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Environ-minds

The Twofold Dimension of Human Cultural Evolution

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This article aims to propose a new look on the distinction between mind, environment and culture. While the first of these has mostly been understood as an interior and individual dimension of experience both by common sense and modern philosophy, an evolutionary and ecological standpoint could help us rethink the practices, information and technologies forming the niches of *Homo sapiens* societies both as the ecological horizon of our actions and as collective and shared minds possessing an external and partially detached existence. Every human being participates in these collective 'exteriorities', extends his body through tools, organizes his behaviour with respect to others and absorbs the social context of his technologies, languages, institutions, values in a partial and unique standpoint, that is an individual 'interiority'.

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1. If mind was the inside and the environment was the outside, could culture be both?

It is not an easy task to define words such as 'mind' and 'environment'. It seems to me that the common sense of everyday life – assisted and secured in this regard by centuries of philosophical discussions – views them as contrasting poles. The mental appears to be the realm of private experiences and the inner dimension of an individual, while the environment corresponds with the public reality of the world, the space where other things and living beings exist independently from my own cognition of them. In other words, mind and environment are usually deemed to be the *inside* and the *outside*, the interiority and the exteriority, the self and the other respectively.

I think that this intuitive distinction captures some important points of the relationship between an organism and its world, but also shows challenging issues. Firstly, minds and environments do not correspond to single things or objects: rather, the former overlap with many different processes and functions inherent

to an organism and its actions[1], while the latter exist as complex systems at the crossroads of several causal chains and hierarchies of events (abiotic phenomena, living beings, organic and man-made by-products, etc.)[2]. The belief in 'things' and 'substances' – due to the use of single words that simplify complex relations and set of events – is a common and durable fallacy of our language and systems of thought, as brilliantly exposed by Francis Bacon in the *Novum Organum*[3]. In this respect, reminding ourselves of the systemic and multi-level nature of these processes helps us avoid the superstition of the words wherein common sense usually falls[4].

Secondly, it makes little sense to consider minds and environments to be independent extremes, since both are shaped from their relationship with the other. As a matter of fact, minds exist only in a constant reference to the natural world, inhering to biological bodies which evolve and develop in an ecological context they need to adapt to. On the other hand, it is precisely an organism – the evolutionary and developmental processes leading to its existence – that selects what from its surroundings counts as its own environment. Biologist Jakob von Uexküll recognized this fact by affirming that «each and every living thing is a subject that lives in its own world, of which it is the center»[5]. The environment is not just a container that living beings occupy, but rather it is defined differently for each organism that inhabits it through an evolutionary and developmental selection of the feelings and actions towards other objects and beings it interacts with. The latter are not stimuli nor do they bring information in themselves, but they are received in this way by the living beings who operate within them and have co-evolved with them[6]. Using the words of common sense, the inside

[1] In contrast to immaterial 'mental entities' or substantial selves which have animated part of our metaphysical and epistemological traditions, for example the notorious and influential definition of *res cogitans* (thinking substance) by philosopher René Descartes (R. Descartes, *Meditations on First Philosophy*, Cambridge 1996). A classical criticism of this substantialist view on the mind and its operations is offered by G. Ryle, *The Concept of Mind: 60th anniversary edition*, London 2009.

[2] A detailed historical reconstruction of the many meanings of 'environment' is offered in E. Gagliasso, *Ambiente*, in F. Michelin – J. F. Davies (eds.), *Frontiere della biologia: prospettive filosofiche sulle scienze della vita*, Milano 2013, pp. 117-144.

[3] The English philosopher called these biases *idola fori*, the illusions coming from the use of language, and *idola theatri*, the ones deriving from bad philosophies. F. Bacon, *New Organon*, Cambridge 2000, pp. 41-42.

[4] An example of systemic approach and ecological perspective about the mind can be found in the thought of anthropologist Gregory Bateson. See G. Bateson, *Steps to an Ecology of Mind*, San Francisco 1972.

[5] J. von Uexküll, *A Foray into the Worlds of Animals and Humans. With a Theory of Meaning*, Minnesota 2010, p. 45.

[6] An interesting field of research on this topic is the one opened by Francisco Varela, Evan Thompson and Eleanor Rosch when they first proposed the concept of *enaction*: a notion conveying the codetermination between organism and environments, as well as the fact that the first bring forth 'their own world' through their sensorimotor systems. F. Varela *et. al.*, *The Embodied Mind*, Cambridge MA 1991. For a contemporary introduction on *enactivism* and its role in recent cognitive studies, see D. Ward *et al.*, *Introduction: The Varieties of Enactivism*, «Topoi», 36, 2017, pp. 365-375.

and the outside, the self and the other, can exist only in a process of mutual specification.

When we think this way, the intuitive consideration of mind and environment as the inside-outside poles acquire a new meaning and can also help us illuminate an interesting aspect of cognitive processes. As maintained by philosopher Thomas Reid, a fundamental feature of a mind seems to be the capacity to discriminate between *perceptions* and *sensations*, that is, the external objects captured by our senses and the internal experiences connected to them[7]. Adding this specification to an evolutionary method, I would outline an individual mind not just as an inside, but rather as the totality of processes and functions that enable an organism to distinguish between and inside and an outside (or between a self and a non-self), then enquiring how and why the distinction could have appeared, be selected and have evolved[8]. Why did organisms develop a capacity of feeling themselves as a distinct unity facing their surroundings? Is this feature a motor for the development of complex cognitive processes? And how about the human mind?

Regarding this last question, philosophers Andy Clark and Desmond Chalmers noted how the inside-outside distinction appears to be nuanced and extremely flexible in the human species. «Where does the mind stop and the rest of the world begins?»[9]. This question opens their notorious paper on the *extended mind hypothesis* (or EM), where the two argue that cognitive processes can happen outside the boundaries of individual brains, involving external tools and technologies who can drive the resolution of mental processes, partially in contrast with the vision of classical cognitive sciences[10]. In this sense, minds should not be located inside of an individual nor limited to the boundaries of its biological structures, but deemed as a phenomenon distributed between an organism and some aspects of the environment it interacts with[11].

However intriguing, EM's standpoint presupposes the existence of individual minds as internal processes which *then* expand to the surrounding environment, embodying some of its features in mental operations. Human minds move from the inside to the outside, and this movement makes the distinction of the latter more nuanced. Thus, I think that this model focuses on some important questions but lacks an evolutionary and ecological perspective on the functioning of an extended mind. As I will show, a *genealogy* of mental processes will not only support us in understanding the emergence of the extending mind of *Homo sapiens*, but also show the peculiarity of its distributed and collective cognition.

[7] T. Reid, *Essays on the Intellectual Powers of Man*, Edinburgh 2002, essay II.
[8] Evolutionary psychologist Nicholas Humphrey has thoroughly applied Reid's insight to the history of life. See N. Humphrey, *A History of Mind*, New York 1992, pp. 65-94.
[9] A. Clark – D. Chalmers, *The extended mind*, «Analysis», 58 (1), 1998, pp. 7-19.
[10] See also M. Rowlands, *Extended cognition and the mark of the cognitive*, «Philosophical Psychology», 22 (1), 2009, pp. 1-19.
[11] E. Hutchins, *Distributed*, *Cognition*, in N. J. Smelser – P. J. Baltes (eds.), *International Encyclopaedia of the Social & Behavioral Sciences*, New York 2001, pp. 2068-2072.

In particular, I suggest that human beings have not just acquired the ability to extend their own minds in the environment. *Homo sapiens* came to the point of forming collective structures that behave both as new environments in respect to the individuals inhabiting them and as supervenient minds capable of determining their own independent existence in respect to the natural world and to other collective structures, coping with their challenges and pressures in a unity of action. These are human cultures, understood as «the total pattern of human behaviour and its products embodied in thought, speech, action and artifacts, and dependent upon man's capacity for learning and transmitting knowledge to succeeding generations»[12]. For this reason, I decided to call them *environ-minds*, to mark their double level of influence: on the individuals, for which they came to almost substitute the natural world[13] and shape their identity and cognition from birth; on ecosystems, of which they continue to modify the selective pressures future humans will be subjected to, triggering ulterior biological modifications on our species[14].

I think that it is precisely this double level of action that led to the extraordinary diffusion and rise of our species in such a rapid evolutionary time. As a matter of fact, these two dimensions constantly interact, speeding up the process of change in respect to the slow pace of mutation and natural selection. Human cultures emerged through the use of tools, social cooperation, and systems of abstract thought that were born from specific natural conditions and transformed the capacity of inside-outside distinction which had first evolved at the origin of animal minds. The humans, growing in their cultural niches, acquired complex social behaviour and cognitive capacities, which in turn resulted in new innovations that favoured the transformation and adaptation of ecosystems, in a process of positive feedback. To understand how this could have happened and the impact it has had on our species, I will proceed to reconstruct the steps toward our cultural evolution.

2. The evolutionary origin of the inside-outside distinction

What is a mind? Where and when does a mind begin? At the first stage of this story, individual cells are equipped with a membrane that not only confines their internal fluid and organelles but divides the world into two

[12] M. Feldman – L. L. Cavalli-Sforza, *Cultural Transmission and Evolution: A Quantitative Approach. Vol. 16*, Princeton 2020, p. 3.
[13] This period may seem a bit of exaggeration at a first look, but latest studies seem to confirm that man-made products have recently outgrown the biomass of all living things on Earth. E. Elhacham *et. al.*, *Global human-made mass exceeds all living biomass*, «Nature», 588, 2020, pp. 442-444.
[14] R. Boyd – P. Richerson, *Not by genes alone*, Chicago 2005. The authors note that cultural transmission can be observed in other animal species, with different means of communication and social regulation. However, this paper will focus on the evolution of human culture which is characterized by a pervasive use of tools, social cognition and cooperation, language and abstract thought.

zones. The membrane is not a simple limit like that of an inanimate object, but an active threshold that gives meaning to the metabolism of the organism, which incorporates what is essential and protects against what is harmful to preservation. Through the membrane and its own metabolic mechanisms, cells give life to the (physiological) distinction between a self and a non-self.[15] In saying this, I am not suggesting that the bacteria and individual cells of our body have their own qualitative experience. But such organisms do have certain features which we intuitively recognize essential to experience the world, to 'feel something to be x'[16].

We can say that these characteristics are important because they give organisms a more interesting 'point of view' on the world than we could abstractly attribute to a rock or an electron. Unlike the latter, living beings necessarily make a distinction between themselves and their world, at the same time outlining within that physical space what constitutes their environment and what counts as a value for their own survival[17]. What we call 'organisms' are systems of self-preservation that must delimit themselves with respect to the rest of the environment and actively respond to it. In this sense, living beings are necessarily and primarily *agents.* This primordial agency provides the evolutionary basis from which subjectivity, experience, consciousness, and autobiographical self-awareness could emerge[18].

However, the agency of a cell is something different from that of a multicellular aggregate. In the former, conduct occurs as local reactions to exogenic stimulations, while in the latter, the organization between the components on a motor level is a fundamental aspect for community life. As suggested by Godfrey-Smith, it is precisely from these latter mechanisms (regulated by early nervous systems) that a new type of subjectivity in multicellular organisms would have evolved further[19]. Bodily actions consist of movements coordinated through nervous activity, which are continuously inserted into an *organic circuit* with perception realized through the aid of sense organs[20]. For an action to

[15] For a review on cellular behaviour, see P. Lyon, *The Cognitive Cell: Bacterial Behavior Reconsidered*, «Frontiers in Microbiology», 6, 2015, pp. 1-18.
[16] I here use a similar expression to the one used by philosopher Thomas Nagel to describe conscious experiences: «There is something that it is like to be…». T. Nagel, *What is it like to be a bat?*, «The Philosophical Review», 83 (4), 1974, pp. 435-450.
[17] Philosopher Evan Thompson has referred to this process as *sense-making* and extended it to the "cognitive" features of simple bacteria: «That sucrose is a nutrient is not intrinsic to the status of the sucrose molecule; it is, rather a relational feature, linked to the bacterium's metabolism. Sucrose has significance or value as food, but only in the milieu that the organism itself brings into existence». E. Thompson, *Mind in Life. Biology*, *Phenomenology and the Sciences of Mind*, Cambridge MA 2007, p. 158.
[18] P. Godfrey-Smith, *Evolving across the explanatory gap*, «Philosophy, theory and practice in biology», 11, 2019, pp. 1-13.
[19] P. Godfrey-Smith, *Animal Evolution and the Origins of Experience*, in D. Smith (ed.), *How Biology Shapes Philosophy: New Foundations for Naturalism*, Cambridge 2016, pp. 51-71.
[20] American philosopher John Dewey intended this concept as the interdependence of perception, cognition and action in the interaction between an organism and its world, in contrast with the idea of *reflex arc*, *i. e.* the linear and compartmentalized succession from stimuli to

be functional and to adjust themselves with external feedback, cell-aggregates must feel and move as an integrated unit, and this unity must be present in the execution of the action[21]. The physiological self of the individual cell must extend to a complex, become (and feel as) a single whole and constitute an element of regulation in the interaction with the world. It is here that the inside-outside distinction in experience can be a valuable tool to cope with the surroundings.

In addition to the emergence of an agent subjectivity, living beings also show what we might call *evaluation skills*. The constitution of life requires the maintenance of an internal balance, the achievement and preservation of a state between a range of biochemical parameters compatible with the activities of individual organisms: *homeostasis*. According to Antonio Damasio, homeostasis constitutes a reference point allowing organisms to evaluate the world in biologically positive or negative aspects for their survival needs, and even the evaluation comparison processes of more complex minds would derive from the evolution of these primordial satisfaction-mechanisms[22]. Homeostasis provides the original yardstick on which an organism regulates its own assessments: what upsets such a balance is 'evil', what brings one closer to it and allows an organism to maintain such a state is 'good'.

Thus, the feeling to be an inside distinct from an outside is the steppingstone for what we can call a mind and constitutes an asset for animals possessing muscles and nervous systems to regulate their own actions in respect to their surroundings. To make a clear example, we can compare the behaviour of a bacterium with that of a simple animal. *E. coli* shows a clear presence of receptive abilities that trigger different responses based on the concentration of positive or negative substances for the organism in the surrounding environment. However, its movements can be easily categorized in two different reactions – *run* and *tumble* – which are triggered by local receptions of positive or negative substances in its surroundings[23]. It is extremely likely that bacteria do not feel the differences in the organization of their internal states, while having mechanisms programmed to respond to dangerous situations or to recognize when they are in balance, allowing them to proceed unbothered[24]. But when cells aggregate in communities and differentiate, some of them are responsible for recording changes in the body's internal *milieu.* Organization and coordination necessarily require a form of internal control and sensitivity, an *interoception*[25]. In contrast

reactions. J. Dewey, *The Reflex Arc Concept in Psychology*, «The Psychological Review», 3 (4), 1896, pp. 357-370.

[21] G. Jèkely *et al.*, *An option space for early neural evolution*, «Philosophical Transactions of The Royal Society B: Biological Sciences», 370 (1684), 2015, pp. 1-10.

[22] A. Damasio, *Self comes to Mind: Constructing the Conscious Brain*, New York 2010.

[23] H. Berg, *E. Coli in motion*, New York 2004.

[24] Nonetheless, other authors have also noted that bacterial behaviour would demonstrate the existence of complex top-down processes of regulation, which have been called *informational control*. See G. Auletta, *Information and Metabolism in Bacterial Chemotaxis*, «Entropy», 15, 2013, pp. 311-326.

[25] G. Carvalho – A. Damasio, *Interoception and the origin of feelings: A new synthesis*, «BioEssays», 43 (6), 2021, pp. 1-11.

to single cells, an earthworm shows a different behaviour when touching the ground or when touched by an external object: in the first case it continues its action straightforwardly, but in the second it retracts into a defense mechanism. Thus, the animal is able to distinguish its action from the reception of stimuli external to it, and this preliminary distinction of its biological self with respect to the not-self constitutes the basis on which its actions are regulated[26].

One of the mechanisms by which this capacity is carried out is the *copy of efference*. Apparently, organisms with nervous systems possess the ability to distinguish between stimulations from sense organs (afferent) and those deriving from neurons to muscular cells (efferent). This would happen because the nervous system, when sending impulses to muscle fibers, also sends signals to other cerebral areas, a kind of carbon-copy of the action to prepare the body for the perceptual changes that will take place[27]. For example, this process explains why we do not perceive our visual world as wobbly even if our eyes constantly move with rapid movements (saccades) to focus on different elements of the perceptual scene[28]. It is as if our nervous system, during the organization of movements, constantly sends a message to our body («don't worry, it's just you») in order to prepare for the perceptual changes that will follow.

Then, we can differentiate a *sense of ownership*, which concerns the feeling that changes felt (or suffered) affect one's body, from the ability to perceive one's own actions as self-generated. This *sense of agency* constitutes the foundation for the development of a subjective perspective experienced by organisms, an agent's point of view that can be integrated with sensory stimuli from the environment, which are defined by the actions of the organism: it is the look that specifies what is seen, the action that determines one's possibilities of regulation. With the evolution of multiple and different sensory organs, the stimuli were conveyed into the shaping of consistent perceptual scenes and 'tuned' to the underlying of the action felt[29].

To sum up, organized movements – that is, the alliance of nervous systems and muscles – laid the groundwork for the emergence of an agent subjectivity, a point of view felt by the acting body which provides a criterion of distinction between oneself and not-self. Subjectivity and experience derived and transformed

[26] B. Merker, *The Liabilities of Mobility: A Selection Pressure for the Transition to Consciousness in Animal Evolution*, «Consciousness and Cognition», 14 (1), 2005, pp. 89-114.
[27] E. Von Holst – H. Mittelsteadt, *The Principle of Reafference: Interactions Between the Central Nervous System and the Peripheral Organs*, in P. C. Dodwell (ed.), *Perceptual processing: stimulus equivalence and pattern recognition*, New York 1971, pp. 41-72.
[28] B. Bridgeman, *A review of the role of efference copy in sensory and oculomotor control systems*, «Annals of Biomedical Engineering», 23, 1995, pp. 409-422.
[29] I characterize the sense of agency differently from when is usually used in neurosciences focused on human brains, for example in C. Farrer – C. Frith, *Experiencing Oneself vs Another Person as Being the Cause of an Action: The Neural Correlates of the Experience of Agency*, «Neuroimage», 15 (3), 2002, pp. 596-603. When I talk about agency, I would rather refer to a pre-reflective and primordial capacity derived from the universal and necessary distinction between one's coordination and the changes 'suffered' by the activity of external stimuli, similarly to Godfrey-Smith.

from the physical-chemical-biological structure of organisms, an accidental event but proved useful, since its crudest origins, in shaping behaviour, learning, incentives and escape mechanisms[30]. Starting from these primordial experiences, more complex evaluation mechanisms – such as emotions – developed and took to new kinds of interaction between the internal worlds of living beings and their environments.

3. Tools, or the dawn of Man

Homo sapiens inherited its capacity of discrimination between an inside and an outside from an ancient past in which minds – or the processes of discrimination between internal experiences and external objects – had long since evolved incorporating new variables such as emotions, simulations, imagination, etc. At the same time, we have also noted how the distinction between inside and outside in human cognition appears nuanced. We can move with a car, remember with a diary, calculate with a pen and a sheet of paper. That is, our actions and cognitive processes are not bound to the interiority of our body and brain, but rather incorporate external tools and extend to outside elements. Moreover, the continuous use of devices and technology seems to have a return-effect on our cognitive process, shaping them and modifying our relationships with ourselves and the natural environment, both on an evolutionary and ontogenetic scale[31]. How could our mind extend beyond the threshold of the body? Was this process a core element in the evolution of human cognition?

In the visionary movie *2001: A Space Odyssey*, Kubrick imagined the history of mankind beginning with the first use of a tool. In the opening sequence, our primate ancestors lived in hunger and fear until their encounter with an alien monolith, which influenced them to use/adopt a bone as a weapon. In that moment, everything changed: hominid minds stepped up, tools made us conquer the world, and in a blink of an eye – that is human history in respect to cosmic time, and such is the transition in the movie – technology evolved to the unthinkable heights of spaceships[32]. Although fictional, Kubrick's reconstruction shows a fundamental element of human cognition. Since the birth of our species, we *sapiens* have lived in a world of tools integrated into most daily activities. While other animals can find tools in their natural environment, use them for contingent activities and then abandon them, we humans constantly resort to them, possess them, take them with us to use them in future and hypothetical situations, and so on. Secondly, we do not just use objects as tools but build

[30] J. Panksepp – L. Biven, *The archaeology of mind: Neuroevolutionary origins of human emotion*, New York 2012.
[31] D. Ihde – L. Malafouris, *Homo faber revisited: Postphenomenology and Material Engagement Theory*, «Philosophy & Technology», 32, 2018, pp. 195-214.
[32] See also the homonymous book by Arthur Clarke (1969), who cooperated with Kubrick in the screenwriting of the movie.

them through a series of specific practices. In other words, *Homo sapiens*' history is characterized by the acquisition of techniques and technology.

Great apes can see in a stick a longer arm to reach food[33], the octopus uses the shells of coconuts as a shelter to hide in and ambush a prey[34]. In neurobiological terms, these activities are probably rooted in the extraction-processes of *affordances*[35] or *micro-affordances*[36], through sensory-motor simulations of the actions that can be performed with the natural object. In human evolution, on the other hand, a further faculty has been acquired, namely that of seeing in the object a possibility that does not yet exist but could be there through a process. The stones used by the first *Homo* are not already sharp weapons, daggers or spears: they become such through a transformation, a labor that produces a leftover for future actions. Once the process of transformation of the natural environment began, it produced a series of chain processing in which the acquired objects could become part of our actions and provide the substrate for further processing and transformation of other objects. As Dennett puts it, humans are not only *Popperian creatures* but also organisms capable of inserting their physical and conceptual tools into a simulation of their actions[37]. In my opinion, this ability has since shaped our mind, allowing us to develop a series of artificial techniques, technologies and tools which gave life to a new bio-social niche: an artificial environment within nature, with evident return-effects on our individual minds and bodies.

From a chronological point of view, the ability to produce tools can be inserted between the development of bipedalism and the acquisition of linguistic communication (gestural and vocal). The first archaeological remains of lithic industry can be backdated to about 3.3 mya, even before the appearance of the first species fully insertable in the genus *Homo*, about 2.8 mya[38]. The production of Australopithecines and *Homo habilis* was limited to a processing technique capable of sharpening a flint core through a ninety-degree percussion (knapping) with another stone (a striker), leaving remains that could be used but without

[33] E. Herrmann *et. al.*, *Great apes' (Pan troglodytes*, *Pan paniscus*, *Gorilla gorilla*, *Pongo pygmaeus) understanding of tool functional properties after limited experience*, «Journal of Comparative Psychology», 122 (2), 2008, pp. 220-230.
[34] P. Godfrey-Smith, *Other Minds: The Octopus*, *The Sea e the Deep Origins of Consciousness*, New York 2016.
[35] J. Gibson, *The Theory of Affordances*, in R. Shaw – J. Bransford (eds.), *Perceiving*, *Acting and Knowing. Towards an ecological approach*, New Jersey 1977, pp. 67-82.
[36] R. Ellis – M. Tucker, *Micro-affordance: The potentiation of components of action by seen objects*, «British Journal of Psychology», 91, 2000, pp. 451-471.
[37] D. Dennett, *From Bacteria to Bach*, New York 2017, p. 161. Dennett uses the expression *Gregorian creatures* in honor of psychologist Richard Gregory, who studied the relationship between the use of tools and cognitive enhancement.
[38] S. Hamilton *et al.*, *3.3-million-year-old stone tools from Lomekwi 3*, *West Turkana*, *Kenya*, «Nature», 521, 2015, pp. 310-315.

further processing. The *choppers* thus obtained could be used to hunt and skin animal carcasses, were kept for future uses and were transported during travel[39].

The so-called Oldowan technology remained unchanged for a long period. Only after more than a million years we witness major technological innovations, such as the consistent use of double-sided choppers and the production of sharp tools in the shape of an almond or tear (amygdala) through tangential percussions. This Acheulean technology initially coexisted with the older Oldowan methods, but through it the members of the genus *Homo* developed more complex techniques and obtained objects far from the physical form of the stones/nucleus they started from[40].

After a long stasis interrupted by some sporadic experimentation, about 600,000 years ago we can date a continuous use of two-phase production techniques by *Homo heidelbergensis*. Some stones were chosen and processed to obtain an additional prepared core from which to extract – with precise and well-settled percussion strokes – splinters, tips or segments that could then be processed for diversified and specific uses. Following the innovation of this multi-stage process, it was possible to develop a series of diversified tools by specializing the sheards and microliths obtained from the previously chipped cores (axes, trenches, blades)[41]. The multiplication of techniques and technologies had thus obtained a further impulse, so much so that in a shortly subsequent period we find a habitual construction of shelters and domestication of fire[42].

At the beginning, lithic productions followed extremely stereotyped canons deriving from the use of limited and repeated percussions. Over time, the acquisition of such percussion practices has made it possible to introduce innovations within this standardized gesture, gradually incorporating such techniques within the motor heritage of our ancestors. The retroflexion from the object to the activity of the one who works it allowed precisely to 'objectify' the gesture and its possible sequences, making them techniques that could be kept in memory, transmitted and reused within the group. From the acquisition of new gestures, the production of new techniques developed, and further tools could be acquired (turning the attention also on new materials such as bones, ivory, leathers, wood etc.).

4. Extending beyond the body

To use a tool, it is not enough to recognize and extract a series of affordances from natural or artificial objects. A tool must not only be grasped and integrated at the visuo-motor level, but also exploited through the motor knowledge of its

[39] I. Tattersall, *Origin of the Human Sense of Self*, in W. Van Huyssteen – E. Wiebe (eds.), *Search of Self: Interdisciplinary Perspectives on Personhood*, Grand Rapids 2011, pp. 33-49.
[40] A. Leroi-Gourhan, *Gesture and Speech*, Cambridge MA 1993, pp. 95-102.
[41] I. Tattersall, *Human Intelligence and how it was acquired*, «Sistemi intelligenti», 1, 2019, pp. 71-85.
[42] R. Shimelmitz *et. al.*, *'Fire at will': The emergence of habitual fire use 350,000 years ago*, «Journal of Human Evolution», 77, 2014, pp. 196-203.

use and through a selection appropriate to the task or needs of the individual. One thing is to know how to grab a hammer, another is to know how to hammer; that is, to select the type of hammering suitable for the purpose and integrate the technique of use to specific situations (for example, when we are in a narrow space). Manipulation presupposes not only the comprehension of volumetric motions – the adaptation of the hand to a type of grip – but also the knowledge of functional gestures, that is the specification of techniques that require the use of motor memory[43].

In this regard, recent experimental data show how at the neurobiological level the use of tools employs two different brain systems. In addition to the front-parietal system extracting (micro-)affordances, it is possible to observe the activation of parietal areas related to the anterior supramarginal gyrus (aSMG), which operates in parallel with the first[44]. This second circuit is a left-lateralized area of the human brain wherein visuo-motor information of the object and motor knowledge of the possible coupling actions are integrated with semantic data about its identity. This area seems to derive from a phylogenetically recent duplication or prolongation of the anterior intraparietal area (AIP) – which took place in human evolution, perhaps in conjunction with the development of Oldowan or Acheulean technology – then *exapted* towards a new function[45].

Thus, although the monkey brain can be trained to use simpler human tools (such as a rake to approach objects), the lack of such an area seems to prevent them from achieving extremely complex manipulations and could not support the instrumental world in which we humans are constantly immersed[46]. At the evolutionary level, our ancestors' brains were sufficient for occasional and effective uses of tools, but it is only with the evolution of specific brain systems and connections such as aSMG that our proto-human ancestors were able to develop that instrumental attitude once only sketched and today so pervasive of our world. Moreover, several experiments on monkeys and humans have shown how the use of tools – and the presence of others, as we will see next – change our perception of the relationship between one's body and space.

To begin with, neurobiological studies have confirmed that our bodies do not measure their spatial positioning in a geometrically neutral way, but rather define it during action with respect to the closeness of graspable objects and others and to the distantness with the out-of-reach ones. The F4 area of

[43] S. Creem-Regehr – J. Lee, *Neural representations of graspable objects: are tools special?*, «Cognitive Brain Research», 22, 2005, pp. 457-469.
[44] G. Orban – F. Caruana, *The neural basis of human tool use*, «Frontiers in psychology», 5, 2014, pp. 1-12.
[45] The concept of *exaptation* was firstly proposed in S. J. Gould – E. Vrba, *Exaptation: A Missing Term in the Science of Form*, «Paleobiology», 8 (1), 1982, pp. 4-15. In a recent paper I have argued that the adoption of this notion in cognitive sciences enhances our understanding of nervous systems' evolution and human cognitive processes: see A. Marconi, *New Uses of Old Functions. Forms of Exaptation in the Evolution of Nervous Systems*, «Azimuth: Philosophical Coordinates in Modern and Contemporary Age», 19, 1, 2022, pp. 121-145.
[46] R. Peeters *et. al.*, *The Representation of Tool Use in Humans and Monkeys: Common and Uniquely Human Features*, «Journal of Neuroscience», 29 (37), 2009, pp. 11523-11539.

macaques – forming a circuit of strong reciprocal connections with the ventral intraparietal area (VIP) – contains neurons having both somatosensory and visual characteristics. These bimodal neurons discharge both during the tactile contact or touching of the object on the neck, arms and hands, and during the sight of these contacts or the approach of such objects. Together with the purely somatosensory and purely visual neurons of these areas, they contribute to defining a somatosensory and visual receptive field with respect to surrounding objects[47]. In other words, they define the coordinates of the body according to space and objects during action, thus allowing to outline the fittest approach for grasping and managing stimuli in one's environment. The activity of these neurons enables us to distinguish between what have been defined as *peri-personal space* and *extra-personal space* of the individual[48].

An object is seen as graspable when it falls into the space where we can reach it. When this happens, our body prepares and regulates its action in a pre-reflective and sub-personal way, adjusting its posture, grip and movements as they proceed, modifying the perception of objects and the course of future actions in a fluid and holistic way. At the same time, these neurons are also employed in mirroring action. When we observe a person approaching an object our peri-personal system is activated: our body understands the object as reachable even when it is in proximity to another individual, and this allows us to extend our perception of space to others[49]. An object, in short, is seen as reachable (and consequently as graspable) even when it is not within our reach but that of another agent. In this sense, our brains are made in such a way that the presence of others influences the perception of our space and the possibilities of action within it. It is as if the presence of others *extends* our own body and mind.

What does this have to do with tools? Well, when we use an instrument, the perception of our peri-personal and extra-personal space changes accordingly. The use of a stick by a macaque extends its personal space to the point that F4-VIP neurons discharge when an object simply approaches the stick alone (the discharge is stronger if the instrument is actively moved to reach it than when it is simply held)[50]. Not only that, but experiments on patients with lesions have shown how even perceptual dysfunctions such as *neglect*, when related to the near space, can extend to the distant one once an extension-tool is used[51]. Therefore, the object is integrated into what the philosopher Shaun Gallagher defined with

[47] L. Fogassi *et al.*, *Coding of peripersonal space in inferior premotor cortex*, «Journal of Neurophysiology», 76, 1996, pp. 141-157.
[48] M. Graziano, C. Gross, *Spatial maps for the control of movement*, «Current Opinion in Neurobiology», 8, 1998, pp. 195-201.
[49] M. Costantini *et. al.*, *Ready Both to Your and to My Hands: Mapping the Action Space of Others*, «PloS one», 6 (4), 2011, pp. 1-6.
[50] A. Iriki *et. al.*, *Coding of modified body schema during tool use by macaque postcentral neurons*, «Neuroreport», 7, 1996, pp. 2325-2330.
[51] A. Berti – F. Frassinetti, *When far becomes near: re-mapping of space by tool use*, «Journal of Cognitive Neuroscience», 12, 2000, pp. 415-420.

the expression *body schema*, the system of self-perception and control that the body – through the coordination of the nervous system – constantly carries out to regulate its relationship with the surrounding world in an automatic, subpersonal and holistic way:

> The body schema is neither the cortical representation discussed by neuroscientists nor the body image discussed by psychologists and phenomenologists. Rather, the body schema reflects a practical attunement of the body to its environment. Its development in the various practices that lead to habitual dispositions – think here on jumping to catch the ball within the context of a game – involves it in relations to physical and social environments that, on one hand, fall short of intentionality, that is, remain prenoetic, and on the other, transcend neurophysiology[52].

The instrument becomes part of this scheme, a variable of the integration and regulation that the body makes with respect to its environment. Our body sees the instrument it uses in the same way as it sees its own hand, as if it were an extension of its biological activities. Through the nervous system, the tool is incorporated into the action and control of the body schema, thus forming what we can call an *extended body*. If so, the instrumental attitude of our species would not initially be due to an evolution in our information processing capabilities (which occurred together with new brain areas such as aSMG), but to that of a more elastic body schema, able to incorporate exo-corporeal elements into its sensory and motor maps.

As a matter of fact, many studies on premotor cortex have revealed that there is no univocal equivalence between motor movements and brain areas. On the contrary, the brain rather carries out a mapping of the body and thinks in terms of potential actions, which can then be manifested with different chains of movements[53]. If the brain thinks in terms of actions, then the boundaries of the body can be extended by incorporating additional elements to the mere muscles of our movements. We can 'reach' with a stick, 'grab' with pliers, 'beat' with a hammer. The brain will see these instruments in the same way that it sees the body when it performs these acts and will adjust posture, approach, grip and much more accordingly to perform the motor act[54].

Once our ancestors' brains learned to incorporate tools continuously, it was also possible to simulate action plans that included their use. The evolutionary reuse of parietal areas for visual association led to the birth of aSMG, which allowed the integration of sensory-motor information fundamental for the development of complex manipulative skills, probably contributed to lithic production (Oldowan or Acheulean) and today allows us *sapiens* to live in a

[52] S. Gallagher, *Body schema and intentionality*, in J. Bermudez *et. al.* (eds.), *The Body and the Self*, Oxford 1995, pp. 239-240.
[53] G. Rizzolatti – M. Gentilucci, *Motor and Visual-Motor Functions of the Premotor Cortex*, in P. Rakic, W. Singer (eds.), *Neurobiology of Neocortex*, New Jersey 1988, pp. 269-284.
[54] A. Maravita, A. Iriki, *Tools for the body (schema)*, «Trends in Cognitive Sciences», 8, 2004, pp. 79-86.

world of shared devices. Moreover, not only do we extend our body through the tools we use, but we also understand other individuals as extended bodies thanks to the same mirror mechanism that underlies our social cognition of actions and emotions. As a matter of fact, experimental data also ascribe to the joint activation of premotor cortex and aSMG the presence of a mirror mechanism that allows one to recognize the actions of subjects observed while using instruments[55]. We understand the tools used by others as extensions of their body, we understand the objects they are reaching (with or without an instrument) as close to their as well as to our body.

Thus, other individuals are understood in terms of their motor possibilities, including within these the tools they are using. In turn, this understanding of others is related to our own possibilities of action, to the things we can do given the presence of other individuals. Each of us lives by extending into a world of possibilities opened by our own tools as well as by the presence of others and their tools, constantly simulated and incorporated into our perception and actions. We are endowed with an extended body, but also with a *shared manifold*, that of the human community with its individuals, its tools, its techniques, its languages, its cultures[56].

5. The We-centred space of cooperation

This brings me to another important feature of our species, that is the origin of human social groups capable of cooperation. As we have seen, humans became able to extend the fundamental delimitation of self and world. Our brains have evolved not only to incorporate tools in the self during cognition, but also to see others as integrated systems and as possible coparticipants to our actions. Technology and techniques are not just private facts, but public phenomena distributed within communities and existing partially detached from our individual life. As a matter of fact, technology could not exist without the presence of others and without the presence of groups surviving their members, wherein information and tools can be stored and transmitted. But why are we a social species? And how did this influence our cognition?

This story begins long before *Homo sapiens*. Most mammals evolved towards social forms – such as families and clans – thanks to new behavioural schemes incentivized by the appearance of new molecules (as the notorious *oxytocin*)[57]. Social evolution pushed to bigger and denser brains, which are required to keep

[55] L. Cattaneo – G. Rizzolatti, *The mirror neuron system*, «Archives of Neurology», 55 (5), 2009, pp. 557-560.
[56] Neurobiologist Vittorio Gallese has used the expression *shared manifold* to refer to the network of joint intentions, empathy and cooperative behaviour enabled by the presence of a common mirror mechanism in each human brain and developed in our social ontogeny. V. Gallese, *The shared manifold hypothesis: from mirror neurons to empathy*, «Journal of Consciousness Studies», 8, 2001, pp. 33-50.
[57] P. Churchland, *The neurobiological platform for moral values*, «Behaviour», 151, 2014, pp. 283-296.

trace of the specific relations with other members of the group. In Primates such as chimpanzees, the dimension of the neocortex and the dimension of groups increased each other allowing the formation of big clusters of apes possessing complex social cognition[58]. Hominins inherited this social structure, but at the same time they were able to develop new forms of cooperation, as claimed by psychologist Michael Tomasello in his *shared intentionality hypothesis*. The idea behind it is that the engine of human evolution is to be identified in the transformation of cooperative systems, due to the introduction of new types of communication. In turn, these social mechanisms would modify the development of individuals and their cognition[59].

To begin with, the thinking of great apes changed with the evolution of their species into social groups governed by relationships of dominance and affiliation. To predict the behaviour and purposes of others was fundamental in a context of intra-group competition in order to obtain food and reproductive success. These abilities converted chimpanzees into creatures capable of formulating causal inferences, self-monitoring their activities in view of intended purposes, using (episodically) tools, manipulating the mental states of their fellows through gestures, coordinating their action with the strongest members to obtain a part of the booty[60]. Thus, these animals became excellent managers of themselves in a situation of non-cooperative social relations. They developed a Machiavellian intelligence for which the identification or communication with others are not required, but rather the self-centered understanding of their gestures and intentions, which enhanced the ability to reflect and evaluate one's own actions[61].

The first forms of shared intentionality would have developed with the emergence of *Homo* species, preceding the first expansion *Out of Africa* (2 mya). With the modification of the ecological context of food procurement, natural selection pushed for the need to cooperate with other individuals, that is, to organize one's actions based on a reference to common purposes[62]. This *joint intentionality* would have begun with the simple formation of a dyadic

[58] R. Dunbar, *The Social Brain Hypothesis*, «Evolutionary Anthropology», 6, 1998, pp. 178-190.
[59] M. Tomasello *et. al.*, *Understanding and sharing intentions. The origin of cultural cognition*, «Behavioral and Brain Sciences», 28, 2005, pp. 675-691.
[60] B. Hare – M. Tomasello, *Chimpanzees are more skillful in competitive than in cooperative cognitive tasks*, «Animal Behaviour», 68, 2004, pp. 571-581. Chimpanzees are not our ancestors: they are evolutionary cousins, another branch of the evolutionary tree. If we are comparing their social cognition skills with ours – in accordance with Tomasello's hypothesis – it is under the supposition that the common traits of social behaviour are due to the common descendance from a great ape lived millions of years ago, while the unique features of *Homo* species would have emerged later because of specific evolutionary and ecological processes.
[61] R. Byrne, *Machiavellian Intelligence*, «Evolutionary Anthropology», 5 (5), 1997, pp. 172-180.
[62] Cooperative hunting was a common practice for *Homo heidelbergensis*, see M. Stiner *et. al.*, *Cooperative Hunting and Meat Sharing 400–200 kya at Qesem Cave, Israel*, «Proceedings of the National Academy of Sciences of the United States of America», 106 (32), 2009, pp. 13207-13212.

relationship wherein the iconic gesture (indexical or mimic) would have constituted the *medium* to inform the companion and define the individual roles during hunting or scavenging[63].

The fundamental aspect of this new type of relationality is constituted by the use of an informative gesture that would have implied the ability – on the part of the user – to take the role of the other in a new way. In fact, since the information must be true and relevant to lead to effective coordination, the individual should not just play the role of the other, but evaluate that information based on his standpoint and adjust his communication accordingly. At this step, individual cognition transformed into the ability to produce *recursive inferences* («I know that you know that I know...») and second-person monitoring, but still did not require any need for conventionalization or culture[64].

Instead, these structures were fundamental for the emergence of *collective intentionality* that characterizes modern human thought and would have developed in *Homo sapiens* before their expansion *Out of Africa* about a hundred thousand years ago[65]. With the enlargement of social communities and in a situation of inter-group conflict, the possibility of establishing common goals and operating as one even beyond the circle of already-known individuals – the companions of dyadic practices – proved to be extremely important[66]. A step in this direction was found in the conventionalization of cultural practices mediated by a common symbolic language. Everyone learned to operate by conforming to what others did and expecting other members to do the same. In the words of sociologist George H. Mead, a human society ceased to be a mere cluster of people to become a *generalized other*, a general standpoint created by the cumulative perspectives of individuals and shaping the ontogenesis of their behaviour and values[67].

This phase involved the formation of a superindividual perspective, the 'objective' point of view of the group which provided a new form of self-regulation and the ability to afford reasons independent of personal motivations. In this way, communication could evolve by acquiring the possibility of exhibiting a degree of abstractness and impersonality («to do / not to do...») unthinkable for the previous linguistic gestures: concepts, norms, timeless and non-specific

[63] M. Tomasello *et. al.*, *Two Key Steps in the Evolution of Human Cooperation: The Interdependence Hypothesis*, «Current Anthropology», 53 (6), 2012, pp. 673-692.
[64] M. Tomasello, *Origins of Human communication*, Cambridge MA, 2008.
[65] Recent data seem to suggest that our species has expanded from Africa in separate waves, from about 120 kya to about 75 kya. While the first expansions may have brought *Homo sapiens* to occupy the territory of other human species previously migrated and cohabit with them (even with some hybridizations), the latest were likely more rapid and invasive, maybe contributing to the extinction of the other branches of our genus. L. Pagani *et. al.*, *Genomic analyses inform on migration events during the peopling of Eurasia*, «Nature», 538 (7624), 2016, pp. 238-242.
[66] A case of between-group selection is exposed in J. Soltis *et. al.*, *Can Group-Functional Behaviors Evolve by Cultural Group Selection? An Empirical Test*, «Current Anthropology», 63, 1995, pp. 473-495.
[67] G. Mead, *Mind, Self and Society*, Chicago 1972.

references were born. At this point it became possible to cooperate with the most disparate individuals (and not only in dyadic form), provided that one was able to refer to the common ground of the reasons and values of the same community of belonging. New human individuals grew up learning their community's normative system in order to interact with other members, while evaluating, interpreting and monitoring their actions based on it. The internalization of this collective social organization then constituted the beginning of a new type of individual cognition, which still regulates the existence of every *sapiens*: the objective-reflective-normative standpoint, the uniquely human thinking[68].

6. Emerging cultures

Defining 'culture' is quite a challenge. Its notion is both broadly extended through many disciplines and extremely elusive with respect to the specific aspects under study. As a matter of fact, cultural theories have highlighted many essential elements without an ultimate agreement. Some of them include the idea of culture as an encompassing group that shapes an individual's beliefs, actions and values in a pervasive way[69]; culture as the participation to a common formative context[70]; or culture as a shared identity which marks one's membership to a common context and delineate a group with respect to another[71]. We are facing a polysemous term, which can be used with seemingly opposite goals. The singular word 'Culture' has been a strong category which can be applied to mankind as a whole, unifying our species in opposition to other living beings[72]; at the same time, 'cultures' can be multiplied indefinitely at many levels to express the diversity of human people and ethnic groups, or different organizations and interest-streams, or subcultures, within and across societies (e. g. 'pop culture'). In recent years, cultures and social learning have been extended by biologists to other animal species, not only to 'evolutionary neighbours' such as other *Homo* species or primates, but also to other mammals, birds and even fishes[73].

Although the exact definition of what counts as a culture is subject to disagreement, I think it is possible to recognize some of its general features

[68] M. Tomasello, *A Natural History of Human Thinking*, Cambridge MA 2014.
[69] A. Margalit – M. Halbertal, *Liberalism and the Right to Culture*, «Social Research: An International Quarterly», 61 (3), 1994, pp. 491-510.
[70] A. Patten, *Rethinking Culture: The Social Lineage Account*, «American Political Science Review», 105 (4), 2011, pp. 735-749.
[71] E. Usborne – R. De la Sablonniére, *Understanding My Culture Means Understanding Myself: The Function of Cultural Identity Clarity for Personal Identity Clarity and Personal Psychological Well-Being*, «Journal for the Theory of Social Behaviour», 44 (4), 2014, pp. 436-458.
[72] Here we have two of the most powerful dichotomies in our philosophical and scientific traditions: the *Nature-Culture divide* and *nature versus nurture*. See Y. Haila, *Beyond the Nature-Culture Dualism*, «Biology & Philosophy», 15 (2), 2000, pp. 155-175 and H. Honeycutt, *Nature and Nurture as an Enduring Tension in the History of Psychology*, «Oxford Research Encyclopedia of Psychology», 30, 2019, pp. 1-29.
[73] K. Laland, *Animal cultures*, «Current Biology», 18 (9), 2008, pp. 366-370.

which can help us delineate the field of the cultural. First, cultures are a social reality: they consist in information, practices, organizations of a specific group or society. Second, cultures can and must be learned: individuals of a group need to acquire the information, rules and habits of the group through a process of imitation and social learning (in this respect, cultural inheritance differ from biological inheritance)[74]; furthermore, this process is essential in order to grow into a participant to the shared practices of the community. Third, cultures are open to modification and innovation through the activity and discoveries of their members. Fourth, cultures show a wide range of diversity and territoriality, dividing themselves and multiplying in many different and recognizable groupings and suborganizations[75]. Lastly, cultures consent to transmit information at a horizontal as well at a vertical level: innovations from an individual can be shared to other individuals and will become a 'storage' for next generations.

If we consider these elements, I think it is safe to assume that cultures are a widespread phenomenon in nature – at least in animals – and that they have been subjected to an evolutionary process, that is a modification over time in the mechanisms of information and knowledge storage within groups and species[76]. Evolutionary biology and ethological studies have been gathering observations and evidence on this notion for decades[77]. However, these perspectives have also illuminated some features of our own cultural processes, helping us understand what is new in the social capacities and learning of *Homo sapiens*, as I have recollected until now. For these reasons, in the opening chapter of this work I have decided to follow an evolutionary approach, straying away from an 'essentialist' discussion – answering *what* a (human) culture is or should be – and focusing more on a genealogical study, that is on discovering *how* the processes we tend to intuitively call 'cultural' came to be and the impact they have on our species' emergence and relationship with nature.

Thus, cultures brought on by human groups using technology and language have not just transformed a mind-brain that has received them passively. They

[74] For a reflection on inheritance and the different ways organism pass on information to conspecifics and successors, see E. Jablonka – M. Lamb, *Evolution in Four Dimensions: Genetic, Epigenetic, Behavioral, and Symbolic Variation in the History of Life*, Cambridge MA 2005.
[75] In this respect, cultural ethology has been discovering the differentiation in local dialects and unique social customs in many non-human species, such as monkeys, songbirds and cetaceans. See M. Celentano, *La scoperta delle menti e delle culture animali*, in M. Celentano – R. Marchesini (eds.), *Pluriversi Cognitivi*, Milano 2018, pp. 121-145.
[76] A similar idea forms the conceptual core of *evolutionary epistemology*, a naturalistic research program which emphasizes the role of selective processes – generation of responses to survival challenges, trial and error, fitness to adapt – in the accumulation and development of knowledge during evolution. K. Lorenz, *Behind the Mirror: A Search for a Natural History of Human Knowledge*, London 1977; K. Popper, *Evolutionary Epistemology*, in J. W. Pollard (ed.), *Evolutionary Theory: Paths into the Future*, London 1984, pp. 239-255; D. Campbell, *Evolutionary Epistemology*, in P. A. Schlipp (ed.), *The Philosophy of Karl Popper Vol. I*, Illinois 1974, pp. 413-459.
[77] A. Whiten, *Cultural Evolution in Animals*, «Annual Review of Ecology Evolution and Systematic», 50 (1), 2019, pp. 27-48.

have modified the environment – or rather the niche – in which *Homo sapiens* has learned to inhabit, and this new-born context of life has been influencing the selective pressures to which our bodies and actions have been subjected. Our cultures are indeed something derived from the bodily and agentive evolution of our species, but also something that, by modifying the bio-social environment around us, has had return-effects on our actions and our subsequent traditions. In this sense, human culture can also be deemed as a phenomenon of *niche construction* and constitutes one of the most peculiar traits of our evolution, with consequences globally extended[78]. To understand this concept, it is necessary to analyze the first steps of our species in the field of culture.

Following the third *Out of Africa* – the *Homo sapiens*' one, about a hundred thousand years ago – our ancestors began to colonize the whole world in a few thousands of years through a *serial founder effect*[79]. Starting from the first migratory community, groups of small units gradually began to break away in a linear succession that led the *sapiens* to inhabit all areas of the world except the poles, coexisting in the territories reached with the various species of *Homo* that preceded them and over time outliving each of them. After settling in a territory, the first communities of *sapiens* – which were still based on systems of hunting-gathering – would have undergone an increase in size until reaching a saturation after a few generations. This led to difficulties in managing the size of the group, worsening management of resources and health conditions and thus re-increasing mortality[80].

This linear trend pushed small groups within the community to move to virgin territories discovered in previous explorations, with an estimated expansion rate of around 140 km every 280 years (about ten generations). The new colonies maintained relations with the 'motherland', but over time they would also organize themselves on a new cultural substrate. Therefore, this process determined the diversification of cultures and languages starting from a common origin, with a branched trend like that of natural species[81]. With the innovation of agropastoral economy – which took place simultaneously in different areas of the world about 10,000 years ago – many populations acquired a sedentary lifestyle, increasing in number and learning new methods for resource management and for the division of work within the community. Further innovations, such as metalworking and the invention of writing (3,000 BC), gave rise to 'real' human history as we know it[82].

[78] K. Laland *et. al.*, *Cultural niche construction and human evolution*, «Journal of Evolutionary Biology», 14, 2001, pp. 22-33.
[79] O. Deshpande *et. al.*, *A serial founder effect model for human settlement out of Africa*, «Proceedings of Biological Sciences», 276 (1655), 2009, pp. 291-300.
[80] L. L. Cavalli-Sforza *et. al.*, *Demic Expansion and Human Evolution*, «Science», 259, 1993, pp. 639-646.
[81] B. Henn *et. al.*, *The great human expansion*, «Biological Sciences», 109 (44), 2012, pp. 17758-17764.
[82] For a popular, yet rich historical reconstruction on the transition from hunting-gathering to sedentary societies (as well as the consequences of the ethnical and geographical differences

The expansion thus described occurred in an extremely brief time, so much so that there were no speciation processes in the various human colonies formed during the processes of global migration. This rapidity was due to the development of cultures, which entailed a new path of development for human individuals. In fact, the ability to accumulate information through language and the possibility of integrating the innovations of individuals that would have been useful – until the emergence of new innovations – for the survival of the group provided a different form of adjustment to the environment, much faster than that of natural selection[83]. In the case of our species, the development of objective-normative-reflective thinking – combined with our peculiar manipulative-instrumental capacity – allowed us to transform the environment, adapting it to our needs, rather than adapting ourselves to it[84]. For example, *sapiens* were able to settle in inaccessible places such as Siberia without having to rely on phenotypic plasticity and a subsequent genetic fixation, but rather building a suitable niche thanks to the construction of shelters, the use of fire to warm up, the manufacture of clothes, etc. In broader terms, the presence of the human being and his practices of agriculture, breeding, mineral extraction, building construction, energy research, etc. on this planet has been a source of enormous change for entire ecosystems. So much so that contemporary ecologists use to call *Anthropocene* the geological era we live in, the age in which climate change, territory and biodiversity are influenced by human technology[85].

Thus, biological evolution and cultural evolution intertwine and modify each other. The first can only be grafted starting from the biological and bodily processes that led to the emergence of the characteristics of us *sapiens*. There is no human culture without hands and without vocal communication. Moreover, the fact that several human populations developed for a serial founder effect means that many phenotypic distinctions are due to genetic drift rather than natural selection, also because the latter was often replaced by a *cultural selection*[86]. In turn, cultural evolution had important consequences in the biological transformation of human beings, influencing and determining the selective pressures that our species faced[87]. Each individual develops through the continuous interaction

throughout this process for contemporary world), see J. Diamond, *Guns*, *Germs*, *and Steel: The Fates of Human Societies*, New York 1997.

[83] See the concepts of *cumulative cultural evolution* and *ratchet effect* in C. Tennie *et. al.*, *Ratcheting up the ratchet: on the evolution of cumulative culture*, «Philosophical Transactions of the Royal Society B: Biological Sciences», 364 (1528), 2009, pp. 2405-2415.

[84] R. Boyd *et. al.*, *The cultural niche: why social learning is essential for human adaptation*, «Proceedings of the National Academy of Sciences», 108, 2011, pp. 10918-10925.

[85] W. F. Ruddiman *et. al.*, *Defining the epoch we live in*, «Science», 348 (6230), 2015, pp. 38-39.

[86] L. L. Cavalli-Sforza, *Cultural Evolution*, «American Zoologist», 26, 1986, pp. 845-855.

[87] A fascinating case is the persistence of the enzyme lactase in the breeding populations of Middle East and Europe, since the capacity of digesting milk even in adulthood – otherwise energetically expensive – allowed greater chances of feeding and more nutrients. See P. Gerbault *et. al.*, *Evolution of lactase persistence: an example of human niche construction*, «Philosophical Transaction of the Royal Society B», 366 (1566), 2011, pp. 863-877.

between his living body and the ecological, cultural, linguistic and instrumental environment inherited from the social practices of his predecessors.

7. Environ-minds: a different vista on human evolution

In this article I have considered the mind to be the whole of processes enabling an organism to cope with its environment – dividing the world between internal experiences and external stimuli – and proposed an evolutionary genealogy of this capacity. However, I also noted how *sapiens* have evolved the faculty of extending the boundaries of the internal/external division to technology and to others, thus giving life to more flexible and extended cognitive systems. Consequently, our ancestors developed social realities (cooperative behaviour, languages, institutions) surviving their individual existence and becoming the common grounds for the growth of every new-born. The cultures thus formed mediated the relations with the natural world and became a niche any human being must adapt to.

In my opinion, it could be convenient to deem the socio-cultural contexts of humans as both new types of environments and collective minds possessing peculiar features. However, I do not mean to simply put an analogy between these phenomena. On the contrary, I consider the idea of environ-minds to be a level of explanation for human rapid evolution and our individual ontogeny. That is, I do not only think that a socio-cultural context is like an environment and like a mind, but that in some respects *it is a kind of environment and a kind of mind*.

From an ecological standpoint, socio-cultural contexts have partially substituted the natural world for human beings. S*apiens* have not just adapted to an external world, but rather adapted the world to their needs and capacities. This process of niche construction is extended to many other animals (*ecosystems engineers*) which evolved to manipulate the environment, forming ecological inheritances and modifying the selective pressures their offspring will be subjected to[88]. However, human beings learned to incorporate their technologies and social cooperation in this process, speeding it up and causing a series of ripple effects whose consequence was the formation of artificial niches. Cultural evolution was allowed by our biological evolution, but in turn induced important changes in the latter, determining new selective pressures and a new way of relating to the *cultural niches* built by the groups of our species, which constituted a distinct inheritance from that of our genes and from natural environments[89].

Every modern *homo sapiens* needs to acquire not just specific physical and biological features (such as walking or talking), but also to adapt to the demands

[88] J. Oddling-Smee, *Niche inheritance*, in M. Pigliucci – G. Muller (eds.), *Evolution: The Extended Synthesis*, Cambridge MA 2010, pp 175-207.
[89] J. Oddling-Smee – K. Laland, *Ecological Inheritance and Cultural Inheritance: What Are They and How Do They Differ?*, «Biological Theory», 6 (3), 2011, pp. 220-230.

of the social group to which it belongs, with its unique and specific culture and the selective pressures resulting from it. New technologies innovated by individuals can spread ecological changes that will potentially induce evolution in individuals[90], but also impose new social standards, norms and values necessary to integrate within one's social group in a process of social adaptation[91]. We could say that we do not just live through technology, societies and cultures, but that *we live them*, as the targets and horizons of our actions.

As a mind, each culture constitutes a totality of processes to cope with the environment (niche construction) and exists through a distinction between what is internal to it and what is not, the natural world and other cultures. Each culture has developed and maintained for centuries posing the conditions of an in-group and an out-group[92], but developing over time active thresholds to incorporate external elements and innovate. Moreover, a culture exists not just as the sum of his participants, but as a system possessing new properties. That is, cultures *emerged* from the social conditions of human beings – like minds have emerged from bodily and agentive processes of animal evolution – but became systems of processes, behaviour and institutions supervenient to individual capacities[93].

Thus, cultures exist as cognitive systems partially independent from the individuals that over time will participate in them. The technologies, the languages, the institutions stored in these everchanging archives outlive their innovators and become disposable for new uses and users. Each member of our species must connect to this network in order to live and act as an individual. He must learn a language, he must adapt to tools, he must cooperate and understand others to realize complex behaviour. Each of these features are

[90] For example, think of the changes that the use of fire has provoked in our alimentation, digestive apparatus and cognitive development. R. Wrangham – N. Conklin-Brittain, *Cooking as a biological trait***,** «Comparative biochemistry and physiology. Part A», 136 (1), 2003, pp. 35-46.

[91] We can think of the Internet and social media, that in many contemporary societies constitute a fundamental way to integrate in the social context, even more for individuals coming from other cultures. See M. Croucher, *Social Networking and Cultural Adaptation: A Theoretical Model*, «Journal of International and Intercultural Communication», 4 (4), 2011, pp. 259-264.

[92] It has been proposed that the social evolution of humans in different groups could explain the selection of both intra-group altruism and inter-group hostility. See J. K. Choi – S. Bowles, *The coevolution of parochial altruism and war*, «Science», 318, 2007, pp. 636-640. Other authors have suggested that, in human cultural evolution, a fundamental role was played by *ethnocentrism*, *i. e*. the establishment of one's own cultural and ethnic group as the yardstick for the consideration of other groups and social practices. See R. Hammond – R. Axelrod, *The Evolution of Ethnocentrism*, «Journal of Conflict Resolution», 50, 2006, pp. 926-936.

[93] For a review on the concepts of *emergence* and *emergent properties*, see S. Achim, *Varieties of emergentism*, «Evolution and Cognition», 5 (1), 1999, pp. 49-59. A similar idea was proposed by anthropologist Alfred Kroeber, who deemed human civilization as the *Superorganic*, a new dimension of evolution transcending biological processes with different mechanisms and rules. A. L. Kroeber, *The Superorganic*, «American Anthropologist», 19 (2), 1917, pp. 163-213. However, the similarity stops at the emergence dynamic, since my account of cultural evolution – as well as the ones proposed in the niche construction hypotheses – reconciles it with our natural evolution and tries to underpin their reciprocal determination.

fundamental grounds for a modern human mind, but this acquiring requires the pre-existing order of socio-cultural structures. When we think and act, it is not a single and detached ego who does this in a void: rather, it is a flexible system comprehending me and the tools I use, the language I speak, the others I depend on, the tradition I belong to and will survive me. It is the culture which made me and speaks through me in a partial, unique and unrepeatable voice.

The idea of cultures as environ-minds is not entirely new, and certainly shares some points of conjunction with other traditions. For example, human collected knowledge (and action) has been described as a new evolutionary dimension, a *noosphere*[94] or, in recent times, an *infosphere*[95]. These concepts amount to a vision of the human world as a novel space of relations with profound effects for our everyday lives and our interface with nature. Moreover, other authors have used the expressions *swarm intelligence*[96] or *collective intelligence*[97] to assess the emergence of new behaviour at a group level, considering these latter as 'super-minds' working in a unity of thinking and action. However, while these accounts are interesting and anticipate some of the themes I have portrayed, I would like to delineate some differences in order to mark the potential contribution of my vision.

With respect to the noosphere or infosphere, environ-minds share their establishment as a collective environment but are more distributed at different hierarchies and levels: any cultural substrate organized in a social reality can be one, and an individual can and does participate in many of them. The first ones are deemed as a global point in the evolution of the human species, but while we do possess some technologies (e. g. Internet) and some institutions (e. g. United Nations) which could operate as a common platform for the formation of a universal culture, I think that this dimension is yet to come (if it will). Environ-minds are similar to the aforementioned spheres in being a product of the evolutionary and technological development of our species: they consist in emergent social realities which play an active role on both people – shaping them through multipurpose pressures – and the natural world – modifying it and adapting it to our needs. Nonetheless, my account of culture is also deeply rooted in a genealogical and pluralistic approach which deems this reach-point as the evolutionary conjunction of many evolutionary features, each with their

[94] W. I. Vernadsky, *The Biosphere and the Noosphere*, «American Scientist», 33 (1), 1945, pp. 1-12.
[95] L. Floridi, *The 4th Revolution: How the Infosphere Is Reshaping Human Reality*, Oxford 2014.
[96] Swarm intelligence is a concept developed by the observation of emergent patterns of organism-clusters – in particular, insect societies – translated in robotics and AI studies as a model for auto-organization. See S. Garnier *et. al.*, *The biological principles of swarm intelligence*, «Swarm Intelligence», 1 (1), 2007, pp. 3-31.
[97] «What is collective intelligence? It is a form of universally distributed intelligence, constantly enhanced, coordinated in real time, and resulting in the effective mobilization of skills». P. Levy, *Collective Intelligence*: *Mankind's emerging world in Cyberspace*, Michigan 1997, p. 13. In the following pages, Levy proceeds describing this new form of intelligence, its relations with culture and the difference with other forms of emergent group-performances (such as swarm intelligence).

own specific origins and 'reasons' but all contributing to these new spaces of relationships.

Secondly, while environ-minds share their cognitive character with concepts such as swarm intelligence, the latter seems to account for the operative function of a group but not for its socio-ecological dimension. In my account, cultural groups do not limit to an organizing function in the production of solutions to a challenge or need, but they also exist as stable platforms which precede specific behaviour and envelop individuals during their lives. That is, our relationship with natural environments is always mediated by our cultural dimension, and each member of a group needs to grow in accordance with the cultural environment of its own group to participate in its functioning. In this sense, I would say that a culture is not just a supervenient collective mind emerging from the networking of many individual consciousnesses, but more like a shared cognitive ground from which each individual mind develops in a process of contingent interiorization. In doing so, people can and will also find innovations to modify them and their (social) pressures to new generations, engaging in a process of mutual determination with their cultural context.

In other words, I think that human cultures work *both* as minds and as environments. Environ-minds can be seen as flexible interfaces between human individuals and the natural world. The former will see a culture as an environment to adapt to and they will develop their cognitive processes in attuning to them, while cultures will work as a collective mind (or organisms) to survive and adapt in respect to their ecology and other groups. As I suggested, these two features are strictly connected as they enhance each other in the evolution of our species, and we cannot conceive them separately. If cultures operate well as collective minds, they will constitute a fertile environment for the ontogenesis of new generations; and if they constitute a good environment for the individual development, innovations and new solutions will increase, promoting the process of niche construction.

To conclude my reflections, I think we could look at the techno-cultural societies of the human species as environ-minds in the same way insect societies can be regarded as *superorganisms*. E. Wilson and B. Hölldobler have stated that the colonies of ants, bees and wasps should not be regarded as sums of insects, but rather as a unity of selection having qualities and behaviour supervenient to its members, which often are to be sacrificed for the good of the group[98]. These animals evolved as social systems to the point of weakening their instinct of individual survival in favor of the colony, living as vehicles for the shared genes of the group[99], but developing in turn efficient behaviours which favoured their colonization of the Earth. Humans are not insects and very few of us would admit being a mere appendix of socio-cultural realities, mostly because

[98] B. Hölldobler – E. Wilson, *The Superorganism: The Beauty*, *Elegance*, *and Strangeness of Insect Societies*, New York 2009.
[99] The idea of organisms as vehicles of genes was firstly exposed in R. Dawkins, *The selfish gene: 4th edition*, Oxford 2016.

everyone feels to possess a strong individuality and an ego distinct from our group of belonging (and rightly so). At the same time, I think there is a point of connection between us and them: while we can decide to rebel against the 'tyranny' of community, in contrast to eusocial insects, the social dimension of our evolution and ontogeny shapes the individual actions and cognitive processes of the organism in a pervasive way[100].

I hope that this view can help us understand the peculiarity of *Homo sapiens* and its cognitive processes, which are always distributed across the network of an individual and its social prostheses. I admit that it does feel strange to speak of cultures as minds, because we tend to use this term to refer to a single unity and to something delimited to a body. But as Chalmers and Clark observed with EM, the delimitation of a mind inside a single body is a simplification of our experience, because cognitive processes can distribute and comprehend multiple devices. And I add, a human mind does not exist alone, but brings on each of its acts the continual connection with the social dimension of its emergence.

As for individual minds, cultures exist through a delineation of an internal and external zone, but their boundaries are flexible the same way human cognition has evolved. A culture can extend, incorporate elements and tools from other traditions, fuse with other cultural systems to become something new. In our era of globalization, maybe we are beginning to understand that cultures can intertwine with each other while maintaining their 'individuality', but this has already happened at the beginning of the *sapiens*' journey out of Africa. Ecologist James Lovelock ventured to sustain that if we consider the whole Earth to be a superorganism (*Gaia hypothesis*), the human species could be its nervous system[101]. We are not at this point yet, but I do think that the constitution of a global shared culture would coincide with the birth of a worldwide human mind capable of coping with the challenges ahead of the survival of our species.

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[100] George H. Mead noted that even anti-social behaviour «are obviously no less social than are the former class of such impulses or behavior tendencies [the cooperative ones]. They are equally common to, or universal among, all human individuals, and, if anything, are more easily and immediately aroused by the appropriate social stimuli; and […] they are just as basic to all human social organization as are the former and play a hardly less necessary and significant part in that social organization itself and in the determination of its general character». G. Mead, *Mind, Self and Society*, p. 304.

[101] J. Lovelock, *Gaia: A New Look at Life on Earth*, Oxford 2000, p. 139. This stage could be identified as the aforementioned noosphere or infosphere.

would be a far more difficult and burdensome reading than it is. And since I believe that reading should first and foremost be a pleasant activity, this is no small merit to me. I hope all of you readers will appreciate the outcome.

Finally, I have been gifted with good friends, relatives and mentors who also enjoy conversing about philosophical matters such as the ones discussed above. Therefore, I would like if they considered this essay to be theirs as well, because I could not have written it without their presence and support, nor outside the cultural environment wherein I was fortunate to grow up.

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