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THE EVOLUTIONARY PERSPECTIVE ON KNOWLEDGE DEVELOPMENT: EMOTION AND REASON FROM ARISTOTELE TO DAMASIO

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Abstract

The analysis of the reason-emotion dynamics intersects several disciplinary fields, such as psychology, medicine, informatics, linguistics, neuroscience, with a specific relevance for Education Sciences, as it offers interesting perspectives over its influence on the learning process.
Such issues are rooted in philosophical reflections by Plato, Aristotle and later by Descartes, Vico and Kant. These dualistic perspectives will be definitively abandoned in favour of a globalist vision of the mind-body relationship, during the first half of the XX century, particularly thanks to Dewey (1933) who, inspired by Darwin's theories, was the first to support this unity by recognizing an intersection among physical, mental and environmental processes. Over the last decades, an imperatively anti-dualistic analysis has been developing in the field of neurosciences and cognitive linguistics: on the one hand, cognitivism, considering the mind in its function of symbolic manipulation; on the other hand, connectionism, studying neural networks. Furthermore, recent scientific research has allowed mapping in a detailed - albeit admittedly incomplete manner - the complex activity of the brain and highlighting analogies between elementary connections and complex interactions. The systemic perspective is hence considering "mind and body", "reason and emotion" as two interconnected and essential aspects of human complexity.
In this regard, Damasio's research shows how participation of the organism to conscious experience returns to the consciousness itself those biological requirements which are essential to legitimate it as an object of scientific study. Knowledge is generated by socio-experiential relationships that play a crucial role within knowledge representation. The mind takes therefore an active role in shaping the representation of the world: understanding does not just consist in a mere reproduction of the external world in our mind; instead, it is a continuous process of creative reconstruction of our perceptive dynamics. Emotion, creativity and rationality are essential elements of the human being, which activate and develop due to personal inclination as well as socio-cultural aspects. Both genetic and social components are decisive in cognitive dynamics, as they represent innate potentials that need to be recognized, understood and exploited.
Key words*: emotion and reason, knowledge, learning, neuroscientific perspective.*

Introduction

Those interested in didactics feel the need to find tools of analysis that intersect several disciplines; one may not ignore social and linguistic influences as well as those related to the learning processes. Equally important within the educational process are the relationships between nature and nurture as well as the "knowability" of the external reality and the method we apply to investigate it. Finding out more about the processes of mental dynamics is certainly useful in many fields of knowledge, especially for scholars of psychology or medicine; also, teachers can benefit from this information in order to understand which emotions, interpersonal relations and body experiences can influence a satisfactory achievement of the educational goals. All of these issues are well rooted in Plato and Aristotle's philosophical reflections, yet they have found significant turning points thanks to studies determining the approach to scientific knowledge for centuries.

A relevant contribution that oriented research during the following centuries came from Descartes who introduced in the XVII century – cradle of modern science – a radical division between body and mind in his studies about knowledge. He considers the mind as innate, universal, undifferentiated and proper to the human race. According to Putnam (1988), from pre-Socratics to Kant every philosopher has been a metaphysical realist in his basic and no further reducible premises. By this he meant that they all used to assume the existence of an objective (independent) reality and that the main problem was to identify the right method to understand it. Kant, in his *Critique of pure reason*, declared instead that the intellect does not derive its laws from nature, but dictates them to it. This means that the operation of understanding is not performed on a previously structured reality by portraying its features to different extents; it rather acts and constructs reality by understanding it. This aspect is well highlighted in Piaget's studies, which refer to a cognitive instance able to self-organize and subsequently sort out experience and then reality. To support these considerations we can report that some of the most interesting elaborations, realized by the aforementioned scholars, lie in Giambattista Vico's reflections. In 1725 he wrote *The New Science* where he anticipated essential ideas related to constructivism, such as *verum ipsum factum* (truth stems from doing), dismantling the established Cartesian teaching of the clear and distinct ideas that are evident to the reason, while to Vico truth and production (the doing) are one and the same (Badaloni, 1982). He affirms that the only truth is consequent to the creative activity; hence, the understanding of the world is just a result of its representation. History can of course convey this knowledge, not in terms of a Hegelian evolution but rather in an eastern philosophies' spirit, which profess a return, meant as re/construction rather than as recursiveness.

The only difference with Descartes is that the mind is no longer considered as an indivisible *unicum*; it has indeed a wide range of functional structures with specific elective competences of every single module. On the other hand, another French scholar, de La Mettrie, considered the mind as a body's property and consequently the brain as the seat of thought (de La Mettrie 1968).

Only after the beginning of the XX century, Dewey, inspired by Darwin's theories (Corbellini, 1991), will affirm that both physical and mental processes are the expression of the same biological organism, which makes them adaptive to the environment (Dewey 1997). This is considered a globalist vision of the mind-body relationship.

Cognitivism and Connectionism between Mind and Brain

Recently, in the fields of neurosciences and cognitive linguistics, connectionism has been developed, in a decisively anti-dualistic perspective. Sticking to computer-themed metaphors, this perspective considers hardware and software as two inseparable elements influencing each other, where software (the mind) is constructed through the involvement of hardware (bodily experience).

The main points of criticism against the computer metaphor highlight that computers operate in an expansible environment by using non-ambiguous symbols that belong to the digital language, whereas the human brain operates through analogic signals, which can therefore assume ambiguous and variable meanings. Such signals we provide with a specific meaning according to the context, thus elevating them to the status of symbols, referents of the external reality in arbitrary correlation

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to it. However, cognitive sciences tend to divide their paths of analysis according to different approaches; on the one hand, cognitivism considers the mind as a manipulator of symbols; on the other hand, connectionism considers the brain as a set of neural networks that produce physiochemical effects in their exchange of quantitative information. For a clearer understanding of these concepts, we may compare them to the hallucinating state of mind provoked by drug assumption. Cognitive scientists believe the brain to be composed of modular structures that process specific information in an elective manner (the visual module processes images) and transfer it interactively to other modules for further processing. The modules are pre-existing (innate) and encoded in the genes but also the result of adaptation processes (evolution).

It is to clarify that among cognitivists, although there is a common belief of innatism, we can also notice a gap when dealing with the presence of the selective function of evolution.

To Pinker, the mental structure is modular and innate: the modules are present since the beginning of life and grow over time, regardless of the educational-social function. For instance, at a certain point of life people experiment accelerated sexual growth and increased sense of maturity (Pinker, 1994); to Fodor, instead, the mental structure is modular but not innate (Fodor, 1988), contrarily to what stated by cognitive innatist Chomsky, who affirms that language is the result of specific evolutionary compulsions. Everything is kept, according to these hypotheses, in the genetic codes. Conversely, Karmiloff-Smith believes that genetic coding, although present, is marginal and that these dynamics intertwine among genetics, growth and experience (Karmiloff-Smith, 2000).

Connectionism is by roots anti-innatist, though we can hypothesize with Elmann and his students a path that does not exclude this important component related to the genetic hereditary aspect and that is not limited, contrarily to cognitive psychology, to indicate what is hereditary, but that rather defines spaces and modes of interaction between what is innate and what is learned (Elmann, et all 1996). They accept the existence of innate elements like neural architecture, connections, development, but they also try to understand the role that the aspects of learning as well as evolution of the species play, including the genetic recombination achieved through parents' coupling. Thanks to this research hypothesis, called "evolutionary connectionism" it is possible to take into account the evolution both at a population level and at an individual level (through a learning process).

To clarify the analysis so far, we can affirm that the main schools of thought are based on the one hand on cognitivism – which considers the mind as innate, modular and manipulator of symbols, like a computer, on the other hand on connectionism, which refers to the mind as a non-innate and non-modular system exchanging physiochemical interactions within neural networks. A further evolution of connectionist thinking sees the mind both as a network and as modules, focusing on the interaction between evolution and learning. However, although no one has ever been able to see a mnestic engram (given the extraordinary complexity of the single morphological changes distributed in neural cells, submerged in turn in an infinity of different synaptic connections) it seems possible nonetheless to agree with the hypothesis comparing the nervous system to a spectrum analyser, distributing the density of occurrences of complex information the way a holographic recorder works. Human beings could never adapt to the environment they live in, had they not in their hereditary programme a cognitive system already set up to face the most significant experiences of their psycho-mental life. According to the spatial model of the cognitive system, the places of the mind are the differential sites of all the faculties of intelligent behaviour, of their skills and hemispheric localizations. What remains is to analyse the relationships between modules and their interconnected functions. The concept of modularity is thus emerging more clearly, as it seems much more credible that the brain be organized in such a way rather than as a postulate of a theoretical construct (Oliverio et all, 1996).

Emotion, Reason and Learning a Neuroscientific Perspective

Research in the field of neuroscience and biotechnology has given significant contribution to the investigation about the functioning of mind and brain, allowing mapping, in a detailed albeit incomplete manner, of the complex activity of the brain, and unveiling analogies between

elementary connections and complex interactions. According to this systemic perspective, "mind and body", "reason and emotion" are part of the human complexity and nothing can be taken for granted. About this aspect, Damasio's research tells us that «the idea that the body's involvement in the conscious experience breaks with a tradition that wants the mind well distinct from the body and returns to the consciousness those biological requirements which are essential to legitimate it as object of scientific study» (Damasio, 2000, p. 82). We can start then by considering the mind in its active role within the shaping of a model to represent the world, which means that understanding does not consist in the repetition of the experience or in a mere reproduction of the external world in our mind; instead, it is a continuous process of creative re-construction of personal perceptive dynamics. Constructivist epistemology shows us that knowledge is generated by socio-experiential relationships and these play a key role in knowledge representation. Ausubel, for example, affirms that it is all about harmonizing the construction that the subject has made in determining his mental models with what is continuously proposed by the reality, in order to integrate/modify what has been learned (Ausubel, 1998). The difference between the two intelligences – emotional and rational - is commonly accepted. It is a distinction based on the fact that emotional knowledge precedes and organizes what is generally defined as rational or cognitive knowledge and that emotionality is to be located outside consciousness and does not respond to the laws of rationality. While the language has a clear and direct correspondence with the conscious status and has a sequential nature, the non-verbal system, made of representations and sensorial/somatic processes, does not follow a linear path and is more difficult to evoke.

More specifically, it is very unlikely that the emotional dynamics could deliberately and directly be brought to an investigable level; sometimes they use indirect paths of analysis, such as those of dreams or pathological behaviours. Recent neurophysiological studies have demonstrated the central role of emotionality to lie not only in relation to the learning process but also to trivial behaviours. Any decision, even standing up, would take an amount of processing time much longer than is needed. Thus, the mind is no longer considered as acting according to an algorithm, but is closely and inextricably dependent on the body and its experiences. It is here that Damasio takes action against the Cartesian hypothesis of the dualism body/mind, portraying understanding as widespread and interrelated between mind and body. The mind is therefore constituted as a result of stratifications intertwined with innatist dynamics and everyday experience, unconscious memory and automatisms which derive from a thick psychogenetic evolution, characterized by layers of joints and branches with a strong component of stabilization, flexibility and adaptation.

Damasio's hypothesis claims that the processes we recognize as dominated by the reason actually receive a great contribution by the emotional component, which is shaped by our experiences. This acts automatically and constitutes, in a unitary process emotion/reason, the adequate conditions to give immediate answers to the multiple questions that fill our brain, which require multiple and fast behavioural as well as linguistic responses. For Damasio (2000), the emotional experience, defined as "symbolic/non-verbal" causes over time an "emotional/somatic intelligence" that allows us to automatize tasks without needing mental processing. This operation is called intervention of somatic markers (Damasio, 2000, p. 246). They would be somatic, being them consequent to body experiences, both at a visceral and at a non-visceral level; somatic markers would mark the neuronal cells in charge of preceding and leading the decision-making process. The somatic marker belongs then to the field of experience and intervenes in mental processes in terms of sensations. It may be determined as an automatic pre-alarm that warns us against possible errors, based on experience. Our mind, in fact, creates a storage of images generated from the situations we face every day. Against this alarm bell, automatically activated by the "somatic marker" (Damasio, 2000, p. 247), the higher reason intervenes. It is composed by logical-rational processes that allow to choose among a very small number of options, those pre-selected by the marker; at this point, we can opt for the best solution after a cost-to-benefits analysis.

This "experiential/emotional memorization" automatically intervenes every time decision making is needed, even if elementary, by sending a positive or negative signal which is anchored to a previous and related experience. Somatic markers reduce the need of a selection because they offer an automatic detection of the components of the scenario that are most likely to be relevant. The association between cognitive processes and the so-called "emotional processes" should then

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be apparent (Damasio, A. 2000, p. 123). According to Damasio, in most of our decisions there is an automatic intervention of the somatic markers that can act together with the reasoning, allowing hence a fast exclusion of the most probable negative choices and favouring the possibility to choose among a few opportune options. These emotions and feelings are connected through learning, expecting future outcomes of certain scenarios (Damasio, 1994, p. 245). We can infer that our experiential baggage, consisting in memory, bases its operative mechanism on constant reminders of related emotional memories, which make us sense whether the actions we are about to undertake will be opportune for us or not. It is likely that previous emotional experiences tend to become mnemonic operating schemes that come to support decision-making: a sort of soft continuous survival instinct. Operating schemes, credibly, are stored through images. Somatic markers find their *raison d'être* in the roots of the feelings generated by secondary emotions and, as previously seen, they operate a first selection leaving room for the rational decision at a further step.

Thus, it results that the apparatus of rationality is not independent from that of biological regulation, and that emotions and feelings are often in a position to influence our beliefs and our choices, strongly and without us knowing (Damasio, 1994, p. 98). This is a problem that involves personal and social choices that assume a high level of uncertainty and that are relevant to our future but also to our daily lives as well as to our psychological well-being, as they help to manage our daily life but are projected in our future. The interaction between emotion and reason is also based on neurological experience. Damasio himself, in order to demonstrate his thesis, recalls the clinical case of a railway worker who, after having his frontal lobe pierced by an iron splinter, had radically changed its emotional/relational behaviour. (Harlow, 1848 pp. 389-3939).

Hence, emotion, creativity and rationality are essential elements of the human being which activate and develop due to personal inclinations as well as socio-cultural aspects. Both genetic and social components are decisive in cognitive dynamics, as they represent innate potentials that need to be recognized, understood and exploited.

The understanding, as a source of emotions, allows us to clear our mind and to go beyond the boundaries, to overcome formalisms, labels, stereotypes as well as to activate a boundless "emotional intelligence" (Goleman, 1997) The final result will be a renewed balance between feeling and thinking. Their fusion will allow emotion to cross through knowledge and to knowledge to pierce emotion creating something original, unprecedented and unpredictable but also instantly usable in everyday life. It is also not to be underestimated that the emotional experience plays a key role in the construction of mental patterns operating behavioural learning. This learning builds what scholars have defined "implicit memory" (Siegel, 1999). For instance, if a child gets burned when touching a hot surface, the next time he will not need to develop a conscious (rational) process such as *if I touch this, I get hurt*, it would be too late then. Instead, a neuronal signal springs and generates a pre-rational automatic emotional response; we might also call this survival instinct, since the implicit memory activates independently, without first having to recognize all the past experiences related to the current action (Squire et all, 1993, pp. 453-495). At that moment, it is not important to know that we are going to get burned in order to think it will be a painful experience or to remember how unpleasant it had been previously. Only afterwards, the process of re-categorization of the experience will activate in terms of awareness and traceability.

It is a mental mechanism defined Hebb's axiom: it says that neurons which are excited together a first time will be predisposed to redo it later. The term predisposed is the word that well defines Hebb's statement and tells us that implicit memory is made up of neurons that are connected in networks, so by preserving the memory of an earlier significant experience they tend to automatically activate when dealing with a similar experiential situation. These neuronal connections are called Hebbian synapses and play a crucial role in the learning processes as well as in behavioural operators (Hebb, 1949).

We are dealing with unaware mental networks, because we are talking of experiences that become forgotten as a specific memory but stay active as structures and neural networks, which automatically intervene in determining our behaviours and choices without actually deciding how we should behave. The place where these structures constitute is the amygdala, the part of the brain that activates as first after the baby's birth, which performs a crucial, even exclusive, role in

the brain activity for the first 24 months. The amygdala is located deep within the phylogenetically oldest part of our brain and is the elective place of emotional management. In cases of surgical removal of this part – it may happen for chronic epilepsy - the subject loses the ability to evaluate the emotional aspects of the events and this may cause an alteration in the management of love, fear, anger, tears, amongst other things. Somehow the amygdala represents the place of mediation between the external world and the cerebral cortex, which is the seat of rational thought; before it can activate to understand what is happening, the amygdala can act independently preventing us from taking risks and putting the cortex in the position of evaluating what to do. In fact, while higher cortical areas act in areas affected by the experiential event, the amygdala is constantly active on all activities with a greater or lesser intensity depending on the greater or lesser emotionality of the experience. The Latin maxim aphorism *primum vivere deinde philosophare* well sums up the basic activities of these two brain structures.

It is safe to say today that the amygdala is the anatomical site of neural networks where the implicit memory works and it represents the first form of experience recording - the only possible memory at birth and for the first 24 months of life, as it happens in the subcortical structures of the brain. The amygdala, basal ganglia, limbic system has already developed at that time. It activates with the sensory experience of the environment and does not come with conscious remembering. It is structured as long-term memory and contains the basics of several kinds of learning: in the case of those related to basic motor experiences is called procedural. It is always emotional memory, meaning that it is determined and determines the emotional quality of the experience; it is a function of the mind that stays with us for as long as we live, and is plastic – that is, capable of transformations (Cassoni, 2004). Thanks to the studies of scholars such as Antonio Damasio (1994), Squire (1993), Schacter's (2001) and LeDoux's (1996) an awareness regarding the central role of the amygdala has developed. What these studies have shown is that we are talking of anatomical and functional structures already present at birth in every single animal organism, but the overabundance of neurons in the brain allows the socio-relational intervention to build structures of neural networks that are context-oriented. The operation involves many neurons made up of groups of cells whose amount varies according to the stimulations that they receive, involving hundreds or even several millions of them. It is a kind of Darwinism applied to neurons; those that are used strengthen and consolidate according to the level of the emotional experience along with is reiteration, those that are not remain dormant and might even die (Edelman, 1987).

This means that the development of the brain, particularly with regard to perceptual categorization and memory, does not occur in terms of pre-existing structures; instead, we are dealing with organized and self-constructed structures according to experience. About this theory, Edelman has developed the Theory of Neural Groups' Selection, which states that the starting point is the observation that every new-born organism happens to live in an unlabelled world, not previously discriminated between objects and events. It is therefore necessary for the body to develop, through its activity within the environment, the information that enables such discrimination. The labelling occurs because of a behaviour that leads to particular selective events within the neuronal structures of the brain (Edelman, 1989, p. 63). According to this evolutionary perspective, all the information coming from the outside through the senses and neural structures is sorted by the thalamus towards two directions, involving on the one hand the cortex for rational and conscious responses, and on the other the amygdala, which decides whether to accept the information or not, if it represents a danger according to past experiences stored in the implicit memory. If that is the case, it resolutely intervenes to inhibit every decision-making process.

LeDoux (1996), in his research, has shown that the amygdala's decisions always take precedence and are much faster than those of the cortex, which is consequently forced to suffer its decisional effects.

Conclusions

What has been said so far highlights the crucial role of emotions and their relative control centres, in other words the close relationship between learning processes - particularly those experiences at the early childhood - emotionality, rationality and psychophysical well-being. Therefore,

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understanding is a way of both feeling and living: feeling the world and ourselves, and living that can be observed, shaped, reorganized. Between thought and emotion subsists, as we have seen, a close relationship, and both carry out an important work in decision-making; we should hence avoid - as many scholars here mentioned have been doing - to place emphasis on one or the other aspect. It would be better to make the two elements harmoniously live together, being both of them decisive in our choices. The art of understanding thus relies on the right balance between emotion and reason. While the rational behaviour is commonly accepted and we are constantly asked to stick to it, the education to emotionality awareness is less practiced, and even often repressed. We hypothesize, in the light of these considerations and of the studies cited in this work, that the current teaching approaches should be deeply reviewed, as they frequently give priority to rationality, neglecting that the learning processes should not be separated from the emotional-bodily ones.

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