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The new forms of embodiment between philosophy and cognitive neurosciences

Abstract
The term "embodiment" is normally used as a generic label to indicate a series of new approaches in the studies of mind. Focusing on the common grounds of these approaches, we will analyse the core meaning of "embodiment", highlighting its intrinsic interdisciplinary attitude. More specifically, we will focus on its connection with the evolutionary perspective as well as the cognitive and relational neurosciences. We will therefore underline the highly heuristic value of embodiment as a neuro-biologically grounded epistemological paradigm for the study of the mind.

Keywords
Embodiment, Cognitive neurosciences, Neural plasticity

As far as philosophy of mind and cognitive sciences are concerned, the term "embodiment" is normally used as a generic label for a new series of approaches to the study of mind, which have been developed since the 1980s. Those are the so-called "4E cognition" approaches (namely the "embedded", "embodied", "enacted" and "extended" mind), which, although sharing a common conceptual ground, are slightly distinguished one from the other (Caruana and Borghi 2013). Focusing on their common conceptual ground, our aim is to explore the theoretical principles of embodiment, in their distance[2] from the computational view of mind and in their deep neurobiological roots. Indeed, computationalism has had an enormous

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[2] It is actually quite difficult to delineate the theoretical distance from the computational view of mind in a univocal way. Indeed, a lot of interpreters tend to find a conciliating proposal between the first and the second generation of cognitive sciences (see Clark 1997). It is our opinion that the great value of the embodiment lies in its capacity of liaising with the traditional approaches to the mind.

diffusion and acceptance since the second half of the 1900s, establishing itself as the reference paradigm for mental sciences (Marraffa and Paternoster 2012, Clark 2001). The proposal of embodiment, instead, is to confer more and more importance and relevance to the roles of brain, body and world in mind studies, emphasizing a naturalized conception of mental phenomena. This vision avails itself of the endorsement of several distinct research programs such as the evolutionistic perspective (Laland *et al.* 2000), the dynamical-system theory (van Gelder and Port 1995) and, above all, the neuro-scientific studies on neural plasticity (Changeux 2012, Huttenlocher 2002, Doidge 2007, Merzenich 1998), that have contributed to strengthen the intrinsic openness of the embodiment, so to have a suitable inter-multi-disciplinarily attitude. In this paper we will present the heuristic value of the epistemological paradigm suggested by the embodiment view for the study of mind in general.

1. *The theoretical framework of cognitive embodiment: forerunners and inter-disciplinary contributions*

In order to analyse the theoretical principles of embodiment, it will be appropriate to define, first of all, its theoretical framework, its conceptual predecessors and the interdisciplinary contributes which, in our opinion, enhance its value in the current state of mind studies research.

Cognitive research, as it is widely known, has always been tightly linked to the computational-representational paradigm for the study of mind, based on the mind/computer metaphor, namely the idea that the mind could be thought of as the software and the brain as the hardware of mental phenomena. This thesis, as well as the multiple-realizability one (Putnam 1967), has contributed to the message of a deep dualistic distinction between the mind and the brain, supporting the classical "metaphysical abyss" between mind and body.

The distance between classical cognitivism and the so-called "second generation cognitive science", in which the embodiment view has spread, can be mainly found in the more and more frequent adoption of connectionist models of explanation and in the development of AI starting from the 1980s (Clark 1997 and 2001). Both these latter approaches convey the idea that cognition could be distributed rather than centralized. Simultaneously and thanks to the diffusion of

neuro-imaging techniques which have first made possible the monitoring of *in vivo* brain activity, cognitive neurosciences have become leading disciplines in the comprehension of mind (Morabito 2008).

Along with this vertical expansion of neuro-scientific studies[3] of both brain and body, through the realization of the former being part of the latter, there is also a horizontal spreading into the world (Marraffa and Paternoster 2012). The precursors of this movement could be singled out in the ecological psychology of James Gibson (Gibson 1986) and in the situated robotics of Rodney Brooks (Brooks 1991). The former, with his theory of affordances, recognized the central role of perception within cognition, arguing that there is no mediation between such perception and action itself: perception is direct and picks the features that have an evolutionary value for the agent out from the environment. The latter, working on the construction of mobots, which are characterized by the absence of centralized control, conveyed the importance of environment in transmitting information to a robot that can easily move within it (Brooks 1991, Clark 1997). There is also an eminent philosophical tradition, addressing perception as a key component in the comprehension of mental phenomena, especially in phenomenology. As a matter of fact, it is no surprise that Varela, Thompson and Rosch (1991), influential forerunners of embodiment studies, were inspired by Merlau-Ponty's thought. Nevertheless, for embodied cognition not only perception is crucial, but also movement has its relevance, as the American pragmatism has always shown, arguing that every mental act carries out a specific function for the agent (Mead 1934, Shook and Solymosi 2014).

2. *The theoretical proposal of embodiment*

The theoretical proposal of embodiment could be synthesized in the following points:
1. the refusal of classical cognitivism (at least in its radical form) and of the mind/body duality, in favour of a vision of mind as embodied in the structures/functions of the organism and embedded in the environment;

[3] Namely the increase of neuro-scientific studies.

2. the refusal of the sensorial input-internal computation-behavioural output sequence, in favour of the perception-action cycle, sustained by the sensory-motor paradigm;
3. the refusal of the metaphor of the brain as a computer, in favour of a conception of distributed cognition.

Nevertheless, in our opinion, it would be misleading to define the theoretical proposal of embodiment only in opposition to classical cognitivism. It would be inaccurate not to display its innovative contents and, simultaneously, its ability to keep the classical approach to the study of cognition and mind in consideration. Establishing thus an active dialectic with the tradition, the embodiment view intervenes in the contemporary historical and epistemological debate on the nature of the mind as one of its main actors.

2.1. *Situated cognition and the mind-body problem*

Embodiment is based on the assumption that cognition cannot be conceived in an abstract way but, on the contrary, has to be situated. The mind is inextricably tied to the brain: there cannot be a mind without a brain, but the former does not coincide with the latter. The brain is firstly a body-control organ and therefore the mind needs the body, totally discrediting the brain-in-a-vat mental experiment (Putnam 1981), which is commonly used to show how our brain happens to be the only responsible factor for the understanding of our mental phenomena.

There are several forms of embodiment, more or less radical, entailing different grades of involvement of the body in cognitive processes. In a paper on social cognition, Goldman and de Vignemont (2009) provided some possible definitions of embodiment, each one of which interprets a specific notion of the body: the body anatomy interpretation, according to which the body has a casual function in cognitive activity (our minds are the way they are simply because our anatomical structures are the way they are and only a different structural organization of our bodies would entail a different functioning of our minds); the bodily activity interpretation (the body in its movements necessarily implies and feeds cognitive processes); the bodily content interpretation (mental states have mental representations with bodily contents and have a causal role in cognition); bodily format interpretation (mental representation in bodily formats are

causally related with cognition). Concurrently, Rowlands (2010) gives his interpretation of the different meanings of the term "embodiment", focusing on the causal-constitutive relationship in the determination of cognitive processes.

Putting the question of the different possible definitions of the term "embodiment" aside, the core meaning of this view can be identified as intrinsically interwoven with the evolutionary perspective: the development of cognitive functions is founded on the motor and perceptive mechanisms of the body, so that brains like ours have been developing coherently with the evolution of our bodies (Damasio 1994). The body is not detached from our mind: human mind is tailored on human body (Shapiro 2004). As Shapiro puts it:

> Not only is the human mind suited to the human body […] but, in addition, the mind depends on the participation of the body in order to execute its various tasks. […] The point is not simply that perceptual processes fit bodily structures. Perceptual processes depend on and include bodily structures. (Shapiro 2004: 187)

In this conception, the mind is so embodied that it would not even make sense to consider a mind separated from the body, but it could be worth thinking of a unique entity, that is to say the "mindbody" (Morabito 2015). Moreover, the mind is embedded in an environment which shapes it and through which it is shaped. This last point will be analysed further, reflecting on the value of the sensory-motor paradigm in the embodiment conception.

2.2. *The sensory-motor paradigm*

The fundamental principle of sensory-motor paradigm states that perception, cognition and action are not differentiated parts of cognitive activity, but are intrinsically tied one to the other. More particularly, this principle can be expressed affirming that perception is already a form of action (Noë 2003). On the grounds of this idea, there is an assertive refusal of the input-output sequence expressed by classical cognitivism and the insistence on the reciprocal interaction between perceptual stimuli and motor answers. Reporting Alva Noë's words:

> The world makes itself available to the perceiver through physical movement and interaction […]. Perceptual experience acquires content thanks to our possession of bodily skills […]. To be a perceiver is to understand, implicitly, the effects of movement on sensory stimulation […]. Our ability to perceive not only depends on, but is constituted by, our possession of this sort of sensory-motor knowledge. (Noë 2004: 1-2)

Perception and action are involved in this reciprocal-interaction causation cycle that prevents from setting a limit between them; rather, they end up being two different aspects of the same cognitive process. The relationship between perception and action is dynamic, because action modulates perception discrimination and selects the functional affordances in a specific and peculiar environment. As Berthoz and Christen suggested:

> One of the essential reasons for the restriction of each species Umwelt[4] is due not only to the matching of each species' need and action repertories but also to the need to reduce neuro-computation to achieve two main goals: speed and robustness. This, I think, is obtained through the selection, in the course of evolution, of simplifying principles that optimize the perception-action process and minimize or even suppress the "computation" needed. (Berthoz and Christen 2009: 22)

Movement is not the bodily answer to an environmental stimulus, but, on the contrary, it reveals the stimulus itself in advance (Noë 2004). The brain is a motor and ecological control system, biologically developed and co-evolved within its environment. It can actually predict the motor possibilities which allow the organism to move in and around the environment. As Clark puts it: "Perception, cognition and action […] work closely together to minimize sensory action errors by selectively sampling, and actively sculpting, the stimulus array" (Clark 2013).

Organisms and environment are inserted in a unique system in which each one influences the other. One of the contribution that strengthens the thesis of this dynamical relationship is the niche construction theory (Laland *et al.* 2000), which insists on the tight connection between organisms and environment, showing how the former influence parts of their environment orienting their successive biological evolution. The animal environment is defined by the pa-

[4] The notion of Umwelt was introduced by von Uexküll who refers to the life environment of the organisms with this very term (see von Uexküll 1934).

rameters that are important for the animal itself. The activities, choices, and metabolic processes conduct the organisms to define, choose and modify their own niche. The niche construction is an extremely pervasive phenomenon that generates several feedback cycles that are fundamental from an evolutionary point of view. The life environment of human beings has to be conceived in a larger sense, since it is not limited to the physical environment, but also to the cultural, social, relational, affective, historical and technological one (von Uexküll 1933, Sterenly 2003, Laland *et al.* 2000).

Starting from this crucial point, we will introduce the last part of our reflection: the role of environment in the determination of the mind.

2.3. *Extended mind, scaffolding and neural plasticity*

In the perspective of embodiment, brain, body and world (referred to as environment) are parts linked in a triadic conception of mental activity, and cognition is a distributed process that involves a dynamical interaction among them. Although it can be ascribed to embodiment in a general way, the emphasis on the role of environment is a peculiar feature of the extended mind hypothesis, that is to say one of the new approaches in embodiment conception. In the extended mind hypothesis, external resources that are parts of the physical, cultural and technological environment of the organism can all contribute to carry out specific cognitive tasks. As Clark and Chalmers (Clark and Chalmers 1998) pointed out, the notion of epistemic actions is crucial to understand the extended mind hypothesis. Epistemic actions are all those actions that alter the world in order to simplify cognitive tasks. For example, we could consider as an epistemic action the act of calculating complex mathematical operations using both pen and paper. This apparently trivial gesture exploits external resources in order to simplify a computational task that the mind alone would find quite difficult to figure out and solve. It is a mechanism that has to be grounded in an evolutionary perspective. Quoting Clark and Chalmers:

> The brain develops in a way that complements the external structures, and learns to play its role within a unified, densely coupled system. Once we recognize the crucial role of the environment in constraining the evolution and

development of cognition, we see that extended cognition is a core cognitive process, not an add-on extra. (Clark and Chalmers 1998: 13)

By referring to external structures, supporters of the extended mind hypothesis indicate structures that are external to the organism itself but parts of its life environment. In our opinion, the notion of epistemic actions can easily be connected to that of external scaffolding promoted by Vygotskij[5] (1934) and developed by Bruner (Wood *et al.* 1976). Vygotskij argued that the historical and social dimension of the individual strongly influences the development of its cognitive functions. At the base of the idea of scaffolding (Clark 2003), there is indeed the existence of external and reliable structures that accelerate the resolution of a specific task, thus enormously simplifying cognitive tasks. It is a theory strictly connected with the distributed cognition, epistemic actions and niche construction. As Vygotski argued, the human being, acquiring the ability of manipulating instruments, of producing and using signs, has enlarged his cognitive capacities. The external manipulating practices, such as cultural connoted activities (i.e. tying a tissue in order not to forget anything), make it possible for the stabilizing of specific functional connections to exist. It is an idea well-expressed by the definition of "extra-cortical connections", referring to the external nature of functional organization of the brain involved in psychic tasks that have a cultural origin (Morabito 2007: 114). Therefore, the external scaffolding is a reliable external help that allows to carry out a specific cognitive task, thus producing modifications in the formation of neural circuits (the so-called extra-cortical circuits).

This vision finds an emblematic confirmation in the neural plasticity paradigm adopted by contemporary cognitive neurosciences.

Starting from the so-called brain plasticity revolution (Doidge 2007, Merzenich 1998), studies that look at the brain as an open and dynamic system, characterised by a strong and pervasive plasticity, have gained an increasing relevance. Practically, this feature of the brain consists in the modification of its circuits through the agent's experiences, revealed by the increase or loss of synaptic connections (Huttenlocher 2002). In the human species, the long post-natal peri-

[5] The term "scaffolding" in psychology was actually introduced by Wood *et al.* 1976. Nevertheless the importance of this concept in Vygotskij's thought is undeniable.

od of development of the encephalon makes this organ extremely exposed to the influence of physical, social and cultural environments. These latter concretely act on the brain through modifications of its anatomical and functional structure (Changeux 2012, Morabito 2015).

Epigenetic mechanisms intervene in this process, since the way genes function entails a strong connection with the context in which the organism lives (Maffei 2011). As a matter of fact, although the genes predispose and regulate the perpetuation of the basic features of cerebral organization (Morabito, Galloni and Della Rocca 2013), such as its form, the distribution of different areas and its general architecture, the human brain presents a deep synaptic variability. It is the synaptic variability that reflects an epigenetic characteristic, since learning procedures allow the consolidation of neural circuits, following the well-known Hebbian rule asserting that "neurons that fire together wire together" (Hebb 1949: 185, Edelman 2006: 21).

Linking these considerations to the niche construction theory, one can easily find that the cerebral organ has to be understood in terms of co-evolution between organism and environment (Sterenly 2003). And this latter, it is worth noting, is mainly the cultural one in our species: "Our brains are modified by the cultural activities we do – be they reading, studying music, or learning new languages. We all have what might be called a culturally modified brain, and as cultures evolve, they continually lead to new changes in the brain" (Doidge 2007: 300).

Focusing on the experiential impact and the environmental context on the anatomical-physiological structures of the brain, neural plasticity describes a neural model which is fundamentally both open and dynamical (Morabito 2017). These latter features appear to support an embodied and embedded model of mind, as suggested by the embodiment view.

3. *Conclusions: a new paradigm for the mind*

From an epistemological perspective, the idea of the embodied cognition entails two far-reaching consequences. On the one hand, it does show the heuristic value of an embodied approach to the mental phenomena, rather than of an abstract one, highlighting the dynamical relationship involving brain, body and world. On the other

hand, studying the mind in a way so different from the reference paradigm calls for a deep redefinition of the classical conception of mental categories. Namely, it could be profitable to look at several classical dichotomy distinctions adopted in mind debates, i.e. external/internal, perception/action, mind/body, in a more interrelated way (Morabito 2013). This kind of reconfiguration of mental categories does certainly have intense consequences on several aspects underlying philosophical research.

As far as the anthropological issue is concerned, the study of mental phenomena as embodied and embedded would implicate a deep reconfiguration not only of the notion of the mind, but also of our idea of the human being. Indeed, if mind develops as the product of the interaction of brain, body and world, then personal experience, the universe of interrelationships, emotions and feelings, the culture we grow in, as well as the physical and technological environment, have to be conceived as a crucial aspect of the human being as a whole and not only of his mind.

In opposition to the reductionist conception, according to which human mind coincides with human brain and on which the widespread neuro-mania of recent years underlies (Legrenzi and Umiltà 2009), embodiment opts for a view which returns mind to the human being. This is ultimately about a perspective that denies neither the contribution of biological studies nor the relevance of a philosophical tradition that it wants to keep in consideration and wishes to renew.

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