



# Making sense of doing science: on some pragmatic motifs guiding the enactive approach to science

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## Abstract

In this article, I will explore the enactive approach to science and the pragmatic motifs that guide it. In particular, in the first half of the article, I will discuss to what extent enactivism can be seen as a philosophy of nature, and by comparing it with Sellars's interpretation of the conflict between the manifest and the scientific image of humans in the world, I will focus on the view of nature that enactivism defends. In the second part, I will compare the enactive approach with Dewey's conception of the organism-environment interaction by focusing on the underlying similarities between their views of evolution and their way of seeing science as the most sophisticated expression of an organism's sense-making.

**Keywords** Philosophy of nature · Metaphilosophy · Theories of evolution · Dewey · Sellars · Enactivism

## 1 Introduction

In recent years, the link between enactivism and pragmatism has been attracting growing attention in various forms and along various directions of investigation.<sup>1</sup> In this article, I would like to contribute to this burgeoning debate by focusing on the

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<sup>1</sup> In some cases, there is a generic association between the two approaches—for instance, in the introduction to Engel et al. (2015), where the “pragmatic turn” is identified with the process that in the last decades has brought cognitive science away from “the traditional representation-centered framework toward a paradigm that focuses on understanding cognition as being ‘enactive’; that is, a cognition as a form of practice.” In the same volume, Menary (2015) and Gallagher (2015) discuss the link between the two approaches in a more accurate and historically grounded way. The same thing happens in Caruana and Testa (2021) and Gallagher (2017). In Crippen and Schulkin (2020), the pragmatist and the phe-

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enactive approach to science. In fact, in his introduction to the revised edition of *The Embodied Mind* (which is, as is widely known, the founding book of enactivism), Thompson (2016, xxvii) pointed out how little it has been noticed in the literature on embodied cognition that “the enactive approach also implies a certain conception of science.” My aim is to insist on the theoretical link between enactivism and the pragmatist tradition by showing how this can help us grasp the pragmatic motifs that drive the enactive approach to science and shed light on what this encounter entails for the human picture of science.<sup>2</sup>

Following Gallagher (2017, 48), in the present article my reference to some of the most important representatives of the pragmatist family is to be understood not as an attempt to provide a historical account of how the pragmatists would have anticipated the assumptions that guide the enactive approach to science, but rather as a willingness to put pragmatism to work on illuminating this approach, in a similar way to what the enactivists themselves did by wedding their perspective with that of phenomenology, especially in Merleau-Ponty’s version. More specifically, with the mediation of Richard Rorty (who is the only pragmatist mentioned in *The Embodied Mind*), I will consider Sellars, because his distinction between the manifest and the scientific image and his metaphilosophical observations will help us to define the issues at stake, and John Dewey, who is the exponent of the pragmatist tradition who has been most frequently associated with the enactive approach in recent years.

I have divided my argumentation into four sections. First—still following Gallagher, who takes up a hint from Godfrey-Smith—I will consider to what extent enactivism can be meant as a philosophy of nature. In the second section, I will see how the enactive approach to science can revise Sellars’s interpretation of the conflict between the manifest and the scientific image of humans in the world by radicalizing the pragmatic dimension of science. In the third, I will find in the attention to evolution the point at which enactivism shifts away from the phenomenological tradition, which it systematically refers to, by coming closer to Dewey’s classical pragmatism. Finally, I will demonstrate how reading the enactive view of science in pragmatic terms allows us to conceive of scientific inquiry as one of the most sophisticated expressions of sense-making in the history of the organism’s co-constitutive interaction with the environment.

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nomenological traditions are described as sharing enactive views from their beginnings. Crippen (2020) explicitly employs the expression “enactive pragmatism.”

<sup>2</sup> Often the adjectives “pragmatic” and “pragmatist” are employed as synonyms, with a general preference to use the former. To prevent from assuming surreptitiously that the enactive approach fits into the historical-philosophical tradition that goes by the name of “pragmatism”, in this article I would like to preserve the adjective “pragmatist” for cases where I refer to this philosophical tradition that finds its founders and most eminent representatives in William James, Peirce, Dewey, and Mead; on the contrary, “pragmatic” will be used more theoretically to designate any action-oriented approach aimed at seeing cognition as a form of practice and know-how.

## 2 A philosophy of nature?

According to Gallagher (2017, 34 ff.), by focusing on the “rich dynamics of brain-body-environment,” the enactive approach offers “a holistic conception of cognition” that challenges the standard view of science. However, it is quite difficult to make holism operative, both because it cannot be verified or falsified by a single critical experiment, and because it does not belong to the typical division of labor in science whereby one does not attempt to take all factors into account at once, but at most to pursue a specific research program with the aim of contributing to an overall view. In other words, even though enactivism makes empirical claims that suggest a new interpretation of the data provided by scientific experiments (such as in the case of sensorimotor contingencies), its emphasis on a holistic and integrated view of embodied cognition presents crucial problems for empirical and experimental investigation. This leads Gallagher to appropriate Godfrey-Smith’s distinction between a scientific research program and a philosophy of nature.

Godfrey-Smith (2001) introduces this distinction in discussing criticism against the development systems theory, that is, the interactionist view according to which all phenotypes are joint products of heterogeneous resources, including genes and environment, which contingently but more or less reliably reassembled themselves for each life cycle (see Oyama et al., 2001, 1–3). According to Godfrey-Smith, the most controversial aspect of this theory is precisely the extreme holism toward which it tends, making it appear to its critics as inconsistent with the practice of ordinary empirical research. Although the development systems theory often aims to make functional proposals for the elaboration of a scientific research program and is evidently committed to a set of empirical claims,<sup>3</sup> Godfrey-Smith (2001, 284) suggests that it seems most effective when thought of as a philosophy of nature. In his view, a good philosophy of nature does “have to be *consistent* with the claims made by science,” but this does not entail that the concepts employed should be the same as those used in the relevant science. This is why the aim of a philosophy of nature goes beyond that of elaborating an experimental research program. Rather, the two main goals are (1) to try “to accommodate the claims made by a number of different sciences”; and (2) to emphasize the relevance of some “scientific ideas” for significant problems treated in philosophy. In Godfrey-Smith’s view, this has at least two consequences, which I would like to discuss critically in this article.

First, far from doing science from an armchair, the philosophy of nature has to be seen as coming *after* empirical science and has to be identified with the attempt to give “a careful philosophical redescription of the picture of the world that science seems to be delivering” (Godfrey-Smith, 2001, 285). This allows Godfrey-Smith to differentiate the “philosophy of nature” from both a “naturalistic philosophy” *à la* Quine—which, in conceiving the philosophical work in continuity with science, gives up the autonomy of philosophy and puts it at the service of the “overall scientific project” (Godfrey-Smith, 2001, 284)—and a “natural philosophy,” which, elaborating on an approach to science influenced by German romanticism (e.g., Schelling and Novalis),

<sup>3</sup> Godfrey-Smith’s references for the notion of a “scientific research program” are Lakatos (1970) and Laudan (1977).

ascribes to philosophy the normative function of developing a teleological view of the unity of nature (see for an overview Gould, 1977, whose main references in the field of 19th century *Naturphilosophie* are Haeckel and Oken).

Second, insofar as a philosophy of nature advocates a holistic view that connects specific scientific programs with the willingness to outline a general image of the world, it does not need to express its theses “in the raw language of science” (Godfrey-Smith, 2001, 284), but at the same time, it can make scientific language itself an object of its critical consideration, emphasizing when it is pragmatically effective in the pursuit of specific research goals and when it conversely hinders the development of a general worldview. For instance, the development systems theory “bets that genetics would benefit in many ways from giving up the special kinds of semantics and computational descriptions of genes” so common in molecular biology (Godfrey-Smith, 2001, 288).

Appropriating Godfrey-Smith’s descriptions, Gallagher (2017, 23) observes that the identification of enactivism with a philosophy of nature “can be seen in the fact that from the very start enactivism involved not only a rethinking of the nature of mind and brain, but also a rethinking of the concept of nature itself.” His references are in particular Di Paolo (2005) and Thompson (2007).

Di Paolo discusses Weber & Varela’s (2002) description of organic life in terms of autopoiesis and sense-making. With these two terms they designated the physical phenomenon of self-maintaining, self-regulation, and self-production that shows how a living system has a natural purpose appearing in the mutual generative relation both between its components and between these components and the whole. Di Paolo argues that this framework needs to include adaptivity, i.e., the capacity of an organism to regulate itself, through sense and agency, with respect to the boundaries of its environment. In this way he pursuing Hans Jonas’s project of thinking mind in continuity with life and of seeing nature as having an internal *telos*.

On the pages of *Mind in Life* that Gallagher refers to, Thompson focuses on Merleau-Ponty’s capacity to bridge the explanatory gap between consciousness and nature by revising the way in which humans ordinarily think about matter, life, and mind. Merleau-Ponty points out that nature cannot be described as pure exteriority; at the natural level of organic life, interiority arises by comprising both the “*self-production of an inside*, that is, an autopoietic individual, and the *internal and normative relation* holding between this individual and its environment” (Thompson, 2007, 79). As Gallagher (2017, 23) notices, “if enactivism is a form of naturalism, it does not endorse the mechanistic definition of nature often presupposed by science, but contends that nature cannot be understood apart from the cognitive capacity that we have to investigate it.” With the insistence on autopoiesis and sense-making, enactivism deconstructs the sharp distinction between the physical and the mental, and challenges cognitive science by replacing the mere brain as the explanatory unit for mental life with the integrated system “brain-body-environment” (see Gallagher, 2017, 126).

More hopefully than Godfrey-Smith, Gallagher (2017, 23) insists on the contribution that enactivism—understood as “a non-reductionist yet scientifically engaged philosophy of nature” (see Di Paolo et al., 2017, 253)—makes to the development of science by offering concrete hypotheses for scientific research programs and rais-

ing novel scientific questions.<sup>4</sup> Gallagher's description of the exchange between the philosophy of nature and empirical scientific investigations is less static than Godfrey-Smith's. The latter attributes only a descriptive and interpretative role to the philosophy of nature by holding that it comes only *after* empirical science; conversely, Gallagher suggests that enactivism as a philosophy of nature comes *after* the establishment of a philosophical image of science through the transformation of a method into a view of the world. Put differently: as Husserl, Merleau-Ponty, and Jonas stressed, the problem is not the attitude that the individual scientist takes up in his or her empirical research, but the transformation, in the modern age, of the standard scientific attitude into a conception of science. Accordingly, what is at stake here is the passage from an empirical investigation into a philosophy of science. The fact that the scientist is induced in his/her experiments to ignore his/her own subjectivity may in itself be a necessary stage in the historical development of science. However, it becomes problematic for this very development when such an attitude rises to philosophical dogma, that is, when the philosophy of nature that arises in continuity with these scientific approaches assumes mechanism, objectivism, and reductionism as non-questionable elements of the scientific image of nature.

### 3 The eye on the whole

In order to appreciate the peculiarity of the ways in which enactivism exemplifies the notion of "philosophy of nature," let me call into question the considerations that Wilfrid Sellars proposes on the relationship between philosophy and science in his famous essay on "Philosophy and the Scientific Image of Man" (1962). In particular, the metaphilosophical observations that Sellars provides in the first and the last pages of this essay seem to me to allow us to delve deeper into the two consequences that Godfrey-Smith draws from his characterization of a "philosophy of nature."

First of all, the impression that a philosophy of nature comes *after* empirical inquiry is due to the general aim of philosophy: this is "to understand how things in the broadest possible sense of the term hang together in the broadest possible sense of the term" (Sellars, 1962, 1). A philosophy of nature tries to join the scientific image of humans in the world with the conceptual framework of persons;<sup>5</sup> more specifically, in the case of the enactive approach, the attempt is to integrate the achievements of the debate within evolutionary and molecular biology with the knowing and feeling of the subject as a "socially and culturally situated person" (Thompson, 2007, 411). In this sense, instead of appearing as a practical complication for experimental sciences, holism could be taken as the necessary outcome of a philosophy of nature. Moreover, the fact that a philosophy of nature does not limit itself to expressing its point of view "in the raw language of science" is explained by the holistic requirement of philoso-

<sup>4</sup> Interestingly, Meyer & Brancazio (2022) support the proposal of conceiving of enactivism as a philosophy of nature as a way out of the untenable claim that enactivism would unseat cognitivism as the dominant paradigm.

<sup>5</sup> Let me remind to Manca (2022a) and (2023) for a discussion of the primacy that Sellars ascribes to the scientific image of humans in the world over the manifest image in light of the problem of the conceptual framework of persons.

phy to consider the language of the community in such a way that by projecting our actions in continuity with scientific results, we directly relate the world as conceived by scientific theory to our ordinary purposes, making it *our* world and no longer “an alien appendage to the world in which we do our living” (Sellars, 1962, 40).

And yet insofar as the enactivists insist on the need to connect the first-person point of view with the investigation of brain-body-environment dynamics, that is, insofar as they maintain that nature cannot be understood apart from the cognitive capacity that we have to investigate it, they expose their view to the risk of appearing as one of the most sophisticated forms of the manifest image, which on Sellars’s account arises through the refinement in the course of human history of the original depiction of the world elaborated by common sense, and substantially consists in taking scientific concepts merely as symbolic tools that explicate how the world appears to human being in specific practices and under determined conditions. In my view, this interpretation is misleading. First of all, exactly like the philosophy of nature that for Godfrey-Smith and Gallagher can usefully cooperate with specific scientific programs, enactivism aims at being consistent with scientific results. It does not break with the scientific point of view. Rather, it discusses the philosophical conception of nature and the corresponding interpretations of the relationship between philosophy and science. Enactivism is undoubtedly critical of those metaphysical accounts that merely contrast science and common sense, in continuity with the modern conceptual framework of persons. In this way enactivism challenges the subordination of a pragmatic approach to science to a scientific realism, as conversely Sellars defends in his essay.

The manifest image is a “group phenomenon” rooted in both common sense and the perennial philosophical tradition (Sellars, 1962, 17–19). This gives it a certain strength in subordinating the results and the categories of science to its view of the world. Thus the manifest image cannot simply be abandoned; it remains “pragmatically useful” for human life. But in Sellars’s view, when the aim is to deal with how things really are, it is a completely inadequate “likeness” of nature (Sellars, 1962, 20).

In the tradition of the Pittsburgh school, Sellars’s adhesion to psychologism nominalism—i.e., the denial that there is any awareness of logical space (and in particular of the supposedly abstract entities of science) prior to, or independent of, the acquisition of a language (see Sellars, 1956, 162–164)—convinced the so-called “left-wing” of his followers and interpreters that a pragmatic approach to science should be preferred to the apparently residual ontological claim according to which entities, forces, and fields postulated by scientific language effectively mean what really is.<sup>6</sup> For

<sup>6</sup> The place of Sellars in the canon of American philosophy is quite controversial. Indeed, despite the influence of his father, Roy Wood, who led him to advocate critical realism, which opposed pragmatism as being involved in radical empiricism, while contrasting C. I. Lewis’s conceptual pragmatism, Sellars attempts to radicalize Peirce’s ideal of science; appreciates Dewey’s idealistic background; and appropriates the later Wittgenstein’s linguistic pragmatism (see in particular Sellars, 1979, 7; what Sellars means by Dewey’s idealistic approach is debatable; compare what Brandom (2011) argues in this regard and consider Dewey’s (1920) account of idealism). On Sellars’s role in the pragmatist tradition, see Olen (2015); Kukla and Lance (2009); Bernstein (2010, 159–163); Misak (2013, 218–224). On the distinction between “left-wing” and “right-wing” Sellarsians, see O’Shea (ed., 2016). Instead, on Sellars’s articulated notion of “psychological nominalism” see Reider (ed., 2017). In the first article of this

instance, Rorty (1981, 176) takes Sellars's psychological nominalism as a condition for the epistemological behaviorism that in his view "might be called 'pragmatism,' were this term not a bit overladen." It consists in the claim that "philosophy will have no more to offer than common sense (supplemented by biology, history, etc.)." In other words, there is no special field for philosophy. Undoubtedly we may identify this thesis with the defense of the manifest image in its most sophisticated version. However, for the enactivists the most relevant aspect is that here there is at work an anti-representationalist conception of cognition that leads us far from the vocabulary of "images." Varela, Thompson, & Rosch (1991/2006) quote Rorty several times precisely to emphasize that the aim of the enactive approach is to abandon the depiction of the mind as a mirror of nature and to gain a more practical conception of mind. We might say that with the vocabulary of "images" Sellars remains entangled in a form of representationalism; on the contrary, by radicalizing the Rortyan rejection of the depiction of mind as a mirror of nature, the enactive philosophy of nature looks for a "knowing-how" that underlies even the "knowing-that" of scientific empirical programs.

After his metaphilosophical beginning in the first part of the 1962 essay, Sellars identifies success in philosophy with the capacity of knowing how to move around all the things that must be held together in the broadest possible sense of the term. Consequently, he introduces Ryle's distinction between "knowing-how" and "knowing-that" in order to maintain that "what is characteristic of philosophy is not a special subject-matter, but the aim of knowing one's way around with respect to the subject-matters of all the special discipline." Inevitably, each special discipline boasts the capacity of knowing one's way around its subject-matter and having a sense of how its methods fits into the intellectual landscape. For instance, "the historian reflects not only on historical events themselves, but on what it is to think historically" (Sellars, 1962, 2). However, what distinguishes the philosophical enterprise is "the eye on the whole" (Sellars, 1962, 3): even though the philosopher cannot hope to know his/her way around in each discipline as the specialist does, there is a sense in which he/she can know how to move around it with respect to the subject-matter of each special discipline. Insofar as the enactivists insist on the pragmatic dimension of their approach to mind,<sup>7</sup> the philosophy of nature that they advocate cannot be seen as a

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volume O'Shea shows how after *Empiricism and the Philosophy of Mind*, Sellars will include psychological nominalism in the context of a naturalistic empiricism, which for "left-wing Sellarsians" would be implausible (see O'Shea, 2017). My conviction is that if we discuss this theme with the help of an enactive conceptual framework, we do not need to abandon scientific realism to adhere to psychological nominalism; rather, we can integrate the two theses by revising, however, Sellars's naturalism. In Manca (2022b) I discussed the relationship between the view of nature that derives from the Pittsburgh School (in particular Sellars and Brandom) and the enactive approach to cognition.

<sup>7</sup> Thompson (2016, xxi) explains the aim of *The Embodied Mind* as the willingness to "forge a mutually enlightening and transformative relationship between cognitive science and human experience via a pragmatic and open-ended phenomenology of embodiment." Indeed, Varela, Thompson, & Rosch (1991/2006, 19) stress that they are elaborating a "pragmatic reflection" or "orientation," and criticize previous phenomenology either for developing a perspective that is "entirely *theoretical*," completely lacking "any pragmatic dimension" (in the case of Husserl), or for stressing "the pragmatic, embodied context of human experience, but in a purely theoretical way" (as Heidegger and Merleau-Ponty would have done). Vörös and Bitbol (2017, esp. 39) pointed out how this conception of enaction is rooted in Varela's original conviction that all theorizing must be grounded in an appropriate existential attitude,

mere descriptive revision of the scientific image of nature that comes *after* empirical investigation, but rather as an eye on the whole that aims to bring to light, and to enhance, the “knowing-how” that implicitly guides every scientific endeavor, and thereby to help each special discipline, each empirical research program, to reorient its own scope on behalf of the integrated exploration of the brain-body-environment interaction.

## 4 An eye for evolution

The best way to investigate how the enactive philosophy of nature aims to strengthen the know-how of the scientific enterprise (and its potential capacity for holistic vision) is not to pit a sophisticated version of the manifest image against a fixed scientific image of nature, but to focus on the discussion of evolutionism upon which Varela, Thompson, & Rosch embark in § 9 of *The Embodied Mind*, a discussion into which Thompson subsequently delves more deeply into in § 6 of *Mind in Life*. They see the topic of evolution as complementary to that of cognition: “The evolutionary themes that we need to discuss actually run parallel to those we have pursued in our discussion of cognition. We have seen that the notion of representation (in its strong version) is the centrepiece of most contemporary cognitive science. Similarly, the notion of adaptation is the centrepiece for much of recent evolutionary biology” (Varela, Thompson, & Rosch, 1991/2006, 185). If bringing to light the sensorimotor basis of perception allows them to overcome mind-body dualism and representationism, keeping an eye on the debate regarding evolution means questioning both the concept of “adaptation” as the best way to explain the mind-environment interaction and the concept of natural selection as the sole explicative mechanism for evolution: “Baldly stated, representationism in cognitive science is the precise homologue of adaptationism in evolutionary theory, for optimality plays the same central role in each domain” (Varela, Thompson, & Rosch, 1991/2006, 194).

In this attempt to place the embodied mind in the environment by recasting the “logical geography” of the debate on evolution, the enactivists find allies precisely in those thinkers who have begun developing a holistic view of research programs in biology, thereby leading Godfrey-Smith to reintroduce the philosophy of nature into the current intellectual landscape.

More specifically, in the work of evolutionary biologists and the philosophers of biology who have criticized the adaptationist research program,<sup>8</sup> they find a thorough

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in an ethical know-how. Commenting on Vörös and Bitbol (2017), Thompson (2017, 41) admits that he basically avoids “using the terms ‘enactivism’ and ‘enactivist,’ preferring instead simply to speak of the ‘enactive approach.’” This is to remark that the word “enaction” was never meant to be “just a theoretical term that referred to perception-action coupling, embodied action, autonomous agency, and so forth [...]. Rather the word ‘enaction’ was also always intended to be performative,” that is, aimed at expressing the realization that “cognition and experience have no ground beyond their own accumulated history of embodied action,” not only “in the ongoing work of science and philosophy but also in the existential setting of our own lived experience.” Thus the word evokes “an orientation or sensibility that would change how we think about and relate to our own minds in science and everyday life.”

<sup>8</sup> Varela, Thompson, & Rosch (1991/2006, 188–189) highlight several “open questions” and “points of dispute” that allowed these evolutionary biologists to enlarge their horizon to include other possible



revision of the conceptualization of the coupling between organism and environment. Varela, Thompson, & Rosch (1991/2006, 198) argue for the need to overcome the standard view according to which “organisms are basically parachuted into a pre-given environment.”<sup>9</sup> For instance, following Levins and Lewontin (1987, esp. 99), they insist that the organism and the environment are not separately determined. More specifically, the environment is not a structure imposed on living beings from the outside but is rather a product of the biology of the species. Another decisive reference is Oyama (1985, 2000), who allows the enactivists to reconceptualize “nature” and “nurture” respectively as a “developmental product” and a “developmental process” of evolution rather than as the internal and the external causes of organic form. In this way the enactivists overcome the dichotomy between the inherited and the acquired elements of the history of species, now updated into the dichotomy between genetically transmitted and environmentally acquired traits (see Varela, Thompson, & Rosch, 1991/2006, 199; Thompson, 2007, 193).

To the extent the development systems theory, of which Oyama is one of the most famous exponents, challenges genocentrism (i.e., the thesis that evolution can be reduced to changes in gene frequencies in a population and that ontogeny consists in the unfolding of a pre-given, genetically encoded program of development; see Oyama, 2000, 78), it supports the enactivists in rejecting the representation of natural selection as a force external to the organism’s process of self-production, and consequently as an optimizing power that leads to the inheritance of only the fittest traits present in the population. By switching “from a prescriptive logic to a proscriptive one, that is, from the idea that what is not allowed is forbidden to the idea that what is not forbidden is allowed” (Varela, Thompson, & Rosch, 1991/2006, 195), the enactivists understand natural selection as an “emergent consequence of reproductive autopoietic systems having acquired the capacity to vary and to pass on the developmental resources needed for reconstructing and propagating their life cycles” (Thompson, 2007, 215). The link with autopoiesis precludes describing an organism

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visions of evolution. For instance, they insist on the fact that genes are strongly linked to each other, so that except in a few remarkable cases (such as eye color), the presence of a gene does not lead to the manifestation of an isolated trait, but rather contributes to generating so-called “pleiotropic effects,” i.e., a network of multiple reciprocal effects determined by genic interdependence. This entails evident problems for adaptationism, for if a gene has multiple effects, it is quite difficult to assess its contribution to increasing fitness: “Selection might push to decrease the frequency of a certain gene, but pleiotropy, on the other hand, might push to increase or maintain the gene. The net result is some compromise that cannot be described as simply the result of selective pressures.” Furthermore, and even more decisively, gene interdependence prevents us from describing the organism as a mere array of characteristics, and instead strengthens the idea of a holistic study of evolution, taking organisms and societies as integral wholes. Among these biologists, Gould & Lewontin (1979, 256) point out how in the adaptationist view, the organism is atomized into a mosaic of separate parts, whereas it is actually an integrated whole. Besides, the environment is seen as posing problems that the organism is required to solve by adapting. According to Thompson (2007, 203), these two aspects describe the organism as “a passive object of selection rather than an active agent or subject of the evolutionary process.”

<sup>9</sup> And yet notice that following Gould and Lewontin (1979) Varela (1984a, 220) highlights that the “adaptationist program is, ironically, out of line with the original Darwinian pluralistic thought which proposed natural selection as a mechanism only shaping the broad overall conditions for an organism’s viability.” On this point and in particular on the role of self-organization in natural systems to be put into discussion in the adaptationist program, see Varela (1984b).

as a set of scattered traits deriving from a precise trajectory aimed at optimal fitness.<sup>10</sup> Instead, the organism is the product of a network of multi-layered patterns that it has implemented throughout its life history. Accordingly, natural selection operates as “a broad survival filter” that by guaranteeing the two fundamental constraints of survival and reproduction, admits “any structure that has sufficient integrity to persist” (Varela, Thompson, & Rosch, 1991/2006, 196).

The enactivists elaborate a philosophy of nature in accordance with the parameters attributed to this kind of approach by Godfrey-Smith, which we have amended with the help of Gallagher and Sellars. In fact, supported by those thinkers who discuss the standard adaptationist neo-Darwinian image of nature, they try to accommodate claims made by different branches of biology (from the evolutionary to the molecular), by evolutionary epistemology, and by other variegated approaches in philosophy. They emphasize the relevance of some scientific research programs for addressing significant philosophical problems such as the dualism between mind and body and the place of mind within the environment. They do this by employing a language that goes beyond strict scientific terminology, although they are careful to remain consistent with the claims of the scientific research programs they consider. And above all, they elaborate a holistic approach that leads them to derive from the criticism of the standard view of evolution a positive theory aimed at bearing on empirical research programs yet to come.

To present their enactive eye on the whole of evolution, Varela, Thompson, & Rosch (1991/2006, 196–197) refer to Maturana and Varela (1987), where evolution is described as a “*natural drift*,”<sup>11</sup> and in this sense, it is a “biological counterpart” of their interpretation of cognition as embodied action. According to this view, the unit of evolution is a “network capable of a rich repertoire of self-organizing configurations,” which generate the process of selection that in turn “triggers (but does not specify) change in the form of viable trajectories.” Moreover, the enactivists replace the standard opposition between inner and outer causal factors with “a co-implicative relation” in which “organism and medium mutually specify each other.” By recovering Varela’s (1987, 63) paraphrase of some words of the poet Antonio Machado, Thompson (2007, 205) describes enaction as “the laying down of a path in walking,” and thus he sees an enactive approach to evolution actually at work when adaptation is interpreted in light of autopoiesis and structural coupling with the environment: “‘Enaction’ connotes the performance or carrying out in action of a lifeline. It evokes the image of living beings laying down historical pathways through their own dynamics and those of the environments to which they are structurally coupled. Enactive evolution is the laying down of a path in walking” (Thompson, 2007, 218).

When Godfrey-Smith (1996, 2001) examines the “philosophies of nature” that influence the enactivists, he places them in the wake of the pragmatist tradition. Although Levins & Lewontin refer to Engel’s unfinished work *Dialectics of Nature*,

<sup>10</sup> Optimal fitness means the reproductive success within an environment that in turn changes independently of life cycles.

<sup>11</sup> The expression was originally coined by Maturana and Varela (1984) and discussed also in Varela (1984a).

Godfrey-Smith sees their work in continuity with a heterogeneous tradition that also includes Dewey.<sup>12</sup>

Dewey is of particular importance for the current discussion, since unlike Lewontin, on whose work Godfrey-Smith (1996) dwells extensively, he does not operate in a period in which Darwin's view is standardized, but in one in which his contribution to philosophical reflection is still to be adequately valued.<sup>13</sup> And yet Dewey's way of addressing the issue of the place of the mind within the environment is very close to that of Lewontin and the other critics of the neo-Darwinian view who distance themselves from the centrality that Darwin and his followers would have ascribed to the notions of "adaptation," "fitness," and "natural selection."

While criticizing this view in his study, Godfrey-Smith (1996, 142–143) rightly finds similarities with Lewontin in passages such as the following:

With every differentiation of structure the environment expands. For a new organ provides a new way of interacting in which things in the world that were previously indifferent enter into life-functions. (Dewey, 1938, 32)

There is, of course, a natural world that exists independently of the organism, but this world is environment only as it enters directly and indirectly into life-functions. (Dewey, 1938, 40)

There is, then, a genuine sense in which the evolution of life, the increase in diversity and interdependence of life-functions, means an evolution of new environments, just as truly as of new organs. (Dewey, 1911, 438)

In other words, the conviction that Dewey shares with the tradition that significantly influences the enactive approach to evolution is that the organism cannot be described as a passive object upon which external forces operate, and consequently organic action involves making changes to the environment rather than merely accommodating to it.<sup>14</sup>

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<sup>12</sup> Godfrey-Smith (1996) also briefly refers to the early James; he has more difficulty placing Peirce and does not mention Mead, but could certainly have done so.

<sup>13</sup> See Dewey (1910), and on the reception of Darwin's thought and the debate on evolution in the context of the pragmatist tradition, see Pearce (2020).

<sup>14</sup> Together with the introductory part of Dewey's *Logic* (1938), see, for instance, the chapters VI and VII of *Experience and nature* (Dewey, 1925), but also *Art as experience* where Dewey (1934, 19) stresses that "life goes on in an environment; not merely *in* it but because of it, through interaction with it. No creature lives merely under its skin; its subcutaneous organs are means of connection with what lies beyond its bodily frame, and to which, in order to live, it must adjust itself, by accommodation and defense but also by conquest". And earlier, see also *Reconstruction in philosophy*, where Dewey (1920, 128) points out that "wherever there is life, there is behavior, activity. In order that life may persist, this, activity has to be both continuous and adapted to the environment. This adaptive adjustment, moreover, is not wholly passive; is not a mere matter of the moulding of the organism by the environment. Even a clam acts upon the environment and modifies it to some extent. It selects materials for food and for the shell that protects it. It does something to the environment as well as has something done to itself." Still, regarding the relationship between Dewey and the phenomenological approach, which influences the enactivists, Crippen (2017) shows how while anticipating Merleau-Ponty's and the enactive approach to science, Dewey combats skepticism against the possibility that perception and cognition can grasp genuine qualities of things rather than giving us a mere representation of them. Crippen (2020) shows how Dewey's perspective permits integrating the focus of enactive constructivism on the living body's capacity to construct its own niche and the external environment-oriented emphasis of ecological realism, thereby giving illustrations of fairly holistic ways of approaching things in science. See also Dreon (2021) and (2022), who exten-

Thus in the ways in which enactivism pays attention to the theme of evolution, we can readily see its interest in rooting philosophical inquiry in the results of science, precisely by elaborating a philosophical holistic conception aimed at affecting empirical research programs. Here is where the point of greatest affinity with pragmatism emerges. In fact, if the effort to find the sensorimotor genesis of cognition can easily be traced to the phenomenological tradition, to which the enactivists explicitly refer, it is more problematic to say the same for the complementary reference to evolution. The two phenomenologists who have mostly influenced the enactivists, Merleau-Ponty and Jonas, are also those who more explicitly confront Darwin, but the intent with which they do so does not denote, as in the case of the enactivists (and even more so of the pragmatists), a willingness to revise the standard evolutionist view of mind-environment interaction working from within such a scientific enterprise. Rather, the critique of the Darwinian view is a challenge to the view of science that evolutionism promotes and is motivated by a more general skepticism toward the possibility that the subject of evolution can solve the problem of the place of the mind within nature.

More specifically, Merleau-Ponty's most extensive confrontation with the theme of evolution can be traced in his lectures on nature of 1956–57.<sup>15</sup> Here we can catch up on his preference for other approaches to the description of mind-environment interaction: by granting that “the milieu discriminates that which allows or does not allow the survival of the organism [...] Darwin retrieves the idea of a perfect agency between the organism and the condition external to it.” But Merleau-Ponty prefers new conceptions of behavior, such as we find in Coghill or in von Uexküll, in which the organism appears as “entirely armed” (Merleau-Ponty, 1995, 151), and instead of being endlessly menaced by death, “there is a solidity of super-structures, a shuffling of life” (Merleau-Ponty, 1995, 171). In his view, life is not only an organization for survival, as in the Darwinian ideology, but in a way that could have effectively anticipated Varela's and Maturana's conception of natural drift, it is “a prodigious flourishing of forms” (Merleau-Ponty, 1995, 186). In line with this last consideration, the quite fragmented notes of the course—in which, following above all Simpson (1944), Merleau-Ponty directly discusses Darwin's theory of evolution—aim at studying the variety of organic forms (morphology) in order to overcome the dogmatism of mutation-selection that would connote the neo-Darwinian renaissance. Still more explicitly, in his essay on the philosophical aspect of Darwinism, Jonas (1966, 42–43) shows how, in the modern epoch, the term “evolution” moves from originally denoting the phenomenon of individual genesis to presupposing the existence of the species and their becoming. In this sense, it has made the production of the living

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sively discusses the match and the mismatch between Dewey and enactivism on the character of human sensibility and affectivity.

<sup>15</sup> Conversely, in the works of Merleau-Ponty most cited by the enactivists, *The Structure of Behavior* and *Phenomenology of Perception*, we do not find any reference to the Darwinian theory of evolution; Merleau-Ponty (1945, 225) only refers to Darwin's analysis of facial expressions to point out that humans appropriate their living bodies in a way that transcends and transfigures the bodies' natural powers: “For example, the knitting of the brows intended, according to Darwin, to protect the eye from the sun, or the narrowing of the eyes to enable one to see sharply, become component parts of the human act of meditation, and convey this to an observer.”

kingdom from matter plausible; it opposes Cartesian dualism by insisting on the continuity of life that binds humans to the rest of the natural world; and finally, it allows the materialistic monism of science to advance a decisive step. Yet “the triumph which materialism achieved in Darwinism contains the germ of its own overcoming” (Jonas, 1996, 53). For Jonas, the fact that Darwinism turned out to be a “thoroughly dialectical event” means that it unwittingly posed the “ontological question anew—when it just seemed settled” (Jonas, 1996, 58). In contrast, for an enactivist like Di Paolo (2005, 431)—who, far from attesting to how modern science flows into Nietzsche’s nihilism (see Jonas, 1996, 47), looks more pragmatically at the development of scientific enterprise—this passage is interesting only because it shows that “our own embodied experience does not withdraw, but trickles onto the natural world across the bridges provided by Darwin.” Evidently the attitude of enactivists toward evolutionism is much more benevolent than that of the phenomenologists. This is evidence of the fact that they want to retain a pragmatic approach to science, one that does not merely assess its capacity for a holistic view, but would also like to steer its direction of investigation.

## 5 A distillation of human sense-making

In the first two sections of this article, we have tried to show that a philosophy of nature makes sense of science because it takes a holistic approach that places scientific inquiry within the conceptual framework of persons. If this approach is pragmatically oriented, rather than aiming to produce a general representation of how things are, it enables the practice of doing science to be refined. Moreover, the enactivists’ focus on the subject of evolution, which we have accounted for in the third section, allows us to make sense of doing science in an even deeper way, since it invites us to explore the hypothesis that scientific know-how is the result of the evolution of the human species.

When Thompson (2016, xxvii) remarks that the enactive approach also implies a certain conception of science, he invites us to apply enactive ideas about cognition to science itself.<sup>16</sup> In his view, insofar as we perform this “reflexive operation we can no longer hold on to the realist conception of science as revealing the way things are in themselves apart from our interactions with them.” Thompson also excludes the notion that science can be described as “a creation or projection of our own mind.” By so doing, he rejects both Sellars’s idea of a primacy of scientific realism over a pragmatic approach to science and the instrumentalist view of scientific concepts and terms as symbolic tools, which Sellars in turn explicitly opposes with his view. Rather, completing the transition of the philosophy of mind from its positivist to its full pragmatic stage, Thompson (2016, xxvii) defines science as “a highly refined distillation of our embodied sense-making.” With a pun, we could say that to make

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<sup>16</sup> In a similar manner Vörös and Bitbol (2017, 31) stress that Varela’s original project entails a radical shift in the Western, modern conception of science, as it encompasses a “theoretical and existential move away from detached observer to an embedded and engaged cognizer.”

sense of science means to trace it back to the activity of sense-making in which the organism's active interaction with the environment consists.

The introduction—and above all, the enhancement—of the notion of “sense-making” to designate the very way organisms live represents a turning point that allows the enactive approach to display the pragmatic motifs that guide it. In *The Embodied Mind*, the authors identify in cognition the embodied action by which the human lived body brings forth a world. In this way, they evidently have to work against the consolidated cognitivist view according to which cognition means mental representation, so that they are actually trying to reshape the very meaning of cognition. They strive to bypass entirely the “logical geography” that lead them between “the Scylla of cognition as the recovery of a pre-given outer world (realism) and the Charybdis of cognition as the projection of a pre-given inner world (idealism)” (Varela, Thompson, & Rosch, 1991/2016, 172). To pursue this goal, they stress that “experience and scientific understanding are like two legs without which we cannot walk”; thus we need to find a “common ground” between cognitive science and human experience (Varela, Thompson, & Rosch, 1991/2016, 13–14). Besides, they refer to evolution to show that the definition of cognition is subordinated to the history of the structural coupling between organism and environment that brings forth a world. However, by doing so, they expose themselves to at least two risks. First, their argument seems to suffer from a certain circularity: to show how cognition is the activity of enaction, they expand the concept of cognition from the very beginning, but the point is precisely to demonstrate why this expansion would be necessary. Second, it becomes difficult to define the boundaries of what life is without cognition and what is cognition proper, or even what is experience and what is knowledge.

For these reasons, the transformation of the operative concept of “sense-making” into a thematic concept becomes quite decisive. It is Thompson in particular who makes a concept used by Varela and others to explicate the way in which cognition as an embodied action manifests itself into a concept to be thematically determined when one wants scientifically to define (in the enactive philosophy of nature) the way in which a living body operates in the process of co-constitutive interaction with the environment.<sup>17</sup>

In the crucial § 6 of *Mind in Life*, Thompson endorses Di Paolo's (2005) argumentation on the difference between the two interwoven modes of thinking about natural teleology that we have already presented. Di Paolo explains, in terms of sense-making, the process that Weber and Varela (2002, 116) describe as “the instauration of a point of view provided by the self-construction.” Indeed, in their article Weber and Varela (2002, 115) employ the expression “sense-making” only on two occasions *en passant*: in particular, to say that “a multicellular organism inherits its autonomous nature and sense-making qualities through the configuration of its neural identity,” and in the last note to refer to the roots of life in accordance with Jonas's phenomenological view. Di Paolo (2005, 433) promotes this term to emphasize the fact that “an individuality that finds itself produced by itself is *ipso facto* a locus of sensation and

<sup>17</sup> The expression “sense-making” already appears in Varela (1984a, 208), but this activity is not accurately explained and is questionably identified with cognitive acts, as I will argue in the following pages. On this notion see also Thompson & Stapleton (2009)

agency, a living impulse always already in relation with its world” (Weber & Varela, 2002, 117). Thompson (2007, 157–158) appropriates this explanation by asserting that Maturana’s (1970) proposition that “living is a process of cognition” has to be reformulated with the proposition that “living is sense-making.” He identifies sense-making with a “viable conduct [...] oriented toward and subject to the environment’s significance and valence.”

To explain what sense-making means, Thompson revisits Varela’s (1991) example of motile bacteria swimming uphill in a food gradient of sugar. That sucrose is a nutrient is not intrinsic to the status of the sucrose molecule; rather, this is a relational feature actualized when bacteria migrate up-gradient and metabolize it. Thus “sucrose has significance or value as food, but only in the milieu that the organism itself brings into existence.” This means that on the part of the organism, its life consists in bringing forth significance and value potentially present in the world, while the environment becomes “a place of valence, of attraction and repulsion, approach or escape” (Thompson, 2007, 158).

Now could we describe this embodied action of the bacterium as cognition? In *Mind in Life*, Thompson remains ambiguous on this point, as he goes on to define life as the sum of autopoiesis and cognition, only to correct himself later:

I have to admit that my characterization in *Mind in Life* of life as “autopoiesis plus cognition” could be read as simply equating mind and life, and hence opening a door for the panpsychist line of thought. What I would now rather say is that living is sense-making and that cognition is a kind of sense-making. [...] A unicellular organism is a self-individuating and sense-making being but not a cognitive one, if by “cognitive” we mean being intentionally directed toward objects as unities-in-manifolds having internal and external horizons. (Thompson, 2011, 122)

Overall, this clarification is crucial because it redefines the use of the term “cognition.” For our purposes, it is also important because it shows us how scientific investigation, which is the most sophisticated form of cognition, must be considered precisely for this reason as an expression of that instauration of a sense that allows the organism—in this case, the species “*homo sapiens*”—to construct its own niche, to characterize with a surplus of “significance and valence” the environment to which it tries to adapt by modifying it for its own needs. The know-how that according to what is argued in the second section of this article is the basis of all knowledge of the individual scientific disciplines—a knowledge that it would be the task of philosophy to trace—is nothing other than that distillation of sense-making with which Thompson identifies science; it is the ability we have as “observers, modelers, and interveners” not so much to show the nature of reality as it is, but rather consciously and reflectively to relate to the world we purport to know (Thompson, 2016, xxvii).

It is not only the pragmatic orientation of the enactive approach that becomes evident here, but also the affinity with the conceptual framework of the pragmatist tradition. For instance, Dewey anticipates the key term of Varela and others when in his *Logic* he adduces some examples to demonstrate that “the processes of living are enacted by the environment as truly as by the organism; for they *are* an integration” (Dewey, 1938, 32). Besides, he also foresees the notion of “sense-making” when he distinguishes signification, which requires the use of a conventional sign or index of something else, from “the sense of a thing” as “an immediate and immanent mean-

ing,” which is thus “felt or directly had” (Dewey, 1925, 200). As Alexander (2013, 29) argues, the denotative method that Dewey accurately describes in the first chapter of *Experience and Nature* is meant “to contextualize the cognitive interest of philosophy within the non-cognitive scope of life.” It aims to remind philosophy and science in general to be rooted in “a pre-reflective world” where the organisms’ impulse is “to make life more meaningful and value-rich.” In fact, Dewey stresses that scientific inquiry is first of all an art aimed at gaining control of the mind and pursuing a final enjoyment; thereby it also appears as the most refined expression of experience that “penetrates into nature and expands without limit through it” (Dewey, 1925, 13). Accordingly, as Johnson and Schulkin (2023, 113) efficaciously recap, insofar as the scientists embody one of the evolutive possibilities for human species, in Dewey’s perspective they are not “disengaged spectators of a mind-independent world but makers and doers” (or “practitioners,” in the terms of Dewey, 1938, 163).

To conclude, one of the tasks of enactivism as a philosophy of nature, with its capacity to develop an eye on the whole that preserves the pluralistic outcomes of evolution, is to see in the practice of doing science the most sophisticated elaboration of the human species’ know-how. By integrating the conceptual framework of Dewey’s classical pragmatism with that of Sellars’s linguistic neo-pragmatism, we might say that the scientific inquiry is the means through which the organism manages to actualize that vital impulse, that form of sense-making that responds to the need to give and ask for reasons.

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## References

- Alexander, T. M. (2013). *The human eros: Eco-ontology and the aesthetics of existence*. Fordham University. (Epub version).
- Bernstein, R. (2010). *The pragmatic turn*. Polity. (Epub version).
- Caruana, F., & Testa, I. (Eds.). (2021). *Habits: Pragmatist approaches from cognitive science, neuroscience, and social theory*. Cambridge University Press.
- Crippen, M. (2017). Embodied cognition and perception: Dewey, Science and skepticism. *Contemporary Pragmatism*, 14, 112–134.
- Crippen, M. (2020). Enactive pragmatism and ecological psychology. *Frontiers in Psychology*, 11, 1–13.
- Crippen, M., & Schulkin, J. (2020). *Mind ecologies: Body, brain, and world*. Columbia University.
- Dewey, J. (1910). The influence of Darwin on philosophy. In J. Dewey (Ed.), *The influence of Darwin on philosophy, and other essays in contemporary thought* (pp. 1–19). Henry Holt.
- Dewey, J. (1911). Organism and environment. Reprinted in J. Dewey (1985). *The middle works, 1899–1924*, vol. 6. (pp. 437–440). Ed. by J. A. Boydston, with an Introduction by H. S. Thayer and V. T. Thayer. Carbondale, IL: Southern Illinois University Press.
- Dewey, J. (1920). *Reconstruction in Philosophy*. Reprinted in J. Dewey (2008). *The middle works, 1899–1924*, vol. 12. Ed. by J. A. Boydston, with an Introduction by R. Ross. Carbondale, IL: Southern Illinois University Press.
- Dewey, J. (1925). *Experience and nature*. Reprinted in J. Dewey (1981). *The later works, 1925–1953*, vol. 1. Ed. by J. A. Boydston, with an Introduction by S. Hook. Carbondale, IL: Southern Illinois University Press.
- Dewey, J. (1934). *Art as Experience*. Reprinted in J. Dewey (2008) *The later works, 1925–1953*, vol. 10. Ed. by J. A. Boydston, with an Introduction by A. Kaplan. Carbondale, IL: Southern Illinois University Press.
- Dewey, J. (1938). *Logic: The theory of inquiry*. Reprinted in J. Dewey (1991) *The later works, 1925–1953*, vol. 12. Ed. by J. A. Boydston and K. Poulos, with an Introduction by E. Nagel. Carbondale, IL: Southern Illinois University Press.
- Di Paolo, E. A. (2005). Autopoiesis, adaptivity, teleology, agency. *Phenomenology and Cognitive Sciences*, 4, 429–452. <https://doi.org/10.1007/s11097-005-9002-y>.
- Di Paolo, E. A., Buhrmann, T., & Barandiaran, X. E. (2017). *Sensorimotor life: An enactive proposal*. Oxford University Press. <https://doi.org/10.3389/fpsyg.2020.538644>.
- Dreon R. (2021). Framing cognition: Dewey's potential contributions to some enactivist issues. *Synthese*, 198(S1), 485–506. <https://doi.org/10.1007/s11229-019-02212-x>
- Dreon R. (2022). *Human landscapes. Contributions to a pragmatist anthropology*. SUNY.
- Engel, A. K., Friston, K. J., & Kragic, D. (Eds.). (2015). *The pragmatic turn: Toward action-oriented views in cognitive science*. The MIT.
- Gallagher, S. (2015). Do we (or our brain) actively represent or enactively engage with the world? In Engel, Friston, & Kragic (Eds.), 285–296.
- Gallagher, S. (2017). *Enactivist interventions: Rethinking the mind*. Oxford University Press.
- Godfrey-Smith, P. (1996). *Complexity and the function of mind in nature*. Cambridge University Press.
- Godfrey-Smith, P. (2001). On the status and explanatory structure of development systems theory. In Oyama, Griffiths, & Gray (Eds.), 283–298.
- Gould, S. J. (1977). *Ontogeny and Phylogeny*. The Belknap Press of Harvard University.
- Gould, S. J., & Lewontin, R. C. (Eds.). (1979). The spandrels of San Marco and the Panglossian paradigm: A critique of the adaptationist programme. *Proceedings of the Royal Society of London* 205, 581–598; rpt. in Sober, E. (Ed.) (1984). *Conceptual issues in evolutionary biology* (pp. 252–270). Cambridge, MA: The MIT Press/Bradford.
- Johnson, M. L., & Schulkin, J. (2023). *Mind in nature: John Dewey, cognitive science, and a naturalistic philosophy for living*. The MIT.
- Jonas, H. (1966). *The phenomenon of life: Toward a philosophical biology*. Rpt. Evanston, IL: Northwestern University Press, 2001.
- Kukla, R., & Lance, M. (2009). *Yo! 'And 'Lo! 'The pragmatic topography of the space of reasons*. Harvard University Press.
- Lakatos, I. (1970). Falsification and the methodology of scientific research programs. In I. Lakatos, & A. Musgrave (Eds.), *Criticism and the growth of knowledge* (pp. 170–196). Cambridge University Press.
- Laudan, L. (1977). *Progress and its problems*. University of California Press.

- Levins, R., & Lewontin, R. (1987). *The dialectical biologist*. Harvard University Press.
- Manca, D. (2022a). Metaphilosophy of the Life-world. Sellars, Husserl, and the quantum image of nature. *Philosophical Inquiries*, X/1, 169–192. <https://doi.org/10.4454/philing.v10i1.387>
- Manca D. (2022b). The Situated Mind and the Space of Reasons. On the Match and Mismatch between Pragmatism and Phenomenology. *European Journal of Pragmatism and American Philosophy*, 1-19&nbsp;nbsp;<https://doi.org/10.4000/ejpap.3000>
- Manca D. (2023). Husserl's lifeworld and sellars's stereoscopic vision of the world. In D. De Santis & D. Manca (Eds.). *Sellars and phenomenology. Intersections, encounters, oppositions*, (pp. 71–92). Ohio University Press.
- Maturana, H. R. (1970). Biology of cognition. In H. R Maturana & F. J. Varela (1984). *Autopoiesis and cognition: The realization of the living* (pp. 2–58). Dordrecht: D. Reidel.
- Maturana, H. R., & Varela, F. J. (1987). *The tree of knowledge: The biological roots of human understanding*. Rev. ed. Boston, MA: Shambhala.
- Menary, R. (2015). Pragmatism and the pragmatic turn in cognitive science. In Engel, Friston, & Kragic (Eds.), 215–234.
- Merleau-Ponty, M. (1945). *Phenomenology of perception*. Trans. C. Smith. London: Routledge & Kegan Paul, 1962.
- Merleau-Ponty, M. (1995). *Nature: Course notes from the Collège de France*. Compiled and with notes by D. Séglaard, trans. R. Vallier. Evanston, IL: Northwestern University Press, 2003.
- Meyer, R., & Brancazio, N. (2022). Putting down the revolt: Enactivism as a philosophy of nature. *Frontiers in Psychology*, 13, 1–12. <https://doi.org/10.3389/fpsyg.2022.94873>.
- Misak, C. (2013). *The American pragmatists*. Oxford University Press.
- Olen, P. (2015). The realist challenge to conceptual pragmatism. *European Journal of Pragmatism and American Philosophy*, 7(2), 1–15. <https://doi.org/10.4000/ejpap.143>.
- O'Shea, J. (2017). Psychological Nominalism and the Given, from Abstract Entities to Animal Minds. In Reider (Ed.), 19–39.
- O'Shea, J. (Ed.). (2016). *Sellars and his legacy*. Oxford University Press.
- Oyama, S. (1985). *The ontogeny of information: Developmental systems and evolution*. Rpt. Durham, NC: Duke University Press, 2000.
- Oyama, S. (2000). *Evolution's eye: A systems view of the biology-culture divide*. Durham, NC: Duke University Press.
- Oyama, S., Griffiths, P. E., & Gray, R. D. (Eds.). (2001). *Cycles of contingency: Developmental systems and evolution*. The MIT.
- Pearce, T. (2020). *Pragmatism's evolution: Organism and environment in American philosophy*. The University of Chicago.
- Reider, P. J. (Ed.). (2017). *Wilfrid Sellars, Idealism, and realism. Understanding psychological nominalism*. Bloomsbury.
- Rorty, R. (1981). *Philosophy and the mirror of nature*. Princeton University Press.
- Sellars, W. (1956). Empiricism and the philosophy of mind. Now in W. Sellars, *Science, perception, and reality* (pp. 127–196). Atascadero, CA: Ridgeview P.C., 1991.
- Sellars, W. (1962). Philosophy and the scientific Image of man. Now in W. Sellars, *Science, perception, and reality* (pp. 1–40). Atascadero, CA: Ridgeview P.C., 1991.
- Sellars, W. (1979). *Naturalism and ontology*. Ridgeview Publishing Company.
- Simpson, G. (1944). *Tempo and mode in evolution*. Columbia University.
- Thompson, E. (2007). *Mind in life: Biology, phenomenology, and the sciences of mind*. The Belknap Press of Harvard University.
- Thompson, E. (2011). Living ways of sense-making. *Philosophy Today*, 55, 114–123. <https://doi.org/10.1007/s11245-008-9043-2>.
- Thompson, E. (2016). Introduction to the revised edition. In Varela, Thompson, & Rosch (Eds.) (1991/2016), xvii–xxxiii.
- Thompson, E. (2017). Enaction without hagiography. *Constructivist Foundations*, 13(1), 41–44. <http://constructivist.info/13/1/031>.
- Thompson, E., & Stapleton, M. (2009). Making sense of sense-making: Reflections on enactive and extended mind theories. *Topoi*, 28, 23–30. <https://doi.org/10.1007/s11245-008-9043-2>.
- Varela, F. J. (1984a). Living Ways of Sense-Making: A Middle Path for Neuroscience. In P. Livingstone (Ed.). *Disorder and Order: Proceedings of the Stanford International Symposium (Sept. 14–16, 1981)* (pp. 208–224). Saratoga, CA: Anmi Library.

- Varela, F. J. (1984b). Two principles for Self-Organization. In H. Ulrich, & G. J. B. Probst (Eds.), *Self-Organization and Management of Social Systems. Insights, promises, doubts, and questions* (pp. 25–32). Springer.
- Varela, F. J. (1987). Laying down a path in walking. In W. I. Thompson (Ed.), *Gaia: A way of knowing. Political implications of the new biology* (pp. 48–64). Lindisfarne.
- Varela, F. J. (1991). Organism: A meshwork of selfless selves. In A. Tauber (Ed.), *Organism and the origin of self* (pp. 79–107). Kluwer.
- Varela, F. J., Thompson, E., & Rosch, E. (1991/2016). *The embodied mind*. Rev. ed., new foreword by J. Kabat-Zinn, new introductions by E. Thompson & E. Rosch. Cambridge, MA/London: The MIT Press.
- Vörös, S., & Bitbol, M. (2017). Enacting enaction: A dialectic between knowing and being. *Constructivist Foundations*, 13(1), 31–40. <http://constructivist.info/13/1/031>.
- Weber, A., & Varela, F. (2002). Life after Kant: Natural purposes and the autopoietic foundations of biological individuality. *Phenomenology and Cognitive Sciences*, 1, 97–125. <https://doi.org/10.1023/A:1020368120174>.

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