PREDICTIVE ENGAGEMENT AND MOTOR INTENTIONALITY

Valeria Bizzari[*] and Inês Hipolito[°]
[*]*University of Pisa*, [°]*University of Wollongong*
valeria.bizzari@libero.it; hipolito.ines@gmail.com

Abstract: In this paper we aim to show that motor intentionality, as the underlying ground for social cognition, can be explained through the predictive engagement model. Sensorimotor processes seem to play central roles in social interaction, cognition and language. We question the phenomenological role of the body in social cognition and further investigate a causal neural explanation. We will adopt a different perspective by linking the role of the body and intercorporeality with recent findings in philosophy of neuroscience under the predictive brain hypothesis. In fact, the living body seems to entertain a dialogical and enactive relationship with the surrounding context, as well as with neural circuits actively responding to external stimuli. The body is thus configured as a living organism, and not as a mere biological substratum, offering to phenomenology and empirical sciences further confirmations of the possibility-and need-for a cooperation.

Key Words: neurophenomenology, predictive engagement, *Leib*, action, movement.

1. *Introduction*

The past 20 years have witnessed a change in focus towards the body in the philosophy of mind, cognitive neuroscience and artificial intelligence. In particular, computational explanations of the mind (Searle 1992; Bechtel and Abrahamsen 1991) have been challenged by embodied cognitive science: our main aim is to offer a contribution to this perspective, specifically emphasizing the fruitfulness of a collaboration between phenomenology and neuroscience. In the Second section, we will describe the importance of the living body and of motor intentionality in perception; while in the Third section we will account for the predictive engagement hypothesis, a neuroscientific theory which seems to be compatible with an enactive and embodied view of perception. The beginnings of this approach date back to Maurice Merleau-Ponty (1962). Interestingly, it was in robotics with Rodney Brooks (1991) that the importance of the body to mental life came into focus again. He aimed to construct perceptual input systems and action output systems, linked by a central system that computed representations. Brooks realized, however, that a disembodied inference-based approach could not succeed without its physical environment. He realized that a certain intelligent behavior could emerge without representational models; it can be produced from interactions between the robot and the environment. He suggested that «the world is its own, best model» (Brooks 1991: 139) since the bodily and the environmental structures can do the work previously attributed to internal states. By focusing on real-world, real-time, task-oriented cognition, Brooks work inspired and transformed studies on intelligent behavior and cognitive science.

The Embodied Mind by Varela, Thompson and Rosch (1991) followed with the idea that conscious experience depends largely on our bodies and their interactions with the environment in which the cognitive system is embedded. They focused on consciousness and rejected a reductionist view of the mind. Embodied cognitive science aims to understand the full range of perceptual, cognitive, and motor capacities we possess, as capacities that are dependent upon features of the physical body. Therefore, since cognition deeply depends on aspects of the agent's body other than the brain, the involvement of the body in both sensing and acting is crucial for thought and mental affairs. Varela, Thompson, and Rosch introduced the concept of enaction[1] to present and develop a framework that places strong emphasis on the idea that the experienced world is portrayed and determined by mutual interactions between the physiology of the organism, its sensorimotor circuit and the environment. According to this perspective, the action itself cannot be conceived in a merely formal sense, but seems to be the product of the subject's intentional activity, originally connected with its corporeality.

This approach has been very influential both on embodied cognition and on the phenomenological tradition. In fact, there is a growing realization and acceptance in cognitive science that embodied perception is not just a subsidiary module. Nevertheless, this tendency is very well accepted for «low-level» cognition, but if we take into account «high-level» cognition, it seems that computational cognitivism could be the only viable option (Stewart, Gapenne and Paolo 2014). A major aim of this paper is to show that this impression is quite false, and that the paradigm of enaction has its own and highly distinctive approach to higher-level cognition, such as social cognition. We will attempt to bring forward a possible linkage between the phenomenological understanding of social cognition (Section 2) and its potential neural explanation (Section 3). Finally, we will show how the lived body is fundamental in perceptual and cognitive processes through which the subject relates to the world.

[1] «Enaction» is the idea that cognition is grounded in the sensorimotor dynamics of the interactions between a living organism and its environment. A living organism enacts the world it lives in; its effective, embodied action in the world actually constitutes its perception and thereby grounds its cognition (Gallagher and Allen 2016).

2. *The bodily self and social cognition*

2.1 *Self-consciousness*

Human self consciousness depends on the metarepresentation of mental and bodily states as one's own metal and bodily states. However, first-person perspective taking is not sufficient, it is necessary for human self consciousness. In fact, to assign a first-person perspective is to center one's own multimodal experiential space upon one's own body, and thus operating in an egocentric reference frame. Does this have to always be conscious? According to the phenomenological tradition, all conscious states seem to involve self-awareness (though not in Descartes's terms). The sense of self seems to be an integral and ubiquous part of our experiential life. Experience, in these terms, seems impossible without the sense of self. According to Zahavi (2015; 2008), a mental state is conscious *if and only if* it is «lived through» in such a way that the subject is immediately and non-objetually acquainted with it as his own. As argued by Gallese and Sinigaglia (2011), mental states or processes are embodied primarily because of their bodily format. Like a map and a series of sentences might represent the same route with a different format which means mental representations might have partly overlapping contents (e.g. a motor goal, an emotion or sensation), they differ from one another in their representational format. This format contains what a mental representation can represent, that is, when planning and executing a motor act, bodily facts constrains what a mental representation can represent (actions, emotions or sensations involved) and corresponding representations involved in observing someone else performing a given action or experiencing a given sensation. Neurobiological evidence and work on special cognition has showed the fundamental role of action and sensorimotor activity in perception and cognitive processing, through neural development and plasticity. The development of neural circuits in the visual system and acquisition of visuomotor skills critically depends on sensorimotor interactions and active exploration of the environment (Kulick *et al.* 2015; Little and Sommer 2014).

Even adult brains show considerable plasticity of cortical maps that are dependent on action context and attention (Singer 2017; Chapman *et al.* 2015). Musicians, who often show functional changes in their sensorimotor system resulting from action-dependent plasticity (Fiori and Guzzetta 2015; Münte, Altenmüller, and Jäncke 2002), show the same level of plasticity. These results seem to indicate that appropriate action and relevant sensorimotor contingencies appear necessary throughout life to stabilize the functional architecture in respective circuits (Engel 2010). Other highly intriguing finding is that motor and premotor systems are also active during «visual actions» (Urgen and Saygin 2015), like, for instance «mental rotation» of objects (Cona *et al.* 2017; Richter *et al.* 2000). To summarize, from a neurobiological perspective, motor system seems to constitute a fundamental part in perception and active engagement with the environment, what one now needs to be addressed is how this engagement is lived by the subject.

2.2. *Motor intentionality*

Phenomenological inspiration is today revolutionizing the role played by the body in cognition, especially emphasizing the relevance of the body in intersubjective understanding and, thus, showing the centrality of the body in the higher processes of perception and knowledge. According to the phenomenological perspective, both the cognitive process and consciousness are simply the product of our being embodied. The body is the means by which the subject may live in the world and differ from inanimate creatures. The living body, in fact, is characterized by being intentionally directed outwards (as a starting point for all kinds of knowledge) and by a self-affection that allows it to be aware of itself regardless of any interaction with the world.[2] One of the main features of the phenomenological approach is *to consider our corporeality as that which is directly responsible of our understanding of the world*:

> According to Merleau-Ponty, in everyday, absorbed, skillful coping, *acting is experienced as a steady flow* of *skillful activity in response to one's sense of the situation*. Part of that experience is a sense that when one's situation deviates from some optimal body-environment relationship, one's motion takes one closer to that optimum and thereby relieves the "tension" of the deviation. One does not need a goal or intention to act. One's body is simply solicited by the situation to get into equilibrium with it. (Dreyfus and Dreyfus 1996: 11, our italics)

In order to explain the entanglement between the corporeal subject and the world, Merleau-Ponty uses the notion of *operative or motor intentionality*,[3] that is a passive and lived intentionality through which the bodies are linked to each other and know each other in a non-tetic, pre-reflexive experience. The main

[2] This dual characterization, along with the dichotomy *Leib/Körper,* has been a source of inspiration to many authors not directly linked to the phenomenological method, which have been focused on fields of study to which classical phenomenology has never been of interest – neuroscience or, more generally, any field which could be defined as cognitive science. Adopting a phenomenological perspective on knowledge has produced, for example, the identification of specific cognitive schemas that belong to the pre-reflective domain: this is how Gallagher, spokesperson of this theoretical change, gave birth to the famous distinction between *sense of ownership* and *sense of agency* – those characteristics of consciousness that allow for an immediate and latent self-awareness, as well as movements and actions which are one's own.

[3] The philosopher referenced by such approach is mainly Merleau-Ponty, who argues for the inseparability between bodily abilities and consciousness: in other words, our perception of the world depends on the structural aspects of our existence.

feature of this kind of intentionality is its motricity: the subject moves and acts according to a specific *bodily schema*, a concept that the phenomenologist borrows from the psychologist Schilder.

The *body schema* is the structure through which the body acquires not only self awareness as an "I can" (and not simply as an "I think"), but also the ability to move consciously in a given space. Motor intentionality makes, thus, the subject capable of perceiving and understanding the facticity of self and of the world in which he/she is immersed, and aware of his/her capacities. The being-at-world presupposes a body that moves and perceives not just through one of its senses (such as sight or touch), but with the totality of its being. The reason behind this assumption is that each part of the body is involved in one another, developing an integral and complex experience. What emerges seems to be a complex subjectivity, capable of dealing with the world through a practical knowledge (*praktognosìa*) and not merely through mental representations.

The role of the lived body would seem, indeed, to structure the perceptive experience and make it meaningful. This is evident, for example, in the acquisition of a new habit: this does not seem at all to be the result of a purely intellectual operation that takes place by means of representations or inferences, but rather a pre-reflexive, involuntary and corporeal act. The key features of the "habitual" body are the physiological structure (because it depends on the operation of various sensory organs) and the need to be put into practice so that it can preserve its "habitual" nature. The perceiving consciousness and the physiological substrate consciousness cannot be separated because they are dialogically and mutually connected. In other words, the Merleau-Pontian conception of perception involves a circular mechanism necessarily involving the body, the cognitive process and consciousness. The meeting between the body and the world also implies a dynamic and dialectic relationship. Perception, in fact, does not seem to be a mere representation because the «habitual body» is constantly modified by its interaction with the environment: learning to dance or to play an instrument require a change of affordances and of the intentional relationship between the subject and the world. As the very core of perceptual activity, the body is the instrument thanks to which there can be a link between the subject and the world, the ego and the alter ego.

Within this perspective, motor intentionality seems to be a pre-reflective and lived kind of knowledge that allows the subject to recognize the other in an immediate and non-thetic manner. More specifically, concerning the issue of intersubjectivity, Merleau-Ponty claims that the experience of self necessarily presupposes the experience of otherness: essential to the subject is his ontological openness and the tendency of overcoming himself. Furthermore, either in the case of the perception of self, or in the case of the perception of otherness, what is at stake is an *embodied subjectivity* whose main feature is the involving of an alterity. In fact, in the case of bilaterality of kinesthesia, the subject makes an internal and an external experience, because he/she anticipates both the manner in which the other would experience him/her and the way through which he would have experienced the other.

In this view, our embodied Self-awareness could be described as a pre-feeling of otherness, and the intersubjective experience as an echo of our own corporeal constitution:

> My right hand was present at the advent of my left hand's active sense of touch. It is no different fashion that other's body becomes animate before me when I shake another man's hand or just look at him. In learning that my body is a "perceiving thing"…, *I prepared myself for understanding that there are other animalia and possibly other men*. (Merleau-Ponty 1962: 212)

In *Phenomenology of Perception* (1962), Merleau-Ponty explicitly faces this issue (especially in the chapter *The Other and the Human World)* and offers a contribution in the course *Les relations avec autrui chez l'enfant*, where he analyzes the psychoanalytic perspective and some developmental theories according to which we can talk about the perception of the alterity in psychogenetic terms.

According to Merleau-Ponty, we are intersubjective creatures from birth simply because we possess a corporeal schema. It is very interesting to notice that an experimental study conducted by Meltzoff and Moore has shown that newborns (the "youngest" 42 minutes old, the "oldest" 72 hours old) are able to imitate facial expressions, thanks to an inner capability very similar to the Merleau-Pontian corporeal schema which creates a bridge between interiority and exteriority. Without the intervention of simulations or inferential capabilities, the subject is able to perceive the other's corporeal movements as *expressive and intentional* starting from the first year of life, and can immediately understand the other as an *agent*, and not as an object or Cartesian mind.

According to this view, there are no epistemological functions exclusively committed to the understanding of other minds: the subject intuitively understands the rage in the other's gestures or facial expressions. To quote Gallagher: «Such perceptions give the infant, by the end of the first year of life, a non-mentalistic, perceptually based *embodied understanding* of the intentions and dispositions of other persons» (Gallagher 2008: 540). The body seems to be the place of the emergence of (shared) meaning.

3. *Movement and cognition: towards a new neurophenomenological paradigm*

Considering this image of perception makes it possible to argue that the living body is a key element of the whole cognitive process, starting from which you need to reframe the relationship between cognition and consciousness and, therefore, to think of an alternative embodied approach. In other words, we can affirm that «embodiment does cognitive work» (Morris 2010: 236) because the living body is essentially «a cognizing agency» (*Ibidem*). Within this proposal, *movement* takes on a key role, as it constitutes the main instrument through which we form cognition: through body movements, in fact, the subject *explores* the world, perceives his affordances and determines his habits *(habit body*). In other words, the cognitive process seems to be the result of an essentially embodied perception, which arises from a living body: «At their most fundamental level, subjective experiences are tactile-kinesthetic experiences. They are experiences of one's own body and body movement; they are experiences of animate form. These experiences are the bedrock of thinking» (Sheets-Johnstone 1999: 435). It is possible to trace an emphasis on the role of the body within the cognitive process even in Husserl's thought: every act of perception (*Noesis*) implies a noetic horizon, which makes it possible to have a complete knowledge of the perceived object. In other words, perception is not a univocal experience, since it implies the possibility of assuming different perspectives. For this reason, the ego seems to be a necessarily *moving body*: in fact, differently, it would not be possible to postulate the existence of other horizons of perception and of other points of view. To summarize, we argue that the possession of kinesthetic skills is the characteristic which constitutes the subject as an *animated organism*. Husserl repeats this expression several times, especially in the *Cartesian Meditations*, where it becomes clear how the subject is essentially a psychophysical organism that interacts with the environment.

Phenomenologists and scientists are increasingly focusing their attention on *body movement*: according to Edelman, for example, movement is instrumental to the knowledge of the world, while the American philosopher M. Sheets-Johnstone argues explicitly that «cognition is not separated from perception, perception is not separated from an environment nor from a larger category designated as a behavior: on the contrary, the movement-perceptual system *is* behavior in the sense that it is the actual "real-time", "real-life" event as it unfolds» (Sheets-Johnstone 1999: 218). In other words, the cognitive process seems to have *affective* features: the movement seems to be the first communication resource, a source of non-linguistic and kinetic concepts (space, time, force, etc.).[4] Motor activities, as well as emotional experiences, are primary resources for the knowledge of the world, before the arising of more complex cognitive abilities, whose proper functioning seems rather to derive from them.

[4] M. Sheets-Johnstone provides the example of walking, an essentially qualitative experience that must be phenomenologically described through terms that refer to the subject's kinesthesia.

In particular, the notion of "living body" is useful because implies a psychophysical organism that, by means of its capabilities, and, therefore, movement, not only manages to gain experience of the environment, but also of himself (self-construction of the living body). The link between the subject and the world is therefore a reality shaped by «non-linguistic corporeal concepts» (Sheets-Johstone 1999: 153). In addition, the same neurobiological findings confirm this hypothesis. In fact, it has been shown that during perception sensory-motor interactions actually occur: for example, the development of neural circuits related to the visual system and its capabilities are dependent on the active exploration and interaction between the organism and the environment (Held 1965; Majewska, Newton and Sur 2006). Therefore, body action is not always complementary to cognition, but it is possible to argue that it is itself cognition.

In this perspective, also intersubjective perception[5] could be outlined as an interactive process, and not purely a cognitive one: as in the encounter with the other, the subject is not a mere observer, but «responding in an embodied way» (Gallagher 2008: 540). In this context, social cognition appears to become a synonym for social interaction, namely a process in which body's movements, expressions and context play a key role. The idea behind this approach is that our intersubjectivity is essentially *a direct bodily mechanism*, not only during childhood but also into adulthood. A representational account of cognition does not seem, thus, sufficient to explain our mental life (Lakoff and Johnson 1999): on the contrary, we should consider perception as an *active bodily interaction with others and the world.* This perspective seems to be coherent with the *predictive engagement* approach, suggesting a promising direction of study. In fact, bodily interaction has been recently considered within its relation to the free energy principle, in which predictive engagement plays an important role.

3.1 *Free energy principle and predictive engagement*

Predictive modeling uses statistics to predict outcomes in the future or an unknown event in the past. In most cases, the model is chosen on the basis of detection theory to try to predict the probability of an outcome given a set amount of input data. Models can use one or more classifiers in trying to determine the probability of a set of data belonging to another set. Predictive brain is, thus, the

[5] According to Merleau-Ponty's perspective, the other plays a crucial role, since intersubjectivity is based on our own identification with a partner's body, identification which happens through an immediate perceptual linkage with his or her body. Thus embodiment constitutes a necessary condition for the possibility of intersubjective agreement about the shared world.

view that the nervous system maintains internal probabilistic models that are updated by neural processing of sensory information using methods approximating those of Bayesian probability (Hohwy 2013).

There can be a fundamental distinction between three philosophical views on neuroscience of predictive models:[6] *predictive coding* is associated with internal Bayesian models and prediction error minimization; *predictive processing* is associated with "simple" embodiment; and *predictive engagement* appears associated with enactivist approaches to cognition (Gallagher and Allen 2016; Kirchhoff 2016; Allen and Friston 2016).

On the enactivist model, social cognitive process is seen as closer to ongoing predictive engagement, that is, a dynamical adjustment in which the brain, as part of and along with the larger organism, actively responds in ways that allow for the right kind of ongoing attunement with the environment: an environment that is physical but also social and cultural. Enactivists suggest that the brain is not located at the center, as neural accommodation occurs via constant reciprocal interaction between the brain and body. So, adjustment and attunement can be cashed out in terms of physical dynamical processes that involve brain and body, including autonomic and peripheral nervous systems. We can see how this enactivist interpretation can work by exploring a more basic conception operating in these predictive models, namely, the free energy principle (Allen and Friston 2016). This concept, originally introduced by Karl Friston, has been recently expanded to serve as a bridge between information theory and biological processes.

The free energy principle, also known as active inference, suggests that (biological) systems maintain order by restricting themselves to a limited number of states. In order to do so, systems minimize a free energy functional of their internal states, which entails beliefs about hidden states in their environment.

Furthermore, free energy principle argues that biological systems are foremost defined by the tendency to resist the second law of thermodynamics, on the basis that to do otherwise would entail the unbounded increase of entropy. This models reveals similarities with the autopoietic system by Francisco Varela (1974), particularly focusing on the linkages between embodiment, environment and brain processes through the application of information theoretical principles. According to this model, an organism both generates internal dynamics of probabilistic predictions embodied in neural networks that maximize survival (minimize free energy), and acts on the world in such a way as to cause sensory information to conform to prior predictions (Gallagher and Allan 2016: 9). Fur-

[6] For a detailed account see the special issue «Predictive Brains», *Synthese* (2016).

thermore, the organism, as an autonomous agent, avoids unexpected states, that is, minimizes surprise.

In short, the free energy principle is an attempt to explain the structure and function of the brain as a minimizer of variational bound on disorder, and it asserts that any adaptive change in the brain will minimize free-energy. This minimization could be over evolutionary time (during natural selection) or milliseconds (during perceptual synthesis). In fact, the principle applies to any biological system that resists a tendency to disorder, from single-cell organisms to social networks (Friston 2009). Free energy is an information theory quantity that bounds the evidence for a model of sensory inputs and the model is encoded by the brain. Free-energy is thus greater than the negative log-evidence or "surprise" in sensory data.

Within the three approaches to predictive model, for *predictive coding* and *predictive processing*, active inference is part of a process that produces sensory experiences that confirm or test expectations, while for *predictive engagement*, active inference is more action than inference; it's doing a doing, an enactive adjustment, a worldly engagement with anticipatory and corrective aspects already included). It is a loop that also navigates through the body and environment and forma a whole (Gallagher and Allan 2016: 9). However, despite the distinctions, there seems to be some common ground in respect to prior experience and how the system embodies interaction and sociality in the world.

This seems to be coherent with the phenomenological account, according to which, as we have previously described, cognition is dinamically incorporated and located in the environment. Predictive engagement approach can integrate phenomenology in a mutually informed manner, enabling a description of the subject not as an "I think" but as an "I move".

4. *Conclusions*

In this paper we have considered the hypothesis that social shared world is portrayed and determined by mutual interactions between the physiology of the organism, its phenomenological experience and the environment. The phenomenologically inspired work on cognition is today increasingly influential. There is a growing realization and acceptance in cognitive science that embodied perception is not just a subsidiary module. We aimed at contributing to an alternative model to high-level cognition and hierarchical neural exchange through the *predictive engagement model*. We looked hence into the phenomenological understanding of perception (Section 2) and its potential neural explanation (Section 3.1).

In Section 2 we attempted to explain the phenomenology of the role played by the body in the shared world. We first explained how motor system appears to constitute a fundamental part in perception and active engagement with the environment, and how this engagement is lived by the conscious self. To further explain this linkage, we focused on a novel viewpoint on intercorporeality: motor intentionality, which seems to yield the subject the ability of perceiving and understanding the facticity of self, and of the world in which he/she is immersed, and aware of his/her capacities. Finally on Section 3, we hope we were able to accomplish the aim of bringing forth predictive engagement as a philosophical position in the neuroscience of predictive brain hypothesis as a liable explanation for social cognition and human sociality. Social cognitive process, in this model, is considered as closer to ongoing predictive engagement, that is, a dynamical adjustment in which the brain, as part of and along with the larger organism, actively responds in ways that allow for the right kind of ongoing attunement with the environment. This brings us to the possibility of exploring a more basic conception operating in these predictive models, namely, the free energy principle· The application of information theoretical principles further permits us to focusing on the linkages among embodiment, environment and brain processes. This, ultimately, seems to leave the door open to look into a new causal explanation for higher cognitive processing, such as social cognition, in its *embodied and phenomenological nature*. The organism both generates internal dynamics of probabilistic predictions embodied in neural networks that maximize survival (minimize free energy), and acts on the world in such a way as to cause sensory information to conform to prior predictions.

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