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The Material, Cultural, and Relational Environment in the New Cognitive Sciences

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C'est dans le présent que les problèmes sollicitent la réflexion[1].

1. *A Problematic Definition of a Concept*

Après avoir longtemps voulu oublier notre appartenance au monde, après une longue période pendant laquelle nous, les humains, avons rêvé (ou cauchemardé) que nous étions des *sujets* séparés d'une nature-*objet*, voilà que le monde se rappelle à nous. Il paraît que l'activité de l'une des espèces terrestres, la nôtre, aurait modifié l'ensemble des cycles et des processus climatiques, écologiques et géochimiques de la planète, à un tel point que celle-ci en porterait déjà les traces jusque dans ses archives du devenir de la planète et nous poussent enfin à voir que nous partageons avec elle un destin commun, que nous ne pouvons ni penser ni agir séparément, et que la responsabilité du vivant s'étend à l'ensemble du vivant lui-même. L'exil de la modernité peut finir, l'homme peut rentrer à la maison, rejoindre l'*oikos*, ce foyer qu'il n'avait jamais vraiment quitté mais qu'il a pourtant maltraité, en le considérant comme un territoire noir à conquérir dans une lutte entre deux puissances[2].

The relationships between body and nature, organism[3], environment and *oikos*, organism and technology, knowledge and culture, constitute the foundational pillars of contemporary philosophical, scientific, historical, and epistemological inquiry. These interconnections are various articulations of a shared theoretical concern. Cognitive science and neuroscience have profoundly reshaped our understanding of the mind and the processes of knowledge acquisition. Likewise, biological sciences – particularly epigenetics – have significantly transformed the paradigm of reductionism. Moving beyond the determinism of classical genetics, the epigenetic perspective emphasizes how experiences can influence the regulation of gene expression. Environment, world, nature, and situations make up an important part of contemporary theoretical, scientific, philosophical, but also political and sociological approaches aimed at understanding living beings in their interactions, intersections, and transactions with their environment.

The concept of *environment* is especially opaque: according to Canguilhem, scientific concepts are historical products and require 'maintenance'. By adopting a historical-epistemological approach – which addresses concepts across disciplinary boundaries – it is useful to investigate their formation, deformation, and rectification over time, to highlight their «dense, opaque, viscous

[1] G. Canguilhem, *Le normal et le pathologique*, Paris, Presses Universitaires de France, 1966, p. 38.

[2] M. Benasayag, *La Singularité du vivant*, Paris, Le Pommier, 2017, pp. 21-22.

[3] Contemporary biological and more specifically cognitive sciences currently encompass wide diverse life forms: one of the most interesting recent trends is devoted to cognition in plants (cfr. M. Bianchi, *La vita ramificata. Cognizione e comportamento nelle piante tra scienza e filosofia*, Milano, Mimesis, 2021; C. *Morabito, Nel mondo dei sistemi complessi: consonanza o cosilience?*, in «Giornale Italiano di Psicologia», 2023, 2, pp. 411-418).

and liquid temporality»[4]. In the same vein, the environment always stems from a 'cut-out' dynamically produced by a kind of dialogue between the organism and the world it inhabits. Due to this dialectic relation, we may only partially trace the environment through the historical development of our understanding of it and of ourselves. Over time, the term has been repeatedly redefined, beginning with a conception of the environment as an external space (objective and instrumental, the *milieu ambiant* of Geoffroy Saint-Hilaire), then reconceptualized from the subject-observer's perspective (thus subjective and anthropocentric, the *behavioral environment* of Koffka), and finally evolving in today's concept of the 'ecological environment' (species-specific, subjective[5], and relational).

Canguilhem shows how the environment has been conceived progressively less as a topological space, and more as a model of interaction:

> The notion of environment (*milieu*) is becoming a universal and obligatory mode of apprehending the experience and existence of living beings; one could almost say it is now being constituted as a category of contemporary thought. But until now it has been quite difficult to perceive as a synthetic unity the historical stages in the formation of the concept, the various forms of its utilization, and the successive inversions in which it is one of the terms – in geography, in biology, in psychology, in technology, in economic and social history[6].

2. *A multidimensional Concept*

In the second half of the 19th century, thanks to Claude Bernard, the concept of the environment gained a new dimension: that of the *internal milieu* or internal environment.

> Chez les êtres vivants élevés, il y a au moins deux milieux à considérer : le milieu extérieur ou extra-organique et le milieu intérieur ou intraorganique. […] Quand on examine un organisme vivant supérieur, c'est-à-dire complexe, et qu'on le voit accomplir ses différentes fonctions dans le milieu cosmique général et commun à tous les phénomènes de la nature, il semble, jusqu'à un certain point, indépendant dans ce milieu[7].

It is essential to emphasize that Bernard used the term 'il semble', that is to say, *'it* seems*',* because his epistemological sensibility immediately led him to clarify:

[4] G. Canguilhem, *Le normal et le pathologique*, Paris, Presses Universitaires de France, 1966, p. 235.

[5] That is to say, linked to an individual's own experiences.

[6] G. Canguilhem, *Knowledge of Life*, New York, Fordham University Press, 2008, p. 98 (ed. or. *La connaissance de la vie*, Paris, Vrin, 1965).

[7] C. Bernard, *Introduction à l'étude de la médecine expérimentale*, Paris, E. Martinet, 1865, p. 66. Today, philosophers of biology use the term 'biological autonomy' in referring to the organization of organisms, which as organized systems are self-producing, self-repairing and generally self-sustaining (A. Frank, M. Gleiser, E. Thompson, *The Blind Spot: Why Science Cannot Ignore Human Experience*, Cambridge (Mass.), The Mit Press, 2024).

Mais cette apparence tient simplement à ce que nous nous faisons illusion sur la simplicité des phénomènes de la vie. … Nous supprimons, dans nos explications, le milieu interne, pour ne voir que le milieu extérieur qui est sous nos yeux. Mais l'explication réelle des phénomènes de la vie repose sur l'étude et sur la connaissance des particules les plus ténues et les plus déliées qui constituent les éléments organiques du corps[8].

Organisms are therefore in close relation with the external world, their equilibrium results from a continuous and delicate osmotic transaction between the internal and external environments. This 'close relationship' has revealed itself in recent years to be ever closer – in fact, this complex relationship can be defined as a 'reciprocal co-production' that makes the living being a 'contextual effect'[9].

3. *My own World*

At the beginning of the 20th century, Jakob von Uexküll revolutionized the concept of environment by challenging the anthropocentric perspective and theorizing the *Umwelt* – the environment as perceived subjectively and species-specifically by each living being: every organism produces its own objective and concrete world, to which it is inextricably linked due to its specific morphology and physiology. Thus, the specificity of the environment is emphasized from the living being's perspective. Everything that the subject perceives becomes its perceptual world (*Merkwelt*) and everything it does constitutes its effector world (*Wirkwelt*). The perceptual world and the operative world form together a closed totality: the environment (*Umwelt*)[10].

Naturally the environment, perceived in a subjective way (*Umwelt*), interacts systemically with the internal environment of the organism (*Innenwelt*), producing an effective adaptive interaction. This view emphasizes the specificity of the environment from the perspective of the living being, a perspective primarily constrained by morphology and physiology but based on a dynamic interrelation between the internal, the operational, and the life environments. The *Umwelt* becomes a property of the individual dynamic in nature as it is continuously modified by experience and by the individual's actions and reactions toward the external world.

In these same years, the 'perspective of the living beings' was investigated by Gestalt Psychology which, starting from experimental research on species-specific perceptual illusions – at the basis of our cognitive functioning – formulated the well-known Principles of Formal Unification, which are innate, as they were shaped in the species through evolutionary adaptation to the environment. Perception takes place according to the operational modes of our

[8] C. Bernard, *Introduction,* cit., p. 66.
[9] M. Benasayag, *La singularité*, cit., p. 22.
[10] J. von Uexküll, *Umwelt und Innenwelt der Tiere*, Berlin, Springer, 1934.

cognitive system, which instinctively applies to a series of criteria, including similarity, proximity, continuity, figure-ground relationship, pregnance, and closure. The context either enhances or diminishes the sensory articulation of the stimulus; the perceptual result is always dependent on it.

There is no simple and direct correspondence between the physical perspective and the phenomenal one; our mind integrates, projects, and interprets reality in a Gestaltic way to organize behavior[11]: «Only rarely, under certain characteristic conditions, and only within very narrow limits – and perhaps never except approximately – do we find (in the mind) purely additive relationships»[12].

4. *Field, Information, Affordance*

In this sense, the systemic, holistic *field* dimension – as adopted by Kurt Lewin in his Field Theory referring to the physical concept of field effects in the distribution of energy – assumes that there is a dynamic order in nature and social relationships. This approach entails the necessity of a phenomenological study of mental activity and behavior. Lewin introduces the expression of 'individual life space', understood as a psychological field structured into different 'regions' (which differentiate during psychological development, progressively increasing the complexity of the overall mental structure), and determined by the interaction between the person and her environment, which in turn is regarded as a constellation of interdependent factors.

The life space, or 'total situation', therefore includes all the factors that influence the person's mind and behavior at a given time, in a clearly integrated and ecological perspective: «If we are to accomplish the task of deriving the behavior of the person (in more general terms: the psychological events) from the life space, we have to characterize it as the «totality of possible events»[13].

Lewin uses the term 'life space' precisely to highlight the inadequacy of a traditional notion of *environment* and the epistemic necessity of semantically reconfiguring the term. The environment is internal, physical, geographical and ecological, but also social, closely related to the individual's position within society. Studies on the effects of the environment on behavior have shaped the theoretical foundations of ecopsychology and environmental psychology[14]. Models proposed by the Soviet cultural-historical psychology of the 1920s-30s (Vygotskij and Lurija) and those born within the constructivism framework

[11] Gestalt psychology in this sense revolutionized the traditional bottom-up approach to perception, making it necessary to take a profoundly different approach to perception and psychic phenomena in general, an approach that would overcome traditional 'mosaic theories,' the atomistic model, and empiricism itself more generally.

[12] M. Wertheimer, *The general theoretical situation*, in W. D. Ellis (Ed.), *A Source Book of Gestalt psychology*, London, Kegan Paul, Trench, Trubner & Company, 1938, pp. 12-16.

[13] K. Lewin, *Principles of Topological Psychology*, New York and London, McGraw-Hill, 1936, p. 81.

[14] They go back to go back to Watson (1913), through Lewin's notion of life space (1936), to Gibson's perceptual psychology (1960), Barker's behavioural settings (1968), Hall's studies on proxemics (1966), and Sommer's work on personal space (1969).

derived from the Piagetian theory also have contributed in many ways to the formation of ecological psychology's identity[15].

The 'family resemblance' that connects Gibson's (1977, 1986) approach to that of von Uexküll (1909) is visible in the conceptual kinship between von Uexküll's notion of the functional tone of an environmental object – what he calls its *funktionale Tönung* or *Wirkton* – and Gibson's notion of affordance, understood as the action possibilities present in an environment and available to an individual[16].

The ecological perspective of James J. Gibson offers a further, fundamental redefinition of the concept of environment as a meaningful space, structured in relation to the singularity of each organism:

> The world of physical reality does not consist of meaningful things. The world of ecological reality, as I have been trying to describe it, does. If what we perceived were the entities of physics and mathematics, meanings would have to be imposed on them. But if what we perceive are the entities of environmental science, their meanings can be discovered[17].

In Gibson's view, the world contains and makes available all the necessary informational features for the organism: the environment becomes not a 'means' for action but a 'device' of action itself, a space that inherently contains the elements needed for adaptation. It thus becomes a structured space of possibilities, action-oriented and responsive to the characteristics of the perceiving agent.

The concept of *affordance*, coined by Gibson, captures this integrated cognitive process in which perception and action are no longer mediated by intermediate cognitive acts: rather, they are parts of a single dynamic. The object is not something first perceived and then acted upon; it is directly *grasped* by the organism in the environment, which continually offers stimuli as potential resources for action. This undermines the notion of 'representation' as an intermediate cognitive stage: such a notion imposes an ontological distance between perception and action, subject and object, activity and passivity. Gibson's ecological approach collapses that distance. Every organism reveals itself as an active subject in the world through its unique way of interacting with its environment or *niche*. As Gibson puts it: «In architecture a niche is a place that is suitable for a piece of statuary, a place into which the object fits. In ecology a niche is a setting of environmental features that are suitable for an animal, into which it fits metaphorically»[18].

[15] W.H. Ittelson, H.M Proshansky, L.G., Rivlin, G.H. Winkel, *An introduction to environmental psychology*, New York, Holt, Rinehart & Winston, 1974.

[16] S. Forestiero, *Ambiente, adattamento e costruzione della nicchia*, in S. Casellato, P. Burighel, A. Minelli (a cura di), *Life and Time: The Evolution of Life and its History*. Padova, Cleup, 2009, pp. 253-283.

[17] J.J. Gibson, *The ecological approach to visual perception* (1979), Boston, Houghton Miffl, 2015, p. 28.

[18] Ivi, p. 121.

The ability to organize perceptual stimuli into coherent behaviors thus depends on the interactional affordances available to a specific organism in relation to its environment; in this way the split between perception, processing, and action is resolved**.** Gibson, in his ecological approach to perception, coined the term *affordance* precisely to indicate that specific elements of reality acquire different meanings and values for different organisms, depending on their perceptual and motor characteristics.

5. *The Context Is Not 'External'*

Context, then, is not pure exteriority in relation to processes and organisms. This theoretical assumption lies at the heart of *enactivism*, the approach to living phenomena developed by Francisco Varela[19]. In the 1980s, Varela introduced the concept of *neurophenomenology* into neuroscience: complex biological systems do not arise from simple or isolated elements; life exists through constant interaction and feedback among systems. Thus, organisms do not passively receive information from their environments, which they then translate into internal representations. Natural cognitive systems participate in the generation of meaning, engaging in transformational and not merely informational interactions: «They enact a world»[20].

Varela, Thompson, and Rosch (1991) propose the enactive approach as a way out of the subject's 'Cartesian anxiety', the dilemma of having to be external to the world in order to know and represent it:

> Consequently, cognition is no longer seen as problem solving on the basis of representations; instead, cognition is not representation but embodied action […] the world we cognize is not pre-given but enacted through our history of structural coupling[21].

> Cognitive processes are not only closely intertwined with action but cognition can actually best be understood as 'enactive', as a form of practice itself. Cognition, on this account, is grounded in a pre-rational understanding of the world that is based on sensorimotor acquisition of real-life situations[22].

The morphology and physiology of the organism give rise to a form of knowledge that is a *pre-rational understanding* founded on the specific dynamics of sensorimotor interaction with the environment. Colombetti calls this internal dimension of the organism's relationship with the environment *neurochemical harmonization*. Bernard's *milieu intérieur* is fully recognized as a foundational ele-

[19] F. Varela, H. Maturana, *Autopoiesis and Cognition: The Realization of the Living*, Boston, Reidel, 1980.

[20] F. Varela, E. Thompson, E. Rosch, *The Embodied Mind*, revised edition, Cambridge (Mass.), MIT Press, 2017, p. 140.

[21] Varela, Thompson, Rosch, *The Embodied Mind*, cit., p. 200.

[22] A.K. Engel, *Directive Minds: How Dynamics Shapes Cognition*, in J. Stewart, O. Gapenne, E.A. Di Paolo (a cura di), *Enaction. Toward a new paradigm for Cognitive Science,* Cambridge (Mass.), MIT Press, 2010, p. 219.

ment of life and knowledge: «The body plays a role in cognition also thanks to its chemical and 'self-regulatory' (as Thompson and Varela [2001] call it) dimension»[23].

The relative autonomy of living beings from the external environment is closely tied to what Varela calls *operational closure*: an evolutionary trait that characterizes an *autopoietic* system (the organism, the environment, and the organism-environment), which continuously redefines itself, sustains itself, and reproduces itself within its 'life space', which is the 'cut-out' of the world according to the ways of its internal functioning as organism.

It is the very act of 'cutting out' –primarily sensorimotor –that co-construct living organisms and their environments in a dynamic process of continuous reality production. Thus, the subject/object dichotomy dissolves in favour of the idea of a dynamic, interdependent whole: the environment is not a scene to be known, but the 'cut-out' performed by the organism in the world based on its own structures, functions, and characteristics.

Le cerveau n'est pas le sujet et le monde son objet. Il existe des mécanismes dynamiques et complexes de coproduction permanente de ce que l'on doit nommer la 'realité', à laquelle participent l'ensemble des organismes et leurs écosystèmes[24].

The brain is not a subject, and the world is not an object; it is in co-production that the function of 'subject' emerges. The brain is not the organ that thinks; it participates, certainly in a fundamental way, in the production of thought, just as bodies and the biological field participate in the constant co-production of reality. Within the theoretical context of *enactivism*, cognition is conceived «as an embodied engagement in which the world is brought forth by the coherent activity of a cognitive agent in its environment»[25].

Engel defines as a 'pragmatic turn' this shift in the attention of cognitive scientists away from representational capacities and toward the embodied and 'situated' nature of cognition understood as motor and 'action-oriented'. The body, unlike a machine, is not reducible to a series of functions and organs; it is a whole, not a mere aggregate of parts. It exists as a unit that is constitutively bound to its environment. The latter is, therefore, not something external to be represented, but rather «a resource that 'scaffolds' cognitive acts. Slightly radicalizing this insight, one might then say that, in fact, the cognitive system comprises the brain, the body, and the environmental niche»[26].

This understanding resonates with *Niche Construction Theory* (NCT), which emphasizes that organisms do not adapt passively to preexisting environments but actively modify them in ways that affect both their own evolution and that of other species. In this perspective, organisms and environments are mutually

[23] G. Colombetti, *Enaction, Sense-Making, and Emotion*, in Stewart, Gapenne, Di Paolo, *Enaction,* cit., p. 150.

[24] Benasayag, *La singularité*, cit. pp. 111-112.

[25] E. Di Paolo, *Extended Life*, in «Topoi», 2009, p. 12.

[26] Engel, *Directive Minds*, cit. p. 224.

constitutive, mirroring the enactivist view. Cognitive systems are anchored, situated and rooted in biological dimension; organism and environment co-define each other[27].

6. *Situatedness*

Many philosophical and scientific studies have examined the inextricable connection between organism and environment. In the latest Cognitive Sciences, the situated dimension is considered one of the four fundamental aspects of the embodied mind paradigm:

> The mind – even when viewed as a kind of computational system – is an essentially embedded entity; such that analyzing it in isolation from the environmental context in which it functions will be fundamentally misleading. The understanding of intelligence, thought, and action cannot <bracket off> the structure of the environment, but can only occur and be analyzed in interaction with it[28].

According to this thesis, some cognitive processes are dependent on environmental structures in the sense that these processes have been designed to function only in conjunction, or in tandem, with these structures. In the absence of the appropriate environmental structures, an organism may be unable to accomplish its usual repertoire of cognitive tasks... or it may be able to accomplish these tasks, but in a less optimal way[29].

The epistemological and phenomenological centrality of the body and the environment in determining cognitive processes pointed out, as we have argued, a crucial moment in the reformulation of the concept of environment. This term has taken on different semantic connotations over time: from the physical environment understood as a materially delimited and objectively configured space surrounding and embracing the subject from the outside to the rootedness of the subject itself and its cognitive capacities in the lived environment that dialectically co-determines it.

So, a key moment in the historical development of the concept of the environment and its epistemological status is marked by the *embodied turn* in cognition, which introduces the necessity of considering at least two further coordinates in the status of the environment: the environment in its hybrid form – both informational and digital – considered in terms of information, relation, and situation.

Embedment, the second declination in the theoretical and epistemological paradigm of *4E cognition* (embodied, embedded, enacted, extended), strongly reaffirms the centrality of the body and its 'situatedness' within the *milieu*,

[27] F.J. Odling-Smee, K.N. Laland, M.W. Feldman, *Niche Construction: The Neglected Process in Evolution*, Princeton and Oxford, Princeton University Press, 2003.

[28] R. McClamrock, *Existential Cognition. Computational Minds in the World*, Chicago, The University of Chicago Press, 1995.

[29] M. Rowlands, *The New Science of Mind. From Extended Mind to Embodied Phenomenology*, Bradford Books, 2010, p. 59.

prompting a profound rethinking of the latter in contrast to the classical cognitive science model of mind of the mid-20th century. While traditional cognitive science viewed the mind as isolated and representational, 4E approaches emphasize that cognition arises through dynamic interaction with the world. The environment is not a static container but a meaningful space co-shaped by the organism's sensorimotor activity and lived experience. Extended Cognition[30] pushes this idea further: cognition can include tools, technologies, and external resources when they function as integral parts of cognitive processes. This view challenges the brain-bound model of mind and sees cognition as distributed across brain, body, and world. Thus, the world is not something passively represented but actively constructed and enacted. Situatedness becomes a space of engagement where perception and action co-create meaning. Rather than mirroring a pre-given world, the cognitive agent participates in shaping its own world – a dynamic process of world-making.

We firstly might identify the environment, in its purely spatial sense, as a convex space, a fulfilled space – one that does not exist independently but only in relation to bodies and organisms and their constant drive to interact with it. To localize a body in space means being able to produce in the brain the representation of the movement needed to reach it. This representation evokes the muscle sensations that accompany such movement. According to brain physiology, space is not conceived as a stage or a theatre; rather, our own bodies, our movements gradually constitute our space of life. As Poincaré worded it: «Il existe autant de dimensions dans l'espace que de muscles»[31].

The determination of a full proxemic space is made possible by at least two key ideas: the environment does not exist independently of the body, and the environment is determined, known, and thus gains meaning for the organism when it becomes actionable, depending on species-specific traits and the neural wiring of the brain:

> The main task of the brain, then, is to imagine – in this sort of amorphous continuity – what the 'world' is: curved lines, boundaries, carved forms that are not already carved in and by the world [...] The brain must 'discretize', that is, 'make discrete' or 'place limits', cutting shapes from what appears or exists as a continuum of stimuli[32].

In this act of delimiting boundaries and cutting out shapes of the world, the organism comes to know and shape its own full space of interaction between the subject and its 'own world'. 'My world' emerges through situatedness. The knowledge of the world, therefore, does not depend on the *priori* knowability of the environment itself, nor – on the other hand – there is a Kantian non-knowability of certain features. It might be argued that the world is neither fully knowable nor completely obscure for living beings; knowledge depends on

[30] A. Clark, D. Chalmers, *The Extended Mind*, in «Analysis», 58, 1998, 1, pp. 7-19.

[31] H. Poincaré, *La valeur de la science* (1908), tr. it. *Il valore della scienza*, Bari, Dedalo, 1992.

[32] M. Benasayag, *Il cervello aumentato, l'uomo diminuito*, Trento, Erickson, 2016, p. 45 (our translation).

the relationship that organisms establish with the environment based on their uniqueness.

As Leibniz argued, knowledge is more appropriately traced back to the sphere of *apperception*, which unites the perceptual dimension of the knowable world and the dimension of *meaning* that the environment acquires in relation to the sensorimotor and perceptual specificity of organisms, as highlighted by the pragmatic turn[33]. In this sense, the environment no longer assumes the linear and symmetrical traits of a static space: its forms and boundaries are *plastic*, *porous*, and *affordable*; they are co-shaped by the capacities for perception, movement, and action of the organisms inhabiting it. Thus, *world-representation* gives way to *perception-action* – a process in which the cognitive agent is no longer a mirror of the perceived world (*world-mirroring*), but an active sculptor of the world (*world-making*). In this 'cut-out' world-space, we can trace the strong phenomenological and hermeneutic influence of the existential conception of space, already present in Heidegger's *In-der-Welt-Sein* (Being-in-the-World) and in Merleau-Ponty's *être-au-monde* (Being-in-the-world). The affirmation of being-in-the-world, far from being a mere ontological aspiration, underscores the necessity of rooting cognitive processes within the *body-world* – a sensorimotor, holistic, and active process of knowledge and co-construction of the *Umwelt*.

In this *humus*, *situatedness* emerges as a 'space of experience' that is pragmatic and never neutral, continuously determined by the engagement of organisms in their life space:

> The world is an a priori unlabeled 'field of experience' in which cognition (as embodied action) draws relevant distinctions. If indeed the world is organized in 'referential wholes' that cannot be decomposed into neutral objects, then the concept of 'situation' should figure as the more basic ontological category[34].

At the epistemological level, the *embedded* dimension of cognition takes on significant theoretical importance within the landscape of the new cognitive sciences, due to the conceptual layering inherent in the very notion of environment as it relates to the bodies that experience it. This perspective reveals clearly that segmenting and decomposing informational elements into neutral stimuli present in the environment – like pieces of a mosaic to be reassembled – still reflects the outdated vision of a mind capable of experiencing the outside world independently of the body that inhabits it, like Putnam's famous mental experiment of the brain in a vat[35].

However, it is precisely in the organism's singularity and in the osmotic relationship between inside and outside that one finds what cognitive theorists would call a meaningful behavioral output. A brain in a vat, for instance, could – if connected to sufficiently sophisticated electrodes – indeed have a represen-

[33] A.K. Engel, 2010, cit.

[34] *Ibidem*, p. 223.

[35] H. Putnam, *Brains and Behaviour*, in N. Block (ed.), *Readings in Philosophy of Psychology*, Cambridge (Mass.), Harvard University Press, 1980, pp. 24-36.

tation of the outside world; but such representation would be equivalent to that produced by a sufficiently advanced machine, capable of generating a hollow, senseless image.

While it might be possible to simulate the experience of the external world in the scenario imagined by Putnam, what would be missing is the very interweaving of inner and outer worlds: relationships. Being in relation with the world – and therefore being situated within an environment – requires a continuous and unceasing osmotic exchange between one's own proximal space of flesh and bone and its boundary with the outside, through which the construction of one's own subjective experience and specific ways of being 'in relation' with the world becomes possible.

> The embodied mind is characterized by extension, enaction, embodiment, and embeddedness; in relation to the anthropological significance of these words then cognitive science must develop ways to understand the specificity and varieties of human cognitive becoming. New things, technologies, and material environments can stretch and enhance our minds, but they can also shrink them, blind them, or deprive them of their creative abilities and what Michel Foucault referred to as critical consciousness[36].

7. *Beyond the dichotomy: nature and nurture, inner and external*

It is now evident how advances in research on these topics have caused the collapse of traditional dichotomous assumptions (mind/body, subject/object, perception/action, brain/body, and body/environment), which for a very long time were the pillars of our conception of mind and environment. Cognition does not correspond to the 'all in the head' view and is not representational. The direction taken by contemporary cognitive sciences leads us to: «Promiscuously crisscross the boundaries of brain, body, and world. The local mechanisms of mind, if this is correct, are not all in the head. Cognition leaks out into body and world»[37].

The close relationship between the functioning of our cognitive system – hence the production of knowledge – and the 'world' (which, for us humans, is primarily cultural and technological), is the cornerstone on which Malafouris (2016) has built the *Material Engagement Theory* (MET). This theory refutes the computationalism of classical cognitive science, grounding itself in the complex developments of embodied cognition. By emphasizing the mutual dependence of elements within an ecosystem – and thus also within our *cognitive ecosystem* – MET theorizes a decentralized conception of mind and agency, again expanding the gaze beyond the old dichotomy between inside and outside, brain and body, environment and mind. Brain processes, taking place within the skull,

[36] L. Malafouris, *How Things Shape the Mind. A Theory of Material Engagement*, Cambridge (Mass.), MIT Press, 2016; L. Malafouris, *Bringing Things o Mind: 4Es and Material Engagement*, in A. Newen, L. De Bruin, S. Gallagher (eds.), *The Oxford Handbook of 4E Cognition*, Oxford, OUP, 2018, p. 763.

[37] A. Clark, *Supersizing the Mind: Embodiment, Action, and Cognitive Extension*, Oxford and New York, OUP, 2008, p. xxviii.

cannot be considered cognition in full sense; they are just one of the factors that, in synergy with the entire body and the environment, generate our knowledge and behavior through a relational domain.

Edwin Hutchins uses the term 'cognitive ecology' precisely to highlight that studying the mind requires a systemic and dynamic approach to the whole ecosystem: if thinking is found in the interactions between brain, body, and world, then it is not the process of a subject reflecting on the world, but a vital flow, preceding even cognitive processes: «Thinking is something that we do rather than something that simply happens to us, or in us»[38].

As neuroscientific studies advance, findings in epigenetics regarding the interplay between genes and the environment, along with the discovery of remarkable brain plasticity, have underscored the need to consider the complex interactions between internal and external factors in cognitive development of biological embodied agents. Thus, the material, cultural, and relational world is acknowledged as a *constitutive part* of our cognitive system – both phylogenetically and ontogenetically.

> The longer the period of parental care, the more time will be available for learning, hence, the greater the opportunity to replace the closed genetic program by an open program. The great selective advantage of a capacity for learning is, of course, that it permits storing far more experiences, far more detailed information about the environment than can be transmitted in the DNA of the fertilized zygote[39].

Behaviour retroacts on the species-specific dimension of the organism, constantly modifying it through experience and learning: «Behaviour thus plays an important role as the pacemaker of evolutionary change»[40].

The old concept of 'critical period' has been replaced by the idea of multiple 'sensitive periods'; we now know that our brain and our cognitive system change constantly throughout the entire lifespan of the individual. 'Activity-dependent plasticity' and the fundamental interaction with the material, cultural, and technological world, are crucial. The brain is an ongoing construction throughout the individual's life; it is a living organ that does not merely 'have' a history but – as Malabou has effectively expressed – «it 'is' a history»[41].

[38] L. Malafouris, *How Things Shape the Mind*, cit., p. 50.

[39] E. Mayr, *Evolution and the Diversity of Life. Selected Essays*, Cambridge, The Belknap Press of Harvard University Press, 1976, p. 699.

[40] E. Mayr, *The Growth of Biological Thought. Diversity, Evolution, and Inheritance*, Cambridge (MA), Harvard University Press, 1982, p. 612.

[41] C. Malabou, *What Should We Do with Our Brain?*, New York, Fordham University Press, 2008.

8. *An Open Architecture*

«In functional terms, there is no such thing as 'a brain'. A brain is always in interaction with the environment».[42]

The open architecture of our cerebral organ and of the human mind – their continuous, plastic and dynamic interaction with the environment – lies at the core of the 'metaplasticity'[43] that characterizes our species: the osmotic relationship that binds mind, body, and world, a dynamic interplay that continuously reshapes the brain, the mind, and the individual's lived environment.

The future progress of cognitive science looks set to involve ever-increasing efforts to anchor research to the real-world poles of sensing and acting. Thus anchored, time, world and body emerge as significant players in the cognitive arena. How could we ever have forgotten them? [44].

Our 'mindbrain' arises from embodied processes, and it is rooted simultaneously in the environment: material, cultural, and relational. The brain is shaped over one's lifetime as the product of a dynamic process of biological and cultural co-evolution. The brain's synaptic plasticity, its context-dependence and experience-dependence allow for the emergence and development of cognitive abilities along an individual and historical developmental trajectory. The subject is constantly transformed within specific environmental 'situations', material conditions, worldviews, and interpersonal relationships.

In the last two decades a consensus emerged: Viale proposes a philosophy of 'human action' within the enactive, embodied, and embedded cognitive paradigm[45]; Malafouris emphasizes the enactive constitutive intertwining between brain and culture[46]; relational neuroscience or affective neuroscience, as suggested by Siegel, proposes an interdisciplinary approach to the mind, in which the structure and functions of the brain –the 'primary' organ of the mind –are shaped by the interpersonal experience of each individual[47]. Cognitive processes do not take place 'in' the brain, nor in the environment: they are inherently relational. They are woven from both the inside and the outside, the body and the environment, the mind and relationships, culture and technique; they un-

[42] R. Meares, *A Dissociation Model of Borderline Personality Disorder*, New York, Norton, 2012, p. 303.

[43] The term 'metaplasticity' was coined in neuroscience to refer to the emergent higher-order properties of synaptic plasticity and to their modification. The emergent higher-order properties of synaptic plasticity provide the substrate for experience-dependent brain development (W. Zhang, D. Linden, *The Other Side of the Engram: Experience Driven Changes in Neuronal Intrinsic Excitability*, in «Nature Reviews Neuroscience», 2003, 4, pp. 885-900).

[44] A. Clark, *Supersizing the Mind*, cit., p. 101.

[45] R. Viale, *Explaining Social Action by Embodied Cognition: From Methodological Cognitivism to Embodied Individualism*, in N. Bulle, F. Di Iorio (eds.), *The Palgrave Handbook of Methodological Individualism,* London, Palgrave MacMillan, 2023, vol. II, pp. 573-601.

[46] Malafouris, *How Things Shape the Mind*, cit.

[47] D.J. Siegel, *The Developing Mind: Toward a Neurobiology of Interpersonal Experience*, New York, Guilford Press, 1999.

fold time and space in a continuous flow of events which is their history[48]. In this sense, the beautiful metaphor proposed by Alva Noë resonates powerfully: «the mind is like a dance»[49]. We are 'open' organisms, and openness is our evolutionary key. We are open to the environment not only in the physico-chemical dimension of the *Umwelt* of the tick, but also to lived experience, history, relationships and affections. We are also open to the innermost and internal levels of the environment, from functional systems to chemical and physical flows, all the way down to the cellular environment in which our genes can activate or not. We are open, therefore, in the body: like the Moken sea nomads of Thailand, who develop, through their experience, an exceptional eye-lens flexibility that allows them to see at great depths underwater. We are 'open' in our brain: as shown by the functional reconfiguration of the cerebral *homunculus* depending on practice[50]. Finally, we are open in both disease and health: we can just think about pathologies like Alzheimer's disease and its possible evolutionary interpretation or consider the brain's remarkable capacity for vicariousness and functional recovery, or even the placebo effect in health conditions. It is an 'ontological openness' that gives rise to multiple dimensions. This openness is 'dense', perhaps unfathomable, and yet it makes the whole architecture 'light'. It grants us malleability, plasticity, and resilience.

[48] Di Paolo, *Extended Life*, cit.

[49] A. Noë, *Out of our heads: why you are not your brain, and other lessons from the biology of consciousness*, New York, Hill & Wang, 2009.

[50] Such as in the famous case of London taxi drivers or in cases of individuals experiencing phantom limb syndrome. Further evidence of this statement is in the cerebral implementation of Literacy, as it is shown by our general species-specific abilities in learning, problem solving, 'dexterity', or intelligent and creative interaction, as well as by the apparent paradox of the cultural maps related to the cerebral implementation of reading and writing. C. Morabito, *Dall'area di Broca al sensorio digitale, trasformazioni antropologiche in atto e 'cervelli in movimento': una mente incorporata in un mondo digitalizzato*, in F. Ciotti, C. Morabito (a cura di*), La narrazione come incontro*, Firenze, Firenze University Press, pp. 82-102.

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– The Material, Cultural, and Relational Environment in the New Cognitive Sciences

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ABSTRACT
The paper addresses the epistemological reconfiguration in contemporary cognitive science of the notion of environment, which has shifted from passive backdrop to an active, co-constitutive dimension of cognition. It reviews the dismantling of traditional dichotomies (mind/body, subject/object) through the lens of the model of 4E cognition (Embodied, Embedded, Enacted, Extended), that, drawing on Bernard, von Uexküll, Gibson, Lewin and the enactivits Varela, Thompson and Rosch, emphasizes the dynamical interaction of the organism with its environment. The environment is recast as a relational and open process, shaped by sensorimotor activity and embodied action. Finally, through the integration of Malafouris' Material Engagament Theory with recent findings in epigenetics and neuroplasticity, it is underscored how cognition, as a relational process, is shaped at different ontogenetic and developmental scales by material, affective and cultural environments.

KEYWORDS: 4E Cognition; Enactivism; Environment; Relationality; Material Engagement Theory.

SOMMARIO
L'articolo esamina il cambiamento epistemologico nella scienza cognitiva contemporanea riguardo al concetto di ambiente, che passa da sfondo passivo a dimensione attiva e co-costitutiva della cognizione. In particolare, l'articolo analizza lo smantellamento delle dicotomie tradizionali (mente/corpo, soggetto/oggetto) attraverso la lente del modello '4E cognition' (Embodied, Embedded, Enacted, Extended: Incorporata, Immersa, Enattiva, Estesa), e, nel confronto con pensatori come Bernard, von Uexküll, Gibson, Lewin e agli enattivisti Varela, Thompson e Rosch, sottolinea l'interazione dinamica dell'organismo con il proprio ambiente. L'ambiente è ripensato come processo aperto e relazionale, modellato dall'attività senso-motoria e dall'azione incarnata. Infine, integrando la Material Engagement Theory di Malafouris con recenti scoperte in epigenetica e neuroplasticità, lo studio sostiene che la cognizione è relazionale e viene plasmata su scale ontogenetiche e filogenetiche da ambienti materiali, culturali e affettivi.

PAROLE CHIAVE
Cognizione 4E; Enattivismo; Ambiente; Relazionalità; Material Engagement Theory