

INCIDENCE OF NEUROSCIENCE ON THE PSYCHOPEDAGOGY RELATION CORPOREITY/ LEARNING

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Review paper

Abstract

The use of Positron Emission Tomography (PET), Functional Magnetic Resonance (fMRI) of Transcranial Magnetic Stimulation (TMS) and Magnetoencephalography (MEG), has allowed to study in depth the functioning of individual neurons or groups of them and has helped to further the knowledge of the central nervous system (particularly the mechanisms by which the brain produces its effects), knowledge that, in the last decade has been a real 'step' forward following the developed capacities of investigation and research through the mentioned new technologies. Nowadays, the experimental research can verify their hypothesis, live and in a non-invasive way, using animals (usually rats and monkeys) and humans (healthy and "clinical" pathologic cases). We could say that, on a theoretical level, the development of neuroscience will lead, hopefully, to revising the classic functionalist top-down model, considering the processes in their emerging complexity. For example, it is correct to state that with this, we are facing the overcoming of the primacy of the "intention" on "communication", as a philosophical mindset that is no longer ante litteram? We answer this question with a reflection that will represent a cultural nature upon which to build the entire study. But the real issue is to clarify what is "mind" for the analysts and what is "consciousness" for scholar of phenomenology and, respectively, what are the "mindset" and what an "act of conscience" is. They are in no way two synonymous.

Key words: neuroscience, neurons, knowledge, conscience

Introduction

The use of Positron Emission Tomography (PET), Functional Magnetic Resonance (fMRI) of Transcranial Magnetic Stimulation (TMS) and Magnetoencephalography (MEG), has allowed to study in depth the functioning of individual neurons or groups of them and has helped to further the knowledge of the central nervous system (particularly the mechanisms by which the brain produces its effects), knowledge that, in the last decade has been a real 'step' forward following the developed capacities of investigation and research through the mentioned new technologies. We could say that, on a theoretical level, the development of neuroscience will lead, hopefully, to revising the classic functionalist top-down model, considering the processes in their emerging complexity. David Hume in his Treatise of Human Nature, in the Anglo-Saxon area with the term 'mind', intends the collection of states of mind or functional to human beings, in opposition to the Cartesian dualism and especially to the concept of *res cogitans* as a thinking substance of an intangible nature. If Descartes supported that the essence of mind is the thought - not "this" or "that" thought, but the thought in generally without content (*Cogito*), for Hume this is totally unintelligible,

because everything that exists is particular and therefore are our different perceptions, with their insuppressible peculiarities, that constitute the mind (Ausubel, 1968). Is the scholar Daniel Dennett (Berthoz, 2000), heir of the Humana tradition that has replaced the "Cartesian theater" of the one flow of consciousness (in which all converge in an orderly and sequential way) with the theory of multiple versions that is multiple channels, in a sort of serials as a functional succession of coalitions of specialized and interconnected circuits? If we reflect and compare on the lived issue of mind-body that informs, now, the almost totality of the contemporary epistemology in the analytical research area, that intersects the cognitive science and neuroscience, we are increasingly distant, to the metaphysical concept of soul that is, in fact, more and more in disuse in the West that has philosophically produced, prepared and articulated it (Buccino et al., 2004). However, the question that we have to ask is: In what measure is a sharing between sensory-motor system of humans and robots needed, so that it is possible to create machines that communicate with us, or that reproduce, simplifying, some characteristics of the cognitive activity of human beings?

This is a radical challenge that wants to make people think. One of the primary characteristics of living bodies, in fact, is that they are autopoiesis (examples of self poetic models in morphogenetic systems have been proposed by Cummings (2001). Using this term in a classical and deep sense that has been proposed by Maturana and Varela (1980), the body can often be ill, but also often able to cure its-self, to heal. Bodies have the proprioception, the self-awareness. Bodies have physiological needs. Bodies have emotions. There is a whole inner life that makes the body a system that produced itself and allows the deployment of key characteristic of any living systems that is the maintenance of its organization, the preservation of a relational system that defines it as a systemic unit. The main principle that should be saved is that the body is a frontier, always under construction, between interoception and proprioception.

Methods

1. Embodiment and situatedness

Embodied or situated cognition? However, it is important, for us, to point out some aspects in order to understand better how to take advantage of these discoveries as well as how to avoid an inappropriate use and/or distorted cultural spreading (Gallese, 2007). If criticisms brought up by some psychologists, conceive neuroscience and in particular the techniques of the brain scanning, as a new phrenology (Cummings, 2001), appear to us immoderate and inadequate, it is still true that the evidence received through brain imaging is in correlation, and not causal. It is not enough, in our opinion, to identify which neural areas are activated to deeply understand and possibly justify mechanisms that regulate behaviors. Moreover, the risk of adopting a non critical approach of pure location functions or forms of phrenology more or less explicit is always around the corner, In other words, it is not enough to focus on showing that a specific process corresponds to a particular pattern of neural activation. It is important to consider not just the correspondences, but the underlying mechanisms not only about where, but also why (Lakoff & Johnson, 1999). Reflecting on the recent discovery on mirror neurons, which highlights the identification of a powerful mechanism that can be called, sometimes discussed, "motor simulation" (Damasio, 1994; Jeannerod, 2007; Gallese, 2007). However, this hypothesis and discovery suggests an urgent need of intermediate models of applied translation, a conversion of neurological brain structures as well as related mechanisms about phenomenological evidence, that should have the function of filters that

connect the dynamic of the body and the space where the bodies live and die: a space that we can not forget, culturally and socially perceived and constructed. Only in recent years a new perspective has emerged, the embodied, that considers not only the neural processes, but the fact that organisms have a body as well as a brain, that the mind is not something separated, but that the cognitive processes are based on sensory-motor processes. Only in recent years, in many fields the fact that cognition is not elaboration of the information, but it is movement and action has been underlined. Now, it is necessary to look whether it is sufficient to consider the body as a situated device of action or, as we think, configuring this vision according to a constructivist perspective in the educational and didactical field, a more complex element (Jeannerod, 2007). In technical terms, embodiment and situatedness, are connected. Cognition is not only embodied, but also situated, variable, contextually determined. Our body is our first setting, the first element of determination.

2. From mirror neurons to embodied cognition

The emerging vision of concept of embodied cognition considers the cognitive processes deeply rooted in the interaction of the body with the world. This aspect, according to the reading of Margaret Wilson of the University of California, of Santa Cruz, currently holds very different versions, some of which are more controversial than others. We distinguish and value the following six options: 1) cognition is situated; 2) cognition is subject in the time; 3) we reduce the cognitive workload through the environment; 4) the environment is part of a cognitive system; 5) cognition is for action; 6) self-cognition is based on the body. Of these, the first three and the fifth appear to be partially true, and their utility is better evaluated as a range of their applicability. We state that the fourth version is very difficult. The sixth version has received less attention in literature about embodied cognition, but it may be, in fact, the best documented and most powerful of the others. It has been shown that neural networks are capable of adaptation and learning, so that an important and comprehensive study about the activity of their circuits has been prevented by the complexity of networks of mammals.

The plasticity of the networks can be defined as the modeling of the morphology and function of the networks induced mainly by experience. This process is based on the complex changes, and it depends on the activity of neurons, which modulate the capacity of neural network to transfer, to process and to store information (Gallo, 2003).

After the first period of genetically determined development, the neural circuits are continuously changed and shaped by experience (epigenetic development). Therefore, synaptic connections that are slightly used are weakened, and they disappear while those synapses that are used frequently grow stronger and eventually grow in number. Synaptic efficiency can be very varied and on a scale of variable time, from a number of factors, including previous network activity, the generation of second messengers, functional changes in pre and post - synaptic proteins, in addition to regulating the expression of genes involved in growth, in survival, and in synaptic transmission. This aspect results in changes of efficiency of synaptic transmission that can last from a fraction of seconds to minutes in the case of synaptic plasticity in the short term, up to hours, days or months in the case of synaptic plasticity in the long term.

These changes profoundly affect the processing of information between the input and output of the network, and at the end they shape the flow (Gallese, Fadiga, Fogassi & Rizzolatti, 1996). Schematizing the key points of the new neuroscience studies to reflect on the possible repetitions in the context of teaching, particularly on the relation between corporeity and learning, we can consider the following important points. 1. Studies of LeDoux sustain that the changes in synaptic connectivity underline learning and the memory represents the consolidation of these changes in the time "when the weak and strong input toward the cell are active at the same time, the stimulus weak results to be strengthened for its association with strong stimulus" (LeDoux, 2002). 2. The theory of Giacomo Rizzolatti in which it shows that mirror neurons are in a group of neurons that are selectively activated when an action is done and when we observe it while it is performed by others. The neurons observer reflects what happens in the mind of an observed person if the observer does an action (Rizzolatti & Sinigaglia, 2006). 3. The theory of Gallese on Embodied Cognition speaks about a notion of knowledge that has its roots in the states of the body and specific systems of our brain, underlining the important role of sensory-motor system in the representations and in cognitive operations (Gallese & Goldman, 1998). A study about mirror neurons, the theory on the evolution of language proposed by Rizzolatti & Arbib (1998), the discovery about audiovisual mirror neurons (Kohler et al., 2002) and a discovery about mouth mirror neurons (Ferrari et al., 2003) laying the foundations for a new research that wants to investigate the involvement of the cognitive linguistics activity in the understanding of the action.

But what does this idea mean for the world of education? And specifically, what do these neuroscientific theories imply in the dynamics of educational relations in the didactic field? In fact, the discovery about mirror neurons, helped to revisit the way of considering the relationship between action, perception and cognitive processes, and it is about this point that the meeting with didactic thought the phenomenology of perception (Merleau-Ponty, 2002). It means that when we are about to carry out an action, we are also able to predict the consequences. This type of prediction is the result of activity of the model of action. If it were possible to establish a process of motor equivalence between acted and perceived, for the activation of the same neural substrate in both situations, a direct form about understanding of others actions would be possible. It is useless to deny the significance of this relapse in within education. It is worth remembering that Alain Berthoz was a scientist who supported the proactive role of the brain, recognizing in the movement not only the physical form and dynamic of action but the instrument that approached to a 'sixth sense' for the ability to anticipate the action (Berthoz, 2000). In order to perceive an action - and to understand its meaning - therefore, is to simulate it internally. Therefore, the Neuroscience sciences, to contextualize their research, requiring the contribution of human sciences, a contribute, that with what is stated by Maurice Merleau-Ponty, we fully agree. In fact, he asserts that the need to find 'the origin of the object in very heart of our experience' (Merleau-Ponty, 2002). For the fourth point, in particular, many studies have been carried out in order to understand how the conjugation of verbs in the future and past times can be related to motor representations required driving a movement of upper limb respectively forward or backward, referring to studies conducted by Boroditsky (2000), by Richardson et al. (2003) and Buccino et al. (2004) concerning the representation of space and time (Buccino et. al., 2004). In this connection, a pilot experiment was carried out involving 18 subjects that required a decoding semantics of verbal stimuli presented acoustically to conjugate a verb in the present, in the future and in the past, and a behavioral response involving a movement of limb forward or upper. In the pilot experiment, the analysis of results was made using analysis of variance (ANOVA) considering as factors in the groups, the past, present, and future time, movement forward and backward movement, and how the factors between groups movement and time. A tendency for subjects to respond more quickly in the execution of movement forward associated with a verb of motion of the hand conjugate in the future was highlighted.

The greater reaction time for made movements by forward persons following the presentation of the verb to the future is related to the direction of the movement: the subject is facilitated when called to carry out a movement that goes in the same direction as the movement evoked spatially by the presented verb. In this experiment, the acoustic stimulus the motor priming that modulates the response, because the person hears the verb and has the time to discriminate it and understand it before it receives the stimulus of the arrow/indicator indicating the direction of movement possibly that must be done. The innovation made by the results of this experiment resides in the modulator effect on the motor response exercised by an implicit representation of the movement implied in the cognitive processing of the time in which the verb is conjugated. In fact, the stimulus presented by us explicitly does not show the reference to the direction of the movement to be carried out in response, unlike the studies conducted up until now (Buccino et al., 2004), in which the phrases-stimulus reproduced explicitly actions of movement of hand and foot directed spatially. The experimental data appear to confirm that the semantics understanding modulates the motor system in different ways depending on the experimental delivery as well as the stimulus presented to evoke it, but are in the same school of studies that confirm the involvement of the motor system not only the observation of the action, but also in the processing of presented action linguistically, in reading and listening (Gallese & Goldman, 1998).

Results and discussion

1. Neuroscience and Psychopedagogy compared. Learning takes shape.

The mirror neurons map the observed actions on the same neural circuits that control the execution and allow active, therefore, an internal representation, a sort of "embodied simulation" of a particular act real, concrete, be it socio-behavioral, and the language (Gallese, 2005). This would be the neurophysiological evidence that human beings are naturally social, and in this direction should be explained to some disorders such as autism: it might be, in fact, the presence of lesions within the mirror system to not allow the subject to get in touch with the world around town, even from the point of view of language delay. The recent contributions of neuroscience in educational and teaching are beginning to consider the body as an integral part of the time learning as "the mind must not only move from one physical Cogito not in the realm of biological tissues, but must also be correlated with a whole, possess a brain and a body of integrated and full interaction with a physical

and social environment" (Damasio, 1994). Referring to embodiment and corporeity, the dialogue between psychological studies, research, cognitive neuroscience and construction of mathematical models on the one hand, and phenomenology, cultural studies and semiotic language of the other, could now envisage a new era: the creation of intermediate models, as the study of spatial-temporal patterns by which we humans perceive ourselves in a relationship and coordination of body and space between body and objects (Lakoff & Johnson, 1999). We could say with a slogan: neither bottom-up nor top-down, but levels that are the result of a continuous reciprocal translation. Inputs from a stimulating environment can affect in a decisive manner on synaptic formation because, even if they are billion neurons that characterize the adult human brain connected in a specific way, there are, in fact, connections which are ordered and well defined and what is achieved, says Elisa Frauenfelder¹³, is a sort of "Neural Darwinism: the cells are assembled, creating sets, groups of cells, which are repeated thousands of times and tend to compete to acquire the ability to transmit as many replicas of themselves, thus entering into the law of evolution" (Frauenfelder, 2002). In a broader sense, this plasticity is identified with the capability of learning, through mechanisms of synaptic connection and disconnection. The phenomenon of sprouting, which literally means bud, explains how the number of synapses may increase during the first years of childhood, and especially thanks to an environment rich in stimuli, in addition to the presence of critical periods defined by their sensitivity to external stimulation during which the synapses increase (Frauenfelder, 2002). Another element to be considered in the study of the relationship corporeity/learning is to ensure that the emotions affect learning and cognitive processes. From a biological perspective, a part of our brain that is the limbic region and is home to emotivity "is related to the environment through the afferent nerve pathways, which convey to the brain sensations and perceptions and is integrated into the cerebral cortex". Between emotional processes and learning there is a deep connection, since it is usually in an emotional relationship". The educational relationship is existential presence of the educator to the student (Goleman, 2006). Through the paradigm of embodied cognition, then, you tend to learn how to interact as though each other, which allows you to create models of the self / other. According to the model of classical cognitive science, however, the sensory systems, the data of the world, then interpreted and understood by most as cognitive systems.

In this light, the motor system does not represent more than a tool for translating movement in the responses prepared by the cognitive system.

2. Neuro-scientific paradigms and pedagogic codes in the education through the body

Regarding the controversial relation between mind and brain and its undue reductivism, philosophically debated especially in the analytical research of the Theory of Mind, in the last decade has been, as already mentioned, the neurophysiology to make great steps forward and indirectly confirm the phenomenological analysis of Husserl, Stein and Merleau-Ponty about subjectivity and un-subjectivity, up to the point to formulate the need to formulate "phenomenologizing the cognitive neuroscience, rather than naturalizing the phenomenology [...]. A better dialogue between neuroscience and phenomenology is not only desirable but necessary. Future neuroscience research will increasingly focus on those aspects of human experiences and try to give more personal characteristics for the experiences of the individual subject" (Gallese, 2006, b). According to Maurice Merleau-Ponty, eyesight, motility and sexuality are functions that "cannot be connected between each other and to the outside world by causal relationships, but they are all involved in a single drama. "The body is not, therefore, an object, a thing or a fact, and for the same reason, the conscience that we have of it is not just a thought. Whether it is considering the body of others or our own, there is an only way to know the human body: living it, making ours the drama that goes through it" (Merleau-Ponty, 2002). Living it, means also relating to other bodies. The contact, the encounter with others, given thanks to the objectification of otherness: the Leib. Through the presence of many experiences, which flows, we have consciousness; it discloses the significance of the intersubjective relationship, thanks to the medium of the living body. Leib is an essential medium of relation, through a subtle game of perception and apperception that allows the seizing of the body, psyche and spirit of others ego¹⁴. Considering in depth, this aspect regarding the educational science field, the reading of signs that the body expresses in interpersonal relations denotes also a strong connection between emotional intelligence and body-kinesthetic intelligence, this interaction is not limited to a mere interdependence, but expresses an opportunity for cognitive constructions. It should be put before the need of a body that shows coherent signals with a message to be communicated, in the work of the interlocutor, is natural to analyze meticulously whether if the motor semeiotics of the subject addressed and reinforced the

significance of the information that should be transmitted (Watzlawick, Beavin & Jackson, 1967). So, how much and how are they connected, dependent, causally linked to the talent of a clever and what are the conditions and contexts where this bond can possibly be fed and driven to succeed? Gardner defines the body-kinesthetic intelligence as an ability of the body expressing, governing itself, manipulating things, orienting with precision, consistently and effectively respond to the motor difficulties that will occur in the most different ways. But if life, what we are, is it the result of biochemical changes of synapses, (Le Doux, 2002) is the result of our experiences, therefore, of our heritage of knowledge, why should the body not be culture (input), emotion (processing), intelligence (output)? On this postulate there is the cognitive relationship between emotional and body-kinesthetic intelligence and the body cannot be the best cultural vehicle that we have! Awareness of the mechanism of these processes helps human beings to intervene constructively in the complex field of education; where human variables is beyond basic search and points of reference. Clarity and awareness of emotional and bodily interaction as cognitive development, express, therefore, thanks to new neuro-scientific contributions, new frontiers in the field of teaching and supply alternative modality that the community requests us nowadays (Paloma, 2004). The organization of the training action, therefore, must be based on appropriate teaching strategies so that individuals are able to learn with maximum efficiency and build up conceptual networks that allow a construction of a systematic organization of stable knowledge, but open, for this reason capitalizable, of real networks of knowledge, "creating conditions of possibility, both cognitive and affective-motivational, understanding what is new, of a self-learning" (Domenici, 1999). From the perspective of perception and reading that Domenici has about the construction of knowledge, it is interesting to reflect on the influence of new research on embodied cognition. For example, about the full sharing of the need to make the methodological procedures innovative in order to make knowledge a significant aspect, the emotional and empathetic involvement of the pupil, bodily speaking, determines the genesis of new knowledge that becomes more easily grafted on to those already owned (Ausubel, 1968). Knowledge, therefore, must be "systematic, namely represent an organic and consistent set and have a structure within which each element is equipped of senses ... stables, in the sense that they should be able to endure over time, which should facilitate the prevalent use of the functional memory or rather semantic relative to the episodic or

mechanic one, ... of basic, not only in the traditional sense of knowledge, but rather and above all of their recent evolution; ... capitalizable, which allow more than others to whom possess them to use them as intellectual picklock of penetration and mastering of more knowledge" (Domenici, 1999). The suggestion to make the construction of knowledge possible, validated by Domenici, and offered by Antinucci: "there is another way to learn, that does not happen only through the interpretation of texts or through mental reconstruction. It happens, however, through the perception and the motor action on reality. Perceiving an object or an event with eyesight, hearing, touch, intervening on it with my action and that makes a change in my perception, a change that is a function of what I have done and the nature of the object. Since the action is inherently known to me, because I have produced it, the differential perception - the reaction that I see - produces the knowledge of the other term, the nature of the object. This learning is called motor-perceptive, because it is based on experiential cycles of action-perception" (Gallo, 2000). Considering these scientific principles, the basis on which to reflect for new teaching protocols, the commitment of our research group, in this sense, is to exploit the latest neuro-scientific studies on the relationship between corporeity and learning, starting from a scientific paradigm that serves as a theoretical framework to reach the table of experiences proposed and to the spectrum of educational activities that, through the body, respect and enhance the many dimensions of the person. From this perspective, "intelligence is a bio-psychological potential, inducing to assert that there are not general cognitive architectures, but different cognitive architectures. Each of these *formae mentis* works in a "relatively independent way from the others" and is structured and emerges only in contact with certain symbolic-cultural systems, "during daily life these intelligences typically work together in a harmonious way, and their autonomy can therefore be invisible. But when you put on one's appropriate spectacles, the distinctive nature of all understanding will emerge with sufficient (and often surprising) clarity" (Gardner, 1983, p. 29). Research in the field of bio-neuro-science today provides possible interpretations on the processes of growth and on the directions of development of individual potential evolutions in different environmental and the neuro-didactics, giving attention to both the complexity of the individual dimension of human system as bio-dynamic entity in training, that to the consideration of the issues involved in the development of the living reality, follows a heuristic approach and synergistic that do not predefine its goals, but

rules them from time to time, which does not intervene but leads, that does not prescribe but interprets, expressing the own desire to know and respect the person in the complexities of the dynamics of interaction and development (Sibilio & Paloma, 2004). But if the context impact on our education and society today, ready to quantify the amount of experiences, at the cost of going to the detriment of their quality, what has happened to our nervous system over recent years? The diversity and high frequency of environmental stimuli has induced over the years, our brain to revisit the receiving, analyzing, processing and synthesis system, focusing attention and the scientific interest on creativity (Gallese & Goldman, 1998). The concept of mental flexibility, seen as an easiness of adjustment that has, however, a contrast in inflexibility. Most of creative thinking, in fact, requires an organization of ideas according more inclusive patterns. For this reason, a capability of synthesizing is necessary. In opposition, it is possible to think that there is an analytical capacity; this is the reason why symbolic structures must be broken frequently, before building more up (Beaudot, 1969). In defined situational contexts (Gallese et al., 1996), actions with the body and through movement, mean as a link between technical conduction and interactive-symbolic, may represent a tool that contributes to the acquisition of mental flexibility remodeling, in this way the perspective view of life under the scientific and cultural outline. We are therefore facing a circular system that is self-conditioned; the nervous system collects information and the related processing and result of a mix between genetic predisposition of neural cells and the building of new functional connections to the responses to achieve. If this is true, it means that in order to make our processes of life creative, the following is necessary:

1. Awareness and personal recognition valence of daily availability for spending of the creativity in the midst of the relational life;
2. Solicitation stimulus and the related functional perception to the construction of creativity forms.

The body and movement, in our opinion, may, through a series of targeted interventions, to create circumstances and contexts for the "construction" of creative minds, the result of games for the solicitation of motor problem solving. In this concept, it is important to be familiar with the reading of the scholar Pierre Parlebas, that to the term socio-motility, intends the research of an action that shows a behavior, and that behavior makes clear a communication. According to Parlebas "a motor action involves emotions and fantasies of the person that plays, touching conscious and non-conscious plans.

The body that plays is between education of the body, of affections and mind, at the same time using a unique and original form of communication. The action during the game has its significant communication and specific language. A person who plays put in action behaviors that lead to communicational needs and social symbols" (Parlebas, 1989). From this interpretation, it is possible to grasp how the motor activity itself, through the use of the body, requires a cultural deepening and a coherent semantic self-elevation, able to combine to the implicitly shown techniques in the disciplines, methodological and educational elements based on the communication. The technique combination and the communication can be made in connection through the Lateral Thinking of Edward De Bono (1969). Attention to how, therefore, and not only to what, capable of upsetting the traditional educational paths through a reading that is not only in a performative biomechanical key but above all relation communicative. Going deeper into the matter and examining the characteristics of the motor action through the body, the person has to:

- select, interpret the feedback information for self-regulation (feedback);

- make assumptions (advances) on the situation and generate appropriate actions.

This means that, in the circumstances activities (e.g. sports team), the person, other than following "technical" rules to optimize the performance, requires a considerable estimation-motor capacity. This is strongly linked to the ability of interpreting and integrating different internal and external, abstracts and contingent, symbolic, physical and interpersonal levels of information. About this context, the motor action through the body is inserted on two basic levels:

1. socio-relational, referring to an interpersonal and socio-cultural context collocated to a symbolic- interactive level;

2. operational, where there is the intelligent adaptation of the movement to the situations and their manipulations in achieving a goal, is collocated in a strategic and tactical level (Nanetti, Cottini & Busacchi, 1996).

The first aspect, socio-relational, is collocated on a symbolic-interactive level and is represented by an elaboration of the sensorial information that is bound to a semantic dimension and to its rules, so the feed-back belongs to the symbolic categorization level and in alternative to the sensory-perceptive. Gathering a meaning both on expressive and communicative level and exactly:

- on the expressive level, the motor action is configured as complex bodily signals (gestures, postures) that transmit messages, often unconsciously related to attitudes and emotional states.

- on the communicational level, it is a strategy that, in agreement or disagreement with the word, intentionally influences the recipient.

The cultural domain that affects the socio-relational is called socio-motility.

Motor conductions of those who act in a particular activity and / or physical discipline through the body "can be considered as signs where the signifier is the observable behavior and the meaning is the corresponding tactical project" (Parlebas, 1989).

At the moment of the action, the subject releases observable indices by other participants: orientation of the body, position of the supports etc.). Such constellation of signs gives a decoding based on very complex cognitive processes. The motor semeiotics, semeiotricity, was established to describe the complex system of signs directly associated to motor behaviors and differs according to this, a reading semeiotricity of the natural environment (natural indices) and a coding and decoding of the same motor behaviors. Low semeiotricity activities are those that take place in a highly predictable context (cyclic motor patterns) and are characterized by motor stereotypes. High semeiotricity activities are performed in unpredictable environmental situations (motor creative games engines and team games), which continuing sensory-motor and symbolic information decisions, should result in motor adaptation decisions. The second operational level, is collocated in a strategic and tactical level, and is present when the motor action assumes the operational meaning to achieve a target in spatial-temporal, complex and changeable situations.

The adjustment of the motor action to the changing of the situational context requires the collection of motor elastic maps that allows the person to produce, transform and adapt the movements according to the needs of the moment. Such capability requires a mindset which clearly shows the need to always have the "field" cleared of symbolic crystallized structures (Robazza & Bortoli, 1990). If it is therefore, reasonable to think that being creative means acting in opposition to logic, it is understandable even if something happens to make a mistake. Acting creatively means using a logic that does not influence the choices of the subject according to the life styles, according to past experiences, according to the principles and values of the context, but according to the need expressed by the present circumstances. Psycho-pedagogical sciences have enabled and then built up, through empiric experiences and through validated research, a solid bridge between the motor activities and educational and training values, recognizing to the body, a fundamental role of the development of children.

Activism by Dewey and Montessori, and the cognitive approach by Bruner and sensory-motor by Piaget, pluralism by Gardner, emotional approach by Goleman, the metacognitive approach by Ausbel and Novak, have contributed to the enhancement of kinesthetic body-dimension as a basis for all learning and to the recognition of several independent *formae mentis* but interacting, to the reevaluation of an emotional mind able to affect our rationally action and the communication of our emotions, that have affirmed, indirectly, a reevaluation of the motor games, of the various forms of games through the body as tools for training and opportunities for personal expression of subjects (Sibilio, 2007). With the contribution of neuroscience today, it is possible to decline scientific theories that explain the hidden and intriguing physiological and biochemical mechanisms of the nervous system and build up new protocols of intermediation for the contextualization of these processes in the world of human sciences.

Conclusions

As previously mentioned, recent studies in neuro-bio-psycho-physiological, through neural Darwinism by Edelman, the contributions by Damasio and LeDoux, Rizzolatti, Berthoz, have provided interesting answers to science on cognitive and emotional mechanisms, on the analysis of the movement and the surprising anticipation and simulation abilities of our brain, opening new horizons in teaching and education. The value attributed to games and to motor activities makes them as an ideal breeding-ground for the development of the body and action, a 'positive transfer' for the access to knowledge, opening new horizons of the educational doing and new opportunities of teaching. The neuro-didactics approach by Hebb, gives the opportunity to reflect about what is already genetically present in each person, and its adaptability, by seeking a possible harmony between what is innate and how much environment and intentionality are able to determine. Teaching using the body and movement to find a new balance between research and innate characteristics of stimuli are able to penetrate and engage emotionally conditioning system mnemonic. The body becomes the subject for interactive problem solving, for the reworking of alternative or complementary approaches of knowledge, a real engine to support the teaching, "a learning environment in which you can follow a complex route where you can open spaces' knowledge, the know-how and skills' through a participatory learning" (Sibilio, 2002). This wonderful wave of enthusiasm that is manifested in us through cultural reflections on the mechanisms of our deep-mind and their

meanings that are in the daily actions of each of us faces, but at the same time, with the concealed attempt to scientific paradigms rules behavior according to a process biologization of life. This should not frighten us, but simply alert. It is an undisputable fact that these new contributions to neuroscience today - and will even more in the future - provide strong evidence of correlation of the phenomena of life, including education. In this context, in fact, you start to value and use from time to time, the various forms of analog communication, to guide and support, involving the body, gestures, that is where knowledge, our report education in a variety of cognitive forms, creating a learning environment where you enhance skills and abilities potential vicariate and formative, open windows on the world of hardship, disability and, more generally, on how to build success training will give the world the possibility of a total rethinking of educational practices that start with subjectivity, the individual needs of the person from his body-knowledge indivisibility. An approach that should be read as a result of a circle conditioner, now validated scientifically on an international level, which is self and self-respecting subjective interaction between genetics and environment, biology and psychology, between neurology and science education (Sibilio, 2003). And 'our customary end a relationship with a question mark, that is, opens a small gap of a reflective on the subject. The study and analysis of this research was interesting, as already mentioned in the 3rd paragraph, the interpretation that in multiple 21st century is attributed to embodied cognition. Margaret Wilson, it enriches the literature of the concept of embodied cognition, thus opening new horizons for thought and interesting cultural comparisons on relapse in training. She, in her article Six Views of Embodied Cognition, presented the six versions of scientific-cultural concept, commenting in a critical-constructive and assigning values and meanings. In brief:

1. Cognition is situated. The cognitive activity takes place in the context of a real environment and involves, with relevance, the perception and action. (eg Chiel & Beer, 1997; Clark, 1997; Pfeifer & Scheier, 1999; Steels & Brooks, 1995; Beer, 2000, Port & van Gelder, 1995; Thelen & Smith, 1994; Wiles & Dartnall, 1999).

2. Secondly, knowledge is subject to time. We are "the mind on the hoof" (Clark, 1997), and cognition must be understood in terms of how it works under the pressures of real-time interaction with the environment. It is often said that agents located must meet the restrictions of real time or time passing (eg Brooks, 1991b; Pfeifer & Scheier, 1999, van Gelder & Port, 1995).

3. Thirdly, we reduce the workload through the cognitive environment. Due to the limitations on our ability to process relevant information (eg about the limits on attention and working memory), we use the environment to reduce cognitive load. Do you maintain that the environment or manipulate information for us and we collect this information only in accordance with the requirements of knowledge (Kirsh & Maglio, 1994).

4. Fourth, the environment is part of the cognitive system. The information flow between mind and world is so dense and continuous that, for scientists who study the nature of the cognitive, the mind is not only a significant unit of analysis (eg Beer, 1995; Green & Moore; Thelen & Smith, 1994; Wertsch, 1998; see Clark, 1998).

5. Fifth, knowledge is for action. The function of the mind is to guide the action and cognitive mechanisms, such as perception and memory, must be included on their last contribution to the behavior appropriate to the situation (Grafton, Fadiga, Arbib, & Rizzolatti, 1997;

Murata, Fadiga, Fogassi, Gallese, Raso, & Rizzolatti, 1997).

6. Sixth and finally, self-knowledge is based on the body. Even when decoupled from the activity of the mind is confined in the mechanisms that have evolved through the interaction with the environment, i.e. the mechanisms of sensory processes and motor control (Glenberg, 1997; Grush, 1996, 1998; Dennett, 1995; Stein, 1994).

Wanting to summarize, we might say that neuroscience began to reveal the treasures contained in our mind and to explain the origin of our behavior more complex and evolved. Probably the future will give great surprises in the training, but we can and must now rely on two important pillars: the certainty that our identity is defined by the relationship with our fellow creatures and the environment and confirmation that our behavior, subjects and objects of neural plasticity are closely related to the earliest experiences of our life (Wilson, 2002).

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UČESTALOST PRIMJENE NEUROZNANOSTI U PSIHOPEDAGOŠKIM ODNOSIMA: TJELESNOST / UČENJE

Sažetak

Korištenje Pozitronske Emisione Tomografije (PET), Funkcionalne Magnetske Rezonance (fMRI) Transkranijalne Magnetske Stimulacije (TMS) i Magnetoencefalografije, je omogućilo detaljnu studiju funkcija pojedinačnih ili grupa neurona, i pomoglo je u proširenju znanja o centralnom nervnom sistemu (posebno o mehanizmima pomoću kojih mozak funkcioniše). To znanje je u posljednjoj deceniji bilo pravi korak naprijed s obzirom na razvoj istraživačkih mogućnosti kroz nove tehnologije. Danas eksperimentalna istraživanja mogu potvrditi hipotezu, na živim bićima i bezopasno po zdravlje, koristeći životinje (obično pacove i majmune) ili ljude (zdrave osobe i 'kliničke' patološke slučajeve). Možemo reći da, na teoretskom nivou, razvoj neuroznanosti će voditi revidiranju klasičnog vrh-dno modela, uzimajući u obzir procese u svoj njihovoj kompleksnosti. Na primjer, može se reći da s ovim, mi se suočavamo sa savladavanjem primata 'namjere' za 'komuniciranjem', kao filozofskog sklopa koji više nije ante litteram. Na ovo pitanje odgovaramo osvrtom koji će predstavljati kulturnu prirodu na kojoj ćemo graditi cijelu studiju. Ali pravi problem je razjasniti šta je 'um' za analitičara, a šta je 'svijest' za naučnika fenomenologa; i u skladu s tim, šta je 'mentalni sklop' a šta je 'čin savjesti'. Oni ni na koji način nisu sinonimi.

Ključne riječi: neuroznanost, neuroni, znanje, savjest

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