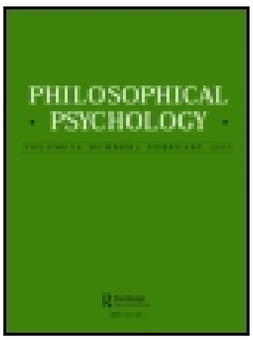

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Bridging embodied cognition and brain function: the role of phenomenology

DONALD BORRETT, SEAN KELLY & HON KWAN

ABSTRACT *Both cognitive science and phenomenology accept the primacy of the organism–environment system and recognize that cognition should be understood in terms of an embodied agent situated in its environment. How embodiment is seen to shape our world, however, is fundamentally different in these two disciplines. Embodiment, as understood in cognitive science, reduces to a discussion of the consequences of having a body like ours interacting with our environment and the relationship is one of contingent causality. Embodiment, as understood phenomenologically, represents the condition of intelligibility of certain terms in our experience and, as such, refers to one aspect of that background which presupposes our understanding of the world. The goals and approach to modeling an embodied agent in its environment are also fundamentally different dependent on which relationship is addressed. These differences are highlighted and are used to support our phenomenologically based approach to organism–environment interaction and its relationship to brain function.*

It is increasingly recognized that cognition should only be understood in terms of an embodied agent situated in an environment. Non-linear dynamical system approaches have been appropriated to model such an embodied organism interacting with its environment. Dynamical system theory provides a vocabulary that is most conducive to such an approach and avoids the traditional prejudices of cognitive science and its adherence to a representational formulation of thought (Thelen, 1995).

All four reviewers supported such an embodied approach to the study of cognition as evidence by their remarks: (1) "As the research on dynamical systems and autonomous agents (for all their reductionism), and the more socially oriented research on situated action nicely demonstrate, embodiment and situatedness are essential to any proper understanding of coordinated action" (Costall); (2) "Contemporary ecological psychologists have refined Gibson's proposals using constructs from nonlinear dynamical systems theory: the subsystems for perceiving

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the environment and one's orientation to it, and the subsystems for getting about in the environment and manipulating it, function synergistically" (Van Orden & Jansen op de Haar); (3) "... functional control theory leads one to the conclusion that organisms are necessarily embodiments, or encapsulations, of the transformational dynamics (i.e. environment) that organism's species has had to overcome, and thus, 'embody,' over the course of evolution" (Jordan); and (4) "The organism–environment interactions are seen as the core problem and the starting point for anyone interested in the functioning of the brain" (Keijzer). All four reviewers also felt that the spirit of such an embodied approach to the organism–environment system was missing in our paper and that our ideas were more commensurate with a traditional view of cognition as reflected in a representing subject. It is necessary, therefore, to elaborate how the presented phenomenologically based ideas concerning brain function accept the primacy of the organism–environment system but differ in the objectives and approach to embodiment that an analytic formulation entails. We take the liberty in assuming that all the reviewers subscribe to the notion of embodiment that we are calling analytic (to contrast it with a phenomenological approach).

First, how embodiment is seen to shape our world is different in phenomenology than in an analytic approach. The arguments and examples used to highlight these differences are borrowed from Charles Taylor's essay "Engaged agency and background in Heidegger," in which he supports the phenomenological over the analytical position (Taylor, 1993). For instance, Taylor points out that as a perceiving agent, I cannot see the wall behind me. This can be explained in physical terms by certain causal relations: the light refracted off the wall behind me cannot reach my retina. My physical constitution and the nature of light conspire to make this impossible. In this sense, my embodiment shapes my perception, and hence, in a sense, my world. This is the sense utilized in analytical approaches to embodiment. The relation between the embodied organism and the environment can be expressed in terms of contingent causality.

Contrast this sense of embodiment to the following description by Taylor. As I sit and observe the room, some things are "up" and some things are "down." Some things are "near" and some things are "far." Some objects are "near to hand" and some are "out of reach." The terms in quotation marks make sense only against the background of an agent with a body like ours. "Lies to hand" makes sense only to an embodied agent that is able to reach and grasp the object at hand. Embodiment, in the simple example described, represents the condition of intelligibility of certain terms in our experience that, in this example, are related to distance and accessibility.

Although, analytically, the wall behind me has no visual presence because I have no immediate causal relation to it, phenomenologically, it does have a presence for me. Merleau-Ponty expresses this as he describes the indeterminacy of objects at the periphery of or out of our visual field. "The region surrounding the visual field is not easy to describe, but what is certain is that it is neither black or gray. There occurs here an indeterminate vision, a vision of something or other, and, to take the extreme case, what is behind my back is not without some element of visual

presence" (Merleau-Ponty, 1962, p. 6). This presence is part of that background that is constituted as a result of our embodiment and presupposes any analytical approach to spatial location. Despite its reality, we have no causal relation to this presence and, as a result, it is not amenable to scientific analysis.

Thus, in discussing embodiment, two different kinds of relationship can be expressed by saying that our experience is shaped by our bodily constitution. In the first case, the analytic case, we note the consequences of this constitution for our experience and this relationship can be asserted in a statement of contingent causality. In the second case, the phenomenological case, we point out how our experience is formed by this constitution and this relationship concerns the conditions of intelligibility of the world. It is this latter sense of embodiment that we utilize in the paper and we distinguish it from the sense of embodiment assumed by the reviewers. Our body is not simply one object among the many in the world but is part of the background that presupposes our understanding of the world. This background is part of our pre-reflective, everyday interaction with the world and aspects of that background are what we tried to model in the paper as pre-predicative experience.

We take the pre-predicative experience as the condition of intelligibility of the objective world and in pre-predicative experience, we describe the experience of our bodily selves interacting with the environment. This experience has a number of features, some of which were described in the paper and were modeled in terms of dynamical networks. The features of pre-predicative experience modeled include the lack of subject–object distinction, lack of the concept of objective distance, the indeterminacy in the perception of the object used and the feeling that the movement is "magically at its completion" from the outset of the movement. We never intended to simply describe the consequences of having a body moving and interacting with the environment, and if that had been our intention, we would be in complete agreement with the reviewers that the paper fell short of this goal. The pre-predicative experience is the foundation from which the constitutive program of phenomenology arises and the objective world is understood. As such, embodiment, in the phenomenological sense, represents the condition of intelligibility of embodiment in the analytical sense. As an example, objective distance, which assumed in the analytic approach, requires a foundation to explain its intelligibility. This foundation is simply our experience in everyday, non-reflective interaction with our surroundings. As was mentioned in the paper, non-linear dynamical systems provides an idiom whereby the transition from the indeterminacy of pre-predicative experience to the quantifiable, objective world is seen as tractable. By conceptualizing movement as the output of a recurrent network, such as the cortical–basal ganglia–thalamic–cortical loop, the number of iterations performed by the loop in a pre-predicative movement toward an object represents a spontaneously occurring, quantifiable variable that may be used by the nervous system in the establishment of a representation of objective distance.

We make no assumptions concerning how the network model of pre-predicative experience actually comes about. As the background that represents the condition of intelligibility of the objective world, it cannot be causally explained. It is posited *a*

priori and the details of its implementation in the models are based on our current understanding of brain function. This highlights another difference between the analytic and phenomenological approaches to embodiment. Whereas an analytical approach to the organism–environment interaction emphasizes the adaptive role of the interaction and a causal relationship between this adaptation and the origin of cognitive thought, phenomenology takes the experience of the organism–environment interaction in pre-predicative experience as given and the starting point for theorization concerning the objective world. The notions of evolution or adaptation are concepts that refer to the world that is objectified and as such await a phenomenological explanation concerning their possibility. As Van Orden and Jansen op de Haar quoted in their review, "The whole universe of science is built upon the world as directly perceived, and if we want to subject science to rigorous scrutiny and arrive at a precise assessment of its meaning and scope, we must begin by reawakening the basic experience of the world of which science is the second order expression. Science has not and never will have, by its nature, the same significance qua form of being as the world which we perceive, for the simple reason that is a rationale or explanation of that world " (Merleau-Ponty, 1962, p. viii). This scrutinization of science can only be accomplished if the differences between the phenomenological and analytical approaches are appreciated and avoidance of analytical tendencies in the phenomenological analysis occurs. Discipline is required to maintain this phenomenological attitude, and failure to maintain this discipline is probably the greatest obstacle to success in this research endeavor (Varela, 1996). The failure to appreciate the radical implications of phenomenology, in particular, the failure to distinguish between the different notions of embodiment, will prevent successful accomplishment of Merleau-Ponty's goal of "reawakening the basic experience of the world" and recognizing science as a second order derivative of this experience.

Costall had a further concern with how we dealt with the organism–environment system. He felt that we presented two separate models—one of movement and one of perception—and that we decided to leave embodiment aside for another day. However, what we suggested is that our simple approach to modeling pre-predicative experience represents a start in formally recognizing the background in which we exist as the condition of intelligibility of the objective world and expressing this point in a formalism that is relevant to neuroscience. This background is non-quantifiable and non-representational. The best that we can do with this background is look at certain aspects of it but always in a context that does not attribute ontological primacy to these aspects. This is what we tried to do in our separate discussions of the body and the world. In fact, our organization of these aspects mirrored Merleau-Ponty's organization in *Phenomenology of perception*. He divided his book into three main sections, entitled "The body," "The world as perceived" and "Being-for-itself and being-in-the-world," but always presented the particular subject of interest in that section in the context of its relevance to the pre-predicative organism–environment system.

We feel that the issue of embodiment was the subject with which all of the reviewers had the most concerns. We also feel that these concerns assumed an

analytic approach to embodiment. By attempting to clarify how embodiment in the phenomenological sense differs from the analytical approach, we hope to show how the organism–environment system is still primary in phenomenology and how the goal and methods of phenomenology allowed us to develop our arguments the way we did in the paper.

Other criticisms were made in the commentaries and we will briefly list the reviewers and respond to their specific criticisms.

Both Costall and Jordan's criticism revolved around the concept and approach to embodiment, and we feel that these concerns were addressed above.

Van Orden and Jansen op de Haar suggested in their conclusion that all descriptions, even existential insights, require assumptions and indicate that "the strained relation between experience and description ... undermines the priority (and even the possibility) of direct description." We disagree and emphasize the difference between the data and the model. Phenomenology attempts to deal with things as they appear in everyday existence without assumptions inherent in any theoretical framework. Through the phenomenological reduction, we suspend belief in any framework involved in objective experience, and return to a description of things as they appear in our experience of them. This is the data. Once we try to model this experience, however, assumptions have to be introduced. Such an obvious assumption is the simple recurrent model of movement generation that was chosen to reflect movement in pre-predicative experience. The assumptions introduced in the model do not compromise the purity of the data that are being modeled and certainly do not obviate the validity of the phenomenological method. In the approach that we proposed, accurate reproduction of the phenomenological data represents a second constraint necessary in successful modeling of brain function. This second constraint is usually absent in analytical approaches to the same problem. A good example of this is Van Orden and Jansen op de Haar's alternative model of grasping and reaching. Although the model could reproduce the behavioral characteristics of these movements in the normal and pathological cases, it failed to incorporate those characteristics that phenomenological analysis reveals as implicit in these movements. In particular, the notion that lived space is more fundamental than objective space and represents the condition of intelligibility of objective space has no place in their approach to modeling or the structural details of the model.

Van Orden and Jansen op de Haar also discussed in detail what they felt were fallacious assumptions in the model. Their criticisms were partially justified because our choice of words in certain sections implied a structure that we did not intend and which would be contrary to phenomenological analysis. In particular, the wording of our remark that it is necessary "to postulate the existence of two physical systems that, although they are clearly related and interdependent such as during learning, can function independently" was ill chosen and did imply a linear combination of component effects that was not intended. We do, however, disagree with their generalization concerning the *a priori* assumptions in Merleau-Ponty's description of Schneider. The fact that grasping behavior remained after a deficit in pointing behavior appeared, to us, simply confirms the phenomenological insight that lived space is more fundamental than objective space. This does not imply a

linear superimposition structure of grasping and pointing in motor control. If one assumes that the determinate structures of objective space arise actively from the indeterminate structures of lived space and require constant updating and reinforcement, then a lesion may simply impair the nervous system's ability to maintain these derivative structures. Such a situation would not represent a linear superimposition of component causes but a more complex functional dependency.

Keijzer also assumes an analytical approach to the study of the organism–environment system and most of his criticisms are based on this reading of our paper. As was discussed previously, it is important to appreciate that phenomenology is not simply an analysis of subjective experience (as may be attempted by cognitive science) but is a methodology whose goals and techniques may be at odds with those of cognitive science. In phenomenology, cognitive science itself is a second order expression of a more fundamental reality which is the world as it is immediately perceived. In attempting to appreciate how cognitive science is intelligible in this context, one cannot simply adopt standard cognitive science techniques but one needs an alternative approach such as that suggested by Merleau-Ponty. By translating Merleau-Ponty's phenomenological insights into a formalism that is also applicable to cognitive science (dynamical neural networks), the hope is that the relationship between these two disciplines will be more transparent. A final word on Keijzer's section concerning phenomenology as a source of data. Keijzer questions whether phenomenology actually provides genuine data on human experience. He says, "After all, what can philosophy do in this respect what science cannot?" Clearly, for Keijzer, the existence of science is not problematic. For those, however, who feel that the question of how science is possible is a valid problem, then the ideas of Merleau-Ponty are as relevant as they are refreshing. The practical success of science does not preclude scrutiny of its foundations and it is the philosophical discipline of phenomenology, with its emphasis on the primacy of the lived world and the derivative status of the objective world, that provides a technique to understand this foundation. The difficulty lies in the choice of a single formalism that can express both scientific and existential data so that relationships can be established. By accepting the brain as the physical substrate of all experience, dynamical neural network models of brain function may represent such a formalism.

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