than indirect measures of synchrony in terms of spectral coherence that do not separate phase and amplitude components). The role played by such synchronization of neuronal discharges has been greatly highlighted by recent results from microelectrode physiology in animals. Two scales of phase synchrony can be distinguished: short- range and long-range. Most electrophysiological studies in animals have dealt with short-range synchronies or synchronies between adjacent areas corresponding to a single sensory modality. These local synchronies have usually been interpreted as subserving 'perceptual binding'. Detailed evidence for long-range synchronizations between widely separated brain regions during cognitive tasks has also been found". (Thompson,Varela, 2001, p. 418)

3. The matter of the question….

From the comparative analysis of two models of research comes out the hypothesis of the existence of a cognitive unconscious that does not coincide, point to point, with the affective unconscious.

Already Piaget, in 1973, wrote on this topic in an article titled "The affective unconscious and the cognitive unconscious" which is the text of a lecture given in 1970 at the American Society of Psychoanalysis.

In that article, written with the intent of establishing a link between psychoanalytic theories and the theories of intelligence, Piaget shows that while the subject, both in cognitive and affective context, has a relative and partial consciousness of the results of affective and cognitive processes, he does not know why instead of his intimate feelings nor their source nor the because of their intensity.

In summary, the cognitive structure is a system of connections that any man can use, but this does not reduce or restrict the content of his conscious thought which is binding on certain forms rather than others, and this happens in a succession of levels of development of unconscious whose origin can be traced back to the primitives nervous and biological coordinations. The cognitive unconscious consists, then, in a set of structures and operations that the subject ignores, except for the results.

When Binet enunciated this truth by saying that "The thinking is an unconscious activity of the mind" had, therefore, good reason to call it so. He wanted, in fact, say that if "I" is conscious of the content of his thought, he does not know, however, nothing of the structural and functional reasons which impel them to think in this or that way, or, to put it another way, the deep mechanism that guides and directs the thought itself. In the case of affective processes, and

therefore energy, the results to which they lead is only partially conscious, it is translated, in other words, in feelings more or less clearly perceived of the subject as real, emotional and actual.

The discourse on the nature of human knowledge assumed a more unique and interesting connotation if, on the basis of the above specified, it is assumed the existence three expressions of the Mind "encysted" in a single dimension of the case, which forms the basis for the "unit/distinction" of the cognitive stages.

It is hypothesized, in this view, the existence of a:

- Phenomenological Mind (semantics of knowing) that answers to questions of "sense";
- Computational Mind (logical syntax of knowledge) which responds to questions of "logic";
- Bio-Physiological Mind (grammar of knowing) that responds to questions concerning human "evolution".

Cogitate is not the same thing as compute. The operations of the calculation result in algorithms that can be processed by any machine capable of operating on the physical symbols (a computer, a brain). The machine computing processes representations following rules that cannot be violated (one of these rules is the logical principle of non-contradiction). In humans, this may be the expression of "Computational Mind".

Some organisms, however, are characterized by the property of possessing different levels of rules: in the lowest level, they are very simple; at a higher level, there are meta-rules, that is, rules of the second level. They consist of the possibility of suspending the application of the rules of the first level in some circumstances. To carry out such an operation must, however, reflect the rules of the lower level. Here the compute takes the form of cogitate.

Cogitate can therefore be defined as the set of operations produced by reflexivity. Reflexivity is a characteristic of the human being and the cogitate is essential prerogative of system thinking. In humans, the quality of thinking is linked to the ability to question the sense of their own position in the world. The sense, in this perspective, is neither in the system nor in the world, but in the relationship that is established between themselves" (Phenomenological Mind) (Minichiello, 1995).

From the comparative analysis of the two methods, it can be hypothesized, moreover, the genetic nature of the human relationship. The biological substrate of the human component (neurons, atoms, etc.) acts, in fact, according to synchronized behavioral patterns (Bio-Physiological Mind).

This conceptual articulation presupposes a unified teaching method (enactive didactic), articulated and harmonized in the three levels of description mentioned above through a dual articulation of learning processes: the "response learning" and the "deep learning". The deep learning is the path that every human being does to maintain its sense unit inside an environment in turn equipped with sense. The purpose of the system is the preservation of their own mental organization (identity) through successive modifications of his own mental structure. (Minichiello, 2003)

4. Conclusion

That having been said, the paideia-society interrelation stands within a paradigmatic vision of contemporary pedagogy like the double–faced Janus, from which a new dimension of man and citizen arises along with a new way of understanding education//educability of the subject-person (Pastena 2011).

It is all about suggesting a new way of interpreting pedagogy where the teaching- learning interaction becomes alternative teaching methodology to the many current practices. No doubt so much uneasiness and failure to achieve success in the schools are caused by the nature and the way of teaching approaches, by an agency that is often too prone to hyper-didacticisms that bring about confusion and disconcert rather than self-orientating enaction. In fact, enaction means understanding learning as the creation of worlds, where the student experiences the didactic action in structural coupling with the teacher.

In short, it is a Paideia that is seen in its atropo-ethical dimension as the hard core that allows interaction (in an enactive circuit) between "sense", "logic" and "evolution".

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