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Abstract

Critics of the paradigm of enaction have long argued that enactive principles will be unable to account for the traditional domain of orthodox cognitive science, namely "higher-level" cognition and specifically human cognition. Moreover, even many of the paradigm's "lower-level" insights into embodiment and situatedness appear to be amenable to a functionalist reinterpretation. In this review, I show on the basis of the recently published collection of papers, *Enaction*, that the paradigm of enaction has (a) a unique foundation in the notion of sense-making that places fundamental limits on the scope of functionalist appropriation; (b) a unique perspective on higher-level cognition that sets important new research directions without the need for the concept of mental representation; (c) a new concept of specifically human cognition in terms of second-order sense-making; and (d) a rich variety of approaches to explain the evolutionary, historical, and developmental origins of this sophisticated human ability. I also indicate how studies of the role of embodiment for abstract human cognition can strengthen their position by reconceiving their notion of embodiment in enactive terms.

Keywords

Cognitive science, enactive approach, higher-level cognition, representation, functionalism

1 Introduction

Ever since the publication of *The Embodied Mind: Cognitive Science and Human Experience* by Varela, Thompson, and Rosch (1991), there has been a growing interest in what has become known as the "enactive approach". Thanks to the strong methodological and conceptual foundations that have been laid by Varela and his extensive network of collaborators, this approach has been maturing into a highly promising alternative framework for the sciences of life and mind. The orthodox critics, who view the enactive approach as merely another passing fad, and who are therefore simply awaiting a return to cognitivist business as usual, will be sorely disappointed. The long anticipated publication of *Enaction: Toward a New Paradigm in Cognitive Science*, a collection of papers edited by Stewart, Gapenne, and Di Paolo (2010b), is sure to irrevocably put the enactive approach on the agenda of the traditional disciplines of cognitive science and beyond.

Varela and his colleagues have always strongly emphasized that the enactive approach is aiming for a revolution of the very foundations of cognitive science, rather than merely a reform within the orthodox framework. This revolutionary notion of breaking with the cognitivist past has had the effect of making some commentators uncomfortable, although they are also forced to concede that the enactive approach is keenly aware of its historical, even occasionally orthodox, roots (Dennett, 1993).

This explicit balancing between reform and revolution is also in evidence in many of the papers in *Enaction*. It is therefore no coincidence that right at the start of the first chapter, Stewart (2010, p. 1) accepts the original tasks of cognitive science, namely to formulate "a genuine resolution of the mind-body problem" and to establish "a genuine core articulation between a multiplicity of disciplines—at the very least between psychology, linguistics and neuroscience." Furthermore, Stewart acknowledges that the field of cognitive science as such owes its very existence to the fact that the computational theory of mind, whatever its limitations and shortcomings, has managed to fulfill these requirements in its own way. In other words, it is largely thanks to the cognitivist–computationalist framework that the study of the mind was made compatible with the natural sciences, and was subsequently

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turned into a mainstream scientific research program. This in itself is a significant achievement. Indeed, as Shanon (2010, p. 389) remarks: "With its proclaiming an autonomous psychology, the cognitive revolution heralded a break with reductionistic explanation." The enactive approach also accepts this non-reductive naturalism as its working hypothesis, although it rejects the use of computationalism and other varieties of functionalism to fulfill the requirements of this task (Di Paolo, Rohde, & De Jaegher, 2010, p. 36).

One major reason for the rejection of the computationalist framework is that orthodox cognitive science has inadvertently overshot its target by postulating a hidden, intermediary level of mental representation and universal logic (Shanon, 2010). What once seemed to be the greatest strength of the idea of the "cognitive unconscious", namely that its principles could be studied by computer science irrespective of biological or phenomenological considerations, has turned out to be its greatest weakness. Ultimately, computationalism leaves the two essential requirements of any cognitive science that were highlighted by Stewart (2010) unfulfilled: not only does it leave the relationship between consciousness and cognition mysterious (e.g., in form of the "hard problem" of consciousness), the absolute logical distinction between cognition on the one hand and brain–body–world on the other prevents a genuine core articulation between the different disciplines from taking place. The enactive approach therefore dispenses with the notions of inner mental representation and symbol manipulation altogether, and instead proposes the establishment of a direct, mutually informing dialogue between biology and phenomenology (Le Van Quyen, 2010).

The development of a new paradigm for cognitive science without the need for representations would indeed be a case of revolution rather than reform, but at the end of the 1980s, there was not yet much experimental work available that could support the enactive case. Brook's (1991) influential work on behavior-based robotics was a notable exception, because it demonstrably emphasized the role of embodiment and situatedness at the expense of internal representations. Varela et al. (1991, p. 212) enthusiastically saw in Brooks' work a "fully enactive approach to AI", a direct appropriation that is understandable, although perhaps it was somewhat premature (Froese & Ziemke, 2009). As was the case with the connectionist "revolution" before it, it is far from clear that the robotics-inspired notions of embodied and extended cognition are inherently opposed to functionalism. On the contrary, they seem like a welcome extension to, rather than a revolution of, the orthodox framework: the idea is that body and world can serve useful functional roles in lower-level adaptive behavior, but that the explanation of higher-level human cognition still necessitates a return to the concept of mental representation (e.g., Clark, 1997; Wheeler, 2005). Given this apparent possibility of reform, we can thus understand Dennett's (1993, p. 125) skepticism regarding the revolutionary potential of the enactive approach:

> The trouble is that once we try to extend Brooks' interesting and important message beyond the simplest of critters (artificial or biological), we can be quite sure that something *awfully like* representation is going to *have* to creep in like the tide, in large waves. Will our Enactive Enlightenment lead us to say different sorts of things about these sorts of cognitive states, events and processes? Probably. *Very* different—revolutionarily different? It is too soon to say, so we won't know for awhile whether we need, or are in the midst of, a revolution in cognitive science.

Dennett was *right* in predicting that it would be a while before we were able to say with any certainty whether the enactive approach was indeed a genuine revolution in cognitive science. Now, 20 years later, with the publication of *Enaction*, we can finally say that Dennett was *wrong* in thinking that the enactive approach would be unable to address higher-level cognition without falling back on the notion of mental representation. In fact, as I will proceed to show in detail, it has opened up a whole new domain of research in human cognition that had previously been obscured by the theoretical commitments of orthodox cognitive science.

2 Sense-making: a new foundation

What precisely is "enaction"? As the editors put it in their introduction, "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" (Stewart, Gapenne, & Di Paolo, 2010a, p. vii). This rough definition is already familiar from *The Embodied Mind*, but with the help of the papers collected in *Enaction*, we can give a much more precise characterization of what is at stake.

A good starting point is to state outright that purposeful movement is essential to the phenomenon of life as such (Barbaras, 2010). The idea of the role of action for perception that was championed by Varela and colleagues is already familiar by now, especially because of the popularity of the related theory of "sensorimotor contingencies" (O'Regan & Noë, 2001). Similarly, it has already long been known from several influential studies that "appropriate action, allowing exercise of relevant sensorimotor contingencies, is necessary throughout life to stabilize the functional architecture in the respective circuits" (Engel, 2010, p. 227). But recent developments of the enactive approach go even further than this, and thereby make a more consistent case against skeptics who were all too happy to point

out cases in which there is experience without any evident role for action. Most importantly, the very existence of the living being is only made possible by its engagement in continuous metabolic and self-regulatory activity. The enactive concept of agency builds on these foundations by highlighting the autonomy and adaptivity of self-production in the regulation of sensorimotor loops:

> Autonomous agency goes even further than the recognition of sensorimotor couplings as dynamical and emphasizes the role of the agent in constructing, organizing, maintaining, and regulating those closed sensorimotor loops. In doing so, the cognitive agent plays a role in determining the norms that it will follow, the 'game' that is being played. (Di Paolo et al., 2010, p. 39)

This metabolic and self-regulatory activity of the living organism is the concrete ground in which an intrinsic normativity can take root, and which enables an inherent openness to new ways of being in the world to develop (more on this later). Although human cognition is often thought to be only dependent on brain activity, and thus appears to be far removed from the influence of these ongoing *internal movements*, a closer look at the neuroscience reveals this assumption to be unfounded. Cosmelli and Thompson (2010, p. 372) carefully trace the role of the biological body for normal brain activity and show that the two cannot easily be disentangled from each other. On the contrary, they suggest that "self-sustaining ongoing [brain] activity, which is crucially coupled to the functioning of the body, holds the highest level in the control of brain functioning." Thus, despite some superficial appearances to the contrary, it is strictly speaking correct to say that "the subject is *always* in movement" (Gapenne, 2010, p. 189).

Even at the level of internal physiology, it is important not to misunderstand the notion of movement as merely a kind of physical translation. Rather than being a passive response to internal and external perturbations, which is how movement was typically defined in the era of cybernetics and early versions of autopoiesis (Froese & Stewart, 2010), movement is now conceived as self-generated motility. Movement spontaneously brings forth the organism and its world, thereby constituting the original meaningful situation of life as a whole in which more specific kinds of movements can then be deployed by the organism to satisfy its needs (Barbaras, 2010). Indeed, this is a concept of movement that places lived experience at the very beginning in the sense of kinesthesia (Sheets-Johnstone, 2010), out of which further articulations into self-world distinctions and object perception must be developed from fetal life throughout ontogeny and into adulthood (Gapenne, 2010). And, of course, that which eventually becomes articulated as being "other" from a "self" continues to be a part of the original context of significance that is inherent in self-generated movement. On the side of biology, this idea connects nicely with the tradition of von Uexküll:

> With respect to the environment, this means that the environment is never, for the living system, a neutral world awaiting to be internally represented and evaluated in order to become meaningful. Rather, the world is directly encountered *as* meanginful by the concerned living system. The world is always the living system's own meaningful *Umwelt*. (Colombetti, 2010, p. 148)

And on the side of phenomenology the enactive approach can build on a vast body of existing literature in the tradition of Husserl, Heidegger, Merleau-Ponty and others, whose careful analysis of the first-person perspective has revealed that "what we encounter as cognitive agents are never 'bare' objects or arrays of contingent features, but rather meaningful situations, that is, contexts we have already structured by prior activity and in which objects are defined as a function of our needs and concerns" (Engel, 2010, p. 223).

Here we thus have the beginnings of an enactive biophenomenology that goes beyond functionalism in at least two crucial respects. On the side of biology, the living body is the ultimate source of significance, but it can only serve this role because it is a continually actively constructed body that is always precarious and vulnerable to disintegration. The core meaning that derives from the ever-present potential of death, an eventuality which can be negatively defined as the *cessation of all functioning*, cannot adequately be captured in functionalist terms (Di Paolo et al., 2010, p. 42). And on the side of phenomenology, there is the notion of a meaningful situation or lived world, conceived as an encompassing horizon of significance, which provides the necessary context *within* which functions can be evaluated. In other words, whereas specific objects can be revealed through sensorimotor activity, in order to be genuinely meaningful they presuppose a center of agency and its world (Thompson, 2005). Although robotics has made much progress in this direction, it has immense difficulties in trying to address these non-functionalist, enactive concepts of embodiment and situatedness (Froese & Ziemke, 2009).

At the core of the paradigm of enaction, we thus have a notion of movement that is actively self-generated through its living and lived embodiment, and which at the same time brings forth a world of significance. Following the influential work of Weber and Varela (2002), this living-lived movement has become known as *sense-making*, a concept that has broader applicability than the notion of action in perception alone (Froese & Di Paolo, 2011). As we have already seen in this brief overview, a systematic explication of the concept of sense-making tightly integrates other central concepts of the enactive approach, namely autonomy, embodiment,

emergence, and experience (Di Paolo et al., 2010). Moreover, the process and result of sense-making, at this fundamental level of description, are resolutely non-functionalist and non-representational.

The next challenge we must address is to scale up this discussion from adaptive behavior to human cognition. As I will now show in detail, many of the papers in *Enaction* do precisely that in a rich variety of ways.

3 Higher-level cognition: new challenges

What is special about the human mind? For orthodox cognitive science, it is the functionality of higher-level cognition, which is conceived of as an independent intermediate stage that takes place after perception and before action. Although cognition varies in implementation details from species to species, perception and action, on the other hand, are assumed to have essentially the same function in all organisms. It is believed that action merely executes preplanned sequences, whereas perception is supposed to be in the business of furnishing cognition with abstract representations of the environment, i.e., with a list of facts, as they would normally be described by Newtonian physics. According to the paradigm of enaction, none of these assumptions hold up to scrutiny.

This idea that perceptual experience is best characterized in terms of the basic concepts of physics, an assumption that I have elsewhere called "methodological physicalism" (Froese, 2009), is the cause of much confusion in cognitive science. It is true that adult, enculturated human beings are highly proficient at adopting a detached stance and abstracting from their immediate experience, but to generalize this ability of objectification as the primary function of perception is misguided. It misconstrues the perceptual worlds of non-human organisms, which, as we have seen in the previous section, are inherently meaningful and structured in relation to the sense-making of the organism. It also insufficiently problematizes the abstract abilities of the human mind. That is, if all of life starts phylogenetically and ontogenetically with the sense-making of an *Umwelt*, where does the specifically human ability of neutralizing and objectifying the *Umwelt* into a physical environment come from?

Shanon's (2010) work on "thought sequences" nicely illustrates what is at stake here. Thought sequences are trains of verbal-like expressions of thoughts that spontaneously pass through people's minds. One participant of this study reported having had the following thought sequence upon seeing a girl who was calling her agitated dog by the name of "Doni":

1. It is really frisky.
2. She should have called it "Shedoni" [in Hebrew, diminutive for devil].
3. Or for short, "shed" [in Hebrew, devil].
4. That has meaning in English too, "shed."

What is of particular interest in this example is the transition between the last two expressions. As Shanon points out, what links these two expressions is the fact that the Hebrew word for "devil" coincidentally happens to be homophonic to the totally unrelated English word "shed". In other words, the spontaneous switch of context, which even took the participant by surprise, was only made possible because the thoughts were articulated in a concrete medium, in this case verbal-like expression. The medium of action becomes a source of creativity:

> Were thought conducted without a medium and governed only by considerations of content, one could think only of what one intends to, and would be confined to one's already established repertory of knowledge and belief. The articulation of thought in a specific medium and the introduction of aspects that are irrelevant from the perspective of content […] presents the possibility for the generation of novelty. (Shanon, 2010, pp. 394–395)

The orthodox view of cognition as "abstract symbol manipulation" cannot easily account for this finding because it is precisely what Shanon refers to as "thought conducted without a medium." But the enactive approach, at least as we have presented it so far, has difficulties to account for the creative transition, too. The main issue is that world perceived by the organism is always "governed only by considerations of content", i.e., defined in terms of what is directly relevant from its own perspective. To put it differently, when starting in the context of a world of relevance, how is it possible for the organism also to consider those aspects that are patently irrelevant for it, given that by definition these do not appear as part of its perceptual world?

The ability to introduce neutral elements into the focus of attention is important in several respects. As demonstrated by Shanon's example, it allows the subject to temporally decouple from the meaningful constraints of local situations and switch to a completely different context of meaning. Moreover, it is likely that this ability to occasionally decouple and enact new flows of meaningful activity is crucial when there is a need to explore the larger space of signification that is available. On this basis, we can hypothesize that the advantages of letting the neutral medium occasionally play a role in shaping the trajectory of situated cognition are formally akin to the well-known advantages of neutral networks in difficult optimization problems (e.g., Schuster & Stadler, 2003). *What the enactive approach to human cognition needs to explain, therefore, is how we are able to cast a neutral network onto our perceptual worlds of*

significance, such that it gives us the ability to traverse the semantic space more freely.

We are faced with a similar problem when considering the role of metaphor in human cognition. Núñez (2010) nicely shows that many metaphors are based on our biological embodiment, and that these metaphors play a crucial role in highly abstract forms of cognition, including in mathematics. This is indeed another highly unexpected finding from the perspective of orthodox cognitive science. If cognition is computation, then it should be logically independent from the mind's physical realization, especially in the case of highly abstract mathematics. And yet it is precisely these metaphors that extend the range of human thought:

> Human everyday language displays hundreds of thousands of these expressions, whose meaning is not literal—in any real physical sense—but *metaphorical*. These expressions are linguistic manifestations of human everyday common sense and make human imagination possible by conveying precise meanings beyond physical reality. (Núñez, 2010, p. 317)

However, the linguistic concept of metaphor also presents the enactive approach with a problem. How can an organism that is directly locked into its own world of significance appreciate that some meaning is *not* to be taken literally? In other words, whereas the results show that metaphors extend human imagination, Núñez is not correct in asserting that they make human imagination possible in the first place. On the contrary, it seems that metaphors already require imagination to be in place before they can even be appreciated as such. The bio-philosopher Jonas ([1966] 2001, pp. 165–167), who considers the faculty of imagination to be a defining characteristic of the human mind, nicely illustrates this problem with the example of a scarecrow. The birds who see it in the field presumably either perceive a threatening person or, if the deception fails, a convenient place on which to land and perch. It's either one or the other, depending on how well the scarecrow fits into the birds' context of relevance. For Jonas it seems safe to say that at no point do the birds see the scarecrow *as if* it was a threatening person. But that is precisely how we would perceive it, namely metaphorically. *What the enactive approach needs to explain, therefore, is how we can perceive something as being and not being at the same time, that is, as being symbolic*.

These two examples highlight the deep challenges that must be addressed if the enactive approach is to account for the specificity of human cognition. And yet at the same time, it should be remembered that orthodox cognitive science does not have the answers, either, because it has so far failed to even ask the questions. If the perceptual world is already conceived of as a barren physical space devoid of any significance, and if cognition is already conceptualized as the manipulation of abstract symbolic representations, neither the neutrality of perception nor the possibility of imagination can be adequately problematized. This demonstrates that orthodox cognitive science does not have such a strong grip on the domain of specifically human cognition as is often presumed. Moreover, the enactive approach, as I will show now, is already starting to explore a variety of ways in which sense-making can become neutralized and invested with new meanings.

4 Human cognition: second-order sense-making

We have now identified what the enactive approach needs to explain in order to account for the specificity of adult human cognition, namely "the development of a capacity to "unstick" meanings from a given situation and "stick" novel ones onto it (to put it graphically), or, generally, the capacity to influence meaning generation" (Di Paolo et al., 2010, p. 74). The objectifying stance, i.e., the ability to neutralize the presence of existing meanings, and the symbolizing stance, i.e., the ability to impute additional layers of meaning, are two sides of the same general meaning-regulating ability, namely the "subtraction" and "addition" of meaning, respectively. Both of these abilities require the normatively guided regulation of primary, situation-bound sense-making, so that in the case of higher-level human cognition we are in fact dealing with a sophisticated kind of sense-making *of* sense-making. In short, *human cognition is second-order sense-making*. Let us consider this hypothesis with some examples.

One of the most powerful forms of second-order sense-making is language. Given that we want to explain the specificity of human cognition, language perfectly fits the bill: "speaking is an alternative cultural medium that can override the natural medium and be utilized to control enactive experiencing instead of letting the physical world "decide" on what should be lived by humans" (Bottineau, 2010, p. 278). Indeed, the use of language has many profound effects that enable human cognition as we have defined it. First of all, it can help to evoke a detached stance regarding the immediate situation because "language, characteristically, has an effect of *taking a distance* from the action itself. To put it crudely, as long as two people are hurling verbal insults at each other, they have not actually come to blows" (Stewart, 2010, p. 16). Secondly, this linguistic distancing not only creates a more neutral space, it also thereby enables us to refer to aspects of our lived situation that normally do not make an appearance in the focus of experience: "words may refer to notions that cannot be treated as entities or events, but to sensations, emotions, and abstract categories born out of highly heterogeneous experiences with no material core" (Bottineau, 2010, p. 283).

The notion of linguistic reference may give the impression that we have entered classical representationalist territory, and that the enactive approach has come around to traditional orthodoxy to deal with higher-level cognition after all, but this is not the case. Instead, what we have is a paradigmatic instance of second-order sense-making. This novel enactive idea is nicely supported by Bottineau's phenomenologically informed linguistic study, which leads him to emphasize that "speaking does not *refer* to the world; it *causes an experience*" (2010, p. 278). Bottineau goes even further and asserts that language-use is instrumental in constituting reflexive consciousness (2010, p. 282).[1]

This is a fitting point also to highlight the role of pedagogy for the development of human cognition, a topic that is regrettably largely absent in *Enaction*, even though several chapters deal specifically with infant developmental (Gapenne, 2010; Sheets-Johnstone, 2010; Sheya & Smith, 2010). In fact, it seems that only Stewart (2010) explicitly touches upon issues related to language instruction and enculturation, albeit only briefly in the context of primatology, and he also mentions the existence of education and teaching in passing. Future work on the enactive transition from adaptive behavior to human cognition will have to take a closer look at the role played by active instruction during human ontogeny. In order to get an idea of what might be involved, we can consider an nice example provided by Bottineau (2010, p. 288), who recounts the following utterance by a mother playing with her 2-year-old daughter at a French skiing resort: "Look! This is snow. Look! It's white, it's cold, it sticks, you can pick some and make a ball, and throw it at Daddy, look, splash!" At which point the family burst out laughing. Bottineau perceptively analyzes the effect of the mother's utterance on the infant in terms of its sensorimotor evocations, but unfortunately he does not comment on the mother's frequent use of "Look!", which is quite a remarkable expression. May this be an example of a special speech act intended to highlight for the infant an instructive opportunity for what the enactive approach refers to as "participatory sense-making" (Di Paolo et al., 2010)? Although this is a topic that still requires further study, it is tempting to consider pedagogical instruction from the perspective of second-order *participatory* sense-making.

What we have said of language is generally also true of writing, but with a new twist that enables its distancing-effect and creative redeployment of primary sense-making to proceed in new directions. Importantly, with the invention of writing there is an even greater effect of decontextualization with respect to immediate practical needs when compared with speaking:

> In the heat of the moment, in the real time of the chanting of a ballad by a gifted orator, all sorts of collective emotional effects are possible. By contrast, writing is structurally individual and private, both during reading and the writing itself; it is thus an instrument that induces a critical distance, which dissipates collective emotion and promotes what is called 'objectivity.' (Stewart, 2010, p. 25)[2]

It is on the basis of writing that logic, philosophy, and the natural sciences could fully develop, thereby inaugurating a socio-cultural process that will eventually culminate in the invention of modern technology. Although the radical idea that technology is constitutive of human cognition is often associated with "extended mind" approaches in the philosophy of cognitive science (Clark, 2003), several chapters in *Enaction* show that it is also a major theme for the enactive approach (e.g., Gapenne, 2010; Havelange, 2010; Hutchins, 2010; Stewart, 2010).

The general idea of sensory substitution technology is well known in cognitive science, although the research described in *Enaction* (e.g., Gapenne, 2010) has a distinctively enactive kind of minimalism that is already familiar from work on simulation models and robotics (Di Paolo et al., 2010). In the current context, what is important about sensory substitution technology is that it enables a systematic study of the process of redeploying sense-making in a neutral action space. Novice users of such a device only experience a strange, opaque tool in their hand, which they are forced to regulate with the help of abstract reasoning. Eventually, however, after a period of active learning, the sensorimotor laws governing this action space will become intuitively apparent, and soon enough the participants will once again experience their perceptual focus directed to aspects of the world, albeit now with the aid of implicit technological mediation (Froese, McGann, Bigge, Spiers, & Seth, in press). Here we thus have an example of how technology enables a detached stance onto a neutral medium, which can then, with practice, open up into a new meaningful perspective on the world.

The example of transformation of perceptual experience by means of sensory substitution technology is particularly illustrative, but according to the paradigm of enaction the same idea applies to all kinds of technology. In other words, "to the extent that their sensorimotor coupling with the environment is mediated by tools, what the 'world' *is* for human beings is largely constituted by these tools" (Stewart, 2010, p. 19). And when we consider that what the world is like for human beings also includes how humans understand themselves, we arrive at what the editors of *Enaction* have highlighted as the hallmark of the "Compiegne School", according to which "Technology is Anthropologically Constitutive" (Stewart et al., 2010a, p. xiv). Havelange (2010) makes an important contribution to this thesis by showing that a serious

consideration of technology plays a crucial role in going beyond a purely biological account of sensorimotor interaction, while at the same time demonstrating that the phenomenological analysis of subjectivity cannot be completely divorced from an appreciation of empirical issues. In other words, the constitution of modern human cognition can only be fully understood with reference to its wider socio-cultural historical context:

> A system of technical artifacts functions as a *collective memory* that is always already-there for members of a given society, but that is not a part of their own experience before they themselves (re)appropriate it. This appropriation is performed by individuals, but the technical system is always already-social; thus, the system mediates a process of individuation which is inseparably psychic and collective. (Havelange, 2010, p. 347)

This macro-level perspective on the thesis that technology is anthropologically constitutive does a good job at painting the bigger picture, but it remains open to the potential criticism that it is too abstract and removed from empirical issues to be of any direct use for researchers in cognitive science. Fortunately, the chapter by Hutchins (2010) dispels this worry by complementing the chapter by Havelange with a detailed micro-analysis of the technological constitution of human cognition from the perspective of anthropology. Interestingly, the notion of representation finally makes a return here, but not in terms of the orthodox tradition's unquestioned assumption of a decontextualized entity internal to our brain-mind, but rather as a product of a distributed socio-cultural process:

> Many people seem to assume that the status of external representations qua representations is unproblematic. But what makes a material pattern into a representation, and further, what makes it into the particular representation it is? The answer in both cases is enactment. To apprehend a material pattern as a representation of something is to engage in specific culturally shaped perceptual processes. (Hutchins, 2010, pp. 429–430)

Hutchins goes on to demonstrate the viability of this assertion by analyzing a concrete instance of navigation practice. He succeeds in showing that what the navigator sees *as* a representation and as what *kind* of representation (the same technique of tool-use can have different meanings depending on the specific goals) is largely determined by the culturally embedded task.

Hutchins shows that, contrary to the expectations of its critics, the enactive approach to higher-level cognition is not impoverished by its rejection of the orthodox concept of representation. On the contrary, by moving its framework into the domain of higher-level cognition, it becomes clear that it is actually the orthodox tradition of cognitive science that is misguided and impoverished: it has failed to take into account the embodied and socio-culturally situated processes by which we are able to enact material patterns as representations. It is only by being blind to these conditions of possibility of representations that the cognitivist core idea, namely that there are representations operative inside the brain, could have any semblance of plausibility at all.

The paradigm of enaction, on the other hand, places higher-level cognition squarely within the relational domain of being-in-the-world, such that tool-use becomes conceived as an advanced form of thinking through movement. Hutchins (2010, p. 446) nicely sums up the guiding idea: "High-level cognitive processes result when culturally orchestrated low-level processes are applied to culturally organized worlds of action." It is also important to note that this work shows how specifically human form of second-order sense-making is open to direct empirical and phenomenological investigation, because it is embodied in gesture and distributed through the social and technological world. This is in stark contrast to the internally hidden, and yet essentially non-biological and non-phenomenological "cognitive architecture" that has traditionally been the focus of speculation in cognitive science.

5 Coming back down: rethinking foundations

Many of the chapters in *Enaction* demonstrate that it is possible to approach the domain of higher-level cognition without having recourse to the notion of mental representations. But although these contributions make a promising case for the constitution of human cognition, we are still left with the question of ultimate origins. All of the ways of facilitating the development of the modern mind that we have discussed so far presuppose that some form of human culture is already in place. But what happened at the very beginning of culture? What enabled us to detach from our ordinary preoccupations in the first place?

One possibility that has recently been receiving a lot of attention in the study of the origins of culture in prehistorical times is the role played by altered states of consciousness (Lewis-Williams, 2002). The evocation of these altered states does not presuppose much, especially because powerful psychoactive elements are naturally contained in many plants, fungi, and animals around the globe. We can therefore assume that early hunter-gatherers must have come across some of them during their activities and would thus have been familiar with their varied effects on consciousness. Depending on the particular substance, the impact can range from subtle modifications to a complete overhaul of normal sense-making:

> The phenomenological domain at hand encompasses affective effects, nonordinary perceptions in all sensory modalities, modifications in the sense of self and reality, altered temporality, nonordinary mentations and ideations, spiritural and religious effects, as well as patterns of over behavior (i.e., singing). (Shanon, 2010, p. 404)

What is especially interesting about these effects in the current context is that, during the experience of an altered state of consciousness, previously negligible aspects of the situation may suddenly become infused with an unexpected sense of profound significance. Altered states can bring into conscious focus what was previously neutral and hidden from view, and which can thereby become the target for further reflection and manipulation. Of course, as is well known, a person's psychological make-up and their situation (the "set and setting") have a strong influence on how these effects are experienced and interpreted. So in order to be a plausible candidate as an early catalyst of human cognition and culture, it still needs to be shown that the intake of such substances not only leads to nonordinary states of consciousness, but that the effects would actually be recognized as a source of creativity and valued to the extent that they become incorporated into ordinary life. For instance, the practices and insights would need to be inscribed into social rituals and material media.

Could the origins of specifically human cognition be explained without recourse to voluntarily altered states? Interestingly, it turns out that in a small percentage of the general population an objectifying stance may be spontaneously forced onto a person without any apparent external trigger. This is often the case for people suffering from epilepsy. Le Van Quyen (2010, pp. 250–252) describes the typical phenomenology leading up to a seizure as consisting of three major aspects: (a) There is what Le Van Quyen calls "thought interference", which means that "the patient experiences thoughts or ideas that suddenly pop up in the mind as if from nowhere and break into the main line of thinking or interfere with it." Time consciousness is altered. In severe cases, it can be like experiencing the intrusion of what the literature refers to as a double consciousness or second stream of consciousness. (b) The experience of thought interference is accompanied by what some patients call "forced attention." Without the patient's voluntary control "the scope of attention becomes narrow and the focus of attention is directed inward, away from external stimuli." One reason for this shift in attention is absorption in the seizure-induced experiences. I note that there is also a certain similarity between this forced internal redirection of conscious attention, and Heidegger's description of the external redirection that is involuntarily induced by a breakdown of tool-use. Both may be caused by a crisis in smooth coping, but with a different causal locus (internal versus external). The next category of characteristic features of seizure phenomenology further confirms this similarity. (c) In association with forced attention, patients often experience a distance between their experiences and their sense of self: "there is a constant self-monitoring in which the patient excessively takes himself as an object of reflection." Smooth coping is thereby further impaired, and the detached stance intensifies, turning the patient into an external observer of her own lived situation. Here we thus have an example of how an internal disturbance causes the normal being-in-the-world to be overlaid by a subject-object split of the kind that also seems to be in play when we voluntarily decouple from our direct immersion in the world in order to assess its objective properties. Indeed, as Le Van Quyen (2010, p. 252) remarks, patients often report that before the seizure "thoughts are experienced in a spatialized way, for example localized to a particular part of the head or body (e.g., 'My thoughts are pressing from the inside') or being described in spatial terms (e.g., 'One thought in front of the other,' 'Thoughts are encapsulated')." This unusual awareness of spatial aspects of mentation may be another example of what Shanon (2010, p. 394) has described as the decoupling between medium and content, whereby aspects of the medium itself enter into the focus of awareness.

In sum, it seems that both externally and internally triggered altered states of consciousness could have potentially played a role in the origin of the modern mind. The possibility that a breakdown of the ordinary human mind can serve as a trigger for an involuntarily imposed mental change also recalls the position of Stewart (2010, p. 22) who, following the work of Jaynes, speculates that "modern consciousness was born in suffering, at a time of crisis with the *breakdown* of the [old mind]." I will not go further into the details of this theory here, except to note that we must be careful when evaluating the effects of such breakdowns, whatever their trigger, on persons who already start out as enculturated human beings. For instance, presumably neither psychoactive substances nor epilepsy alone could transform the chimpanzee mind into a human mind.

But these reflections do raise the question of what a pre-modern and even pre-human mind must have been like in order to account for the eventual emergence of the modern human mind. In other words, an enactive account of higher-level cognition requires a double gesture, namely to show how the principles of the lower-level are retained and modified in the constitution of the higher-level, and also to show how the principles of the higher-level are already prefigured in the constitution of the lower-level. In what follows, I will briefly consider how the chapters in *Enaction* address the latter aspect.

A useful starting point is to consider human ontogeny from the perspective of the embodied mind, which allows us to conceive of the notion of "thinking in movement", and which reveals that "tactile-kinesthetic analogical thinking is an elemental mode of thinking" (Sheets-Johnstone, 2010, p. 171). Thus, even in the initial phases of human life, the mind is not completely locked into biologically pre-established patterns. To be sure, there are a whole variety of constraints (in addition to the biological ones we may also recall the role played by the socio-cultural context), but there is also significant room for autonomous exploration and opportunistic exploitation. As Sheets-Johnstone (2010, p. 171) puts it, "infants continually shape their movement spatially to the intentional urgings that prompt them to move. In a very real sense, they play with movement, discovering kinetic awareness and possibilities in the course of moving." Let us unpack this idea a bit further.

One way of investigating the infant mind is through an infant's interactions with its toys, an idea that recalls what we have already said about the distributed nature of cognition. Sheya and Smith (2010) highlight the fact that infants often spontaneously create their own goal-driven tasks by chancing upon the laws that govern their sensorimotor interaction with the toys. Fortuitous movement of a rattle creates a sound, which excites more movement, resulting in more sound, and so forth. Or a movement happens to push a mobile, which creates interesting visual patterns, thereby inviting more movement, and so forth. Sheya and Smith (2010, p. 129) explain: "It is spontaneous non-task-related movement that starts the process off by creating the opportunity for the coordination of the infant's action with the mobile's movement. It is this coordination that ultimately defines the task and thus becomes the goal." They consider this process of goal and task creation to be profoundly important to understanding both development and the openness of human potential.

But why should the coordination process be valued by the infant and how does that relate to the openness of human potential? The paradigm of enaction is starting to provide precise answers to these questions. Di Paolo et al. (2010, p. 48) "propose to define value *as the extent to which a situation affects the viability of a self-sustaining and precarious network of processes that generates an identity*." And, indeed, the infant's sensorimotor coordination is an example of a process with a self-sustaining organization that creates an identity, for instance of a "mobile-moving-and-seeing-infant". Such autonomous systems can be considered as realizing an intrinsic form of teleology. They are distributed across brain, body and world, but are asymmetrically centered on the side of the embodied agent. There is an asymmetry because the self-creation of the agent is what originally constitutes the relational domain.

These considerations are not limited to human infants—all living beings are fundamentally autonomous in that they actively build their own physical and systemic identity at various levels of description. To ignore the fact that autonomous agents can reinvent themselves, at least in principle, by modifying these processes of self-construction is to "ignore the crucial possibility that the cognitive agent may also be an *active creator of meaning* and that such creation can be subject to change and eventual control by emergent levels of cognitive identity" (Di Paolo et al., 2010, p. 73). The pre-human roots of higher-level human cognition might thus be best studied in the context of play, which not only has a crucial role in human ontogeny but also has precursors in many animal species.

Even more deeply, we can ask about where the drive to play comes from. What is the origin of what Sheets-Johnstone called "intentional urgings" and what Sheya and Smith referred to as "spontaneous non-task-related movements"? The idea of autonomous agency as being merely about the conservation of an identity fails to explain these kinds of observations, and the traditional concepts of homeostasis and autopoiesis are faced with the same kind of problem, namely of accounting for an intentional movement that goes beyond a mere reaction to environmental triggers (Froese & Stewart, 2010). Similarly, Barbaras (2010) takes Jonas' influential philosophy of the organism to task because his concept of "needful freedom", namely an autonomy that is grounded in and constrained by the necessities of metabolism, only enables the creation of a well-defined opening that cannot be meaningfully transcended. Barbaras argues persuasively that positing passive rest, which is ultimately the outcome of any satisfied need, as the essential nature of life is an explanatory dead end. Instead, he suggests that the phenomenon of life is better captured by the phenomenological notion of "desire", a notion that emphasizes the open-ended dynamics of becoming rather than the closed stasis of being. In the end, therefore, the horizons of human creativity may well be prefigured in the horizons opened by life itself.

6 Discussion

Throughout this review, I have emphasized that the paradigm of enaction cannot be easily dismissed as merely filling in the low-level details of orthodox cognitive science. On the contrary, it offers a fresh scientific look at higher-level cognition and the specificities of the human mind, thereby revealing profound insights that have escaped the orthodox tradition. At no point was there the slightest need to fall back onto the concept of mental representation, nor does the rejection of this concept evoke the specter of nihilistic reductionism because the concretely lived first-person perspective of

human experience is always tightly integrated into the scientific framework.

I have also indicated some of the reasons why there is a limit to how much of the paradigm of enaction can be appropriated by a more progressive functionalism, especially because of the constitutive role of mortality. Because the rejection of functionalism as such strikes directly at the core of orthodox cognitive science, more deeply even than the rejection of mental representation, it is important to be sure about this assertion. In what follows I will therefore try to motivate a conceptual revolution over a conceptual reformation by highlighting what can be gained by switching from an embodied-embedded functionalism to the paradigm of enaction. Instead of negatively focusing on the limits of functionalism, the strategy I will pursue this time is to show positively how an ambiguous piece of work can benefit from further radicalizing its enactive content.

Of all the chapters collected in *Enaction*, the one that is most amenable to be appropriated by functionalism is the one by Núñez (2010) on bodily grounded conceptual metaphors. Consider, for instance, the linguistic expressions "The summer lies ahead of us" and "The big game is now behind us". Taken literally, the expressions do not make any sense because "the summer" and "the game" do not refer to spatially localizable entities. But taken metaphorically, we can make use of our knowledge of our own spatial embodiment (a "source domain") and re-apply this bodily knowledge to the non-spatial context of temporality (a "target domain"). Núñez argues that in the case of these two expressions, the linguistic cross-domain mapping is based on a single general conceptual metaphor, namely that "Time Events Are Things in Unidimensional Space". This metaphor is taken to be dependent on the specific morphology of our body, or at the very least it is only conceivable for creatures with a body that has an unambiguous front and back. Núñez goes on to repeatedly emphasize that this finding is not culturally relative and that all metaphorical construals of time "are, as far as we know, based *only* on a spatial source domain" (2010, p. 319). He finds the reason for this cross-cultural validity in the details of human embodiment:

> Human abstraction is thus not merely 'socially constructed.' It is constructed through strong nonarbitrary biological and cognitive constraints that play an essential role in constituting what human abstraction is. Human cognition is thus embodied, shaped by species-specific nonarbitrary constraints. (Núñez, 2010, p. 319)

Conceptual metaphors are not the only linguistic tools we can use in higher-level cognition. It is possible to derive further categories of linguistic constructs from the specificities of the biology of human embodiment (e.g., "conceptual blends" that mix and combine different domains, and "aspects" of processes, like deriving the concept of iteration out of a cyclical bodily process such as breathing). Núñez then demonstrates how these bodily grounded concepts enable us to understand even the most abstract concepts. In particular, he focuses on the mathematical concept of actual infinity, and especially its use in the influential work of the controversial mathematician Cantor.

These are some impressive intellectual fireworks, but it is also not too difficult to see that the new breed of functionalists in cognitive science will not be seriously worried by this performance. After all, another way of telling the story is, to put it crudely, that the mathematical mind has functionalized the body. For instance, Núñez appears to have demonstrated that even the mere biological fact that our body has a distinct front and back can serve a functional role. What more can the functionalist ask for? This is like serving them the concept of embodiment on an orthodox platter.

We can also detect a certain uneasiness or tension in Núñez's argument, which comes to the fore in his frequently repeated assertion that the general validity of mathematics, although no longer absolutely mind independent, is not threatened by a total relativism, because of the non-arbitrary constraints of the biological human body. But the constraints are non-arbitrary in what sense? Perhaps here is the root of the tension, because Núñez is surely aware that our biological body is, in the end, a contingent accident of evolution. Is mathematics therefore also contingent on this accident? It therefore seems that the specificities of the human body are not a suitable anchor for mathematics, whose insights we encounter in our experience as being absolutely valid universally, and quite independently of our particular evolutionary history on earth. I propose to resolve this dilemma in two complementary steps, both of which strengthen Núñez's position by making its foundations more in line with the paradigm of enaction.

First of all, it is quite remarkable that Núñez accepts the orthodox conception of space as an independently given abstract dimension as the basis for his general conceptual metaphors, e.g., "a Unidimensional Space". This is in stark contrast to the other papers in *Enaction*, which give a whole variety of different studies of the embodied subject's active constitution of spatiality. For example, there are detailed investigations of the socio-cultural constitution of space (Hutchins, 2010), the psychological and dynamical constitution of space (Gapenne, 2010), and the developmental constitution of space (Sheets-Johnstone, 2010). I have already discussed some of these studies and it is not necessary to repeat their findings here. Effectively, what they all have in common is an emphasis on the necessity of intentional and active movement in order for a sense of spatiality to be realized in the first place. In other words, a deeper grounding of the spatial conceptual metaphors of temporality can therefore be found in motility, namely by recognizing that what is "before

us" or "behind us" can only be meaningfully understood on the basis of active movement.

The second step is to realize that active movement is not an attribute that is in any way dependent on the biological details of the human body. On the contrary, if we follow the persuasive arguments of Barbaras (2010), then active movement turns out to be the most defining aspect of the phenomenon of life as such. This insight allows us to propose a crucial generalization of the validity of abstract concepts. In particular, the notion of living movement enables Núñez to ground his linguistic insights not only in the contingent evolutionary accidents that happen to constitute the human body, but also, and more importantly, in the essential properties of *life itself*. In other words, in as much as the conceptual metaphors and linguistic constructs underlying the foundations of mathematics are dependent on the essential characteristics of life in general, the mathematical insights are no longer dependent on the properties of any one particular species, but are in fact universally valid in the only meaningful sense of the term, namely for all actual and potential living subjects. In the end, therefore, once we take the initial step to conceive of mathematics as grounded in the empirical domain of embodied practice, rather than as being transcendentally mind-independent, the universality of its insights depends on ensuring that the notion of embodiment is conceptualized as radically enactive.

7 Conclusion

In this review of the book *Enaction*, I have traced the paradigm of enaction from its unique foundations in the key notion of sense-making to its rich insights into abstract human cognition, which can be productively considered as a form of second-order sense-making. Contrary to the expectations of its critics, even in the case of addressing the specificities of human cognition, at no point does one get the impression that something crucial is left out of this paradigm because it avoids the concept of "mental representation" and rejects functionalism. Quite the reverse, it quickly becomes clear that it is actually the orthodox theory that has painted a highly impoverished picture of life and mind. One major reason for this state of affairs is that the orthodox tradition is primarily based on the invention of a hidden mental domain (i.e., the "cognitive unconscious") that invites endless speculation about abstract computational architectures, but which essentially is not open to a genuine dialogue with biology and phenomenology.

Of course, the paradigm of enaction is far from complete, but this should not be a surprise given its young age. Its current gaps are not insurmountable problems, but rather invitations to further explore the rich synergies between its various methods and insights. If anything, the subtitle of *Enaction*, namely *Toward a New Paradigm for Cognitive Science* is rather modest. Looking into the future, we can expect that the basic principles of enaction, which describe how we relate to our world, will be applied to even more disciplines outside of the traditional mix of the cognitive sciences. It is therefore not inconceivable that eventually there will be a distinctively enactive approach to all of the humanities and natural sciences. In fact, many of those disciplines have already rejected the representationalist framework long ago, and are in need of rigorous new foundations. Moreover, the emphasis on concrete practice, social participation, and personal responsibility, which have always been prominent themes of the paradigm of enaction, strongly resonates with the many practical disciplines of mind-body exploration that are increasingly popular in the general population. Further developing these links as mutually informing dialogues could go a long way in unifying the natural and human sciences, as well as science and other practices in our lifeworld.

Is it too soon to predict that the representationalist theory of mind is going to share the fate of phlogiston theory and be consigned to the dustbin of scientific history? Time will tell, but in the meantime, the small but growing community of enactive researchers has successfully demonstrated that it can stand on its own feet without the crutches of representationalism and functionalism.

Notes

1 If this assertion is in fact valid, then we must be careful not to misunderstand reflexive consciousness as merely providing a reference to primary consciousness. Reflexivity is better conceptualized as another instance of second-order sense-making, which brings forth new experiences rather than representing existing ones.
2 In another important sense, we can characterize writing as essentially *public*, because it is a process by which linguistic expression is inscribed in solid matter. Text transcends the momentary, and in that sense *private*, nature of a speech act (Bottineau, 2010, p. 275).

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