THE INCOMPLETENESS OF HUMANITY. ANTHROPOLOGICAL REFLECTIONS

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Abstract

Science, philosophy and theology may each legitimately claim that anthropology is their own field. In this paper I shall first develop some considerations of scientific kind especially about the evolution of the human being. Then, some relevant philosophical lessons are considered. In particular, it is dealt with the nature of intelligence and culture, their relationship with the biological dimension, the issue of self-canalization and the openness of the human being, whether or not we can speak of a biological species. Then, some philosophical and theological questions are raised. Finally, the possible future of humanity is discussed.

Key Words: Incompleteness, Humanity, Anthropology, Theology, Philosophy of Science.

1. Introduction

Science, philosophy and theology have since long time (at least from the beginning of the 19^{th} century) gone along separated paths, and each of these fields considers now specific problems as exclusively pertinent to its domain and requiring specialized methodologies. For instance, natural sciences consider the investigation on the causal mechanisms responsible for all phenomena that can be empirically investigated as its exclusive domain. Theology considers the problem of soul and the discourse on God in such a way. Philosophy views as its specificity the interpretation of philosophers and philosophical texts, epistemological problems and, in general, problems devoid of immediate empirical contents but whose investigation method does not rely on any kind of Revelation either. All of this points of view are also to a certain extent true and these different claims are somehow justified. This situation can even be considered one of the most positive effects (the only one to my current knowledge) of the mentioned fracture among these three provinces of knowledge. Certainly, some negative consequences cannot be denied. I mention a couple of them:

- Some afferents (in general, a minority) to any province like sometimes to make incursions into the other provinces without being equipped of the minimal methodo-

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logical tools and the necessary background knowledge. So, scientists sometimes will support the idea that evolution does deny the existence of God (Dawkins R., 1986; 2006; Dennett, 1995), often without having idea, at an epistemological level, of what a disproof would look like in such a case, and without having even a remote understanding of what we are saying when we use the word «God». They often take some popular opinions diffused in followers of historical religions as expressing this idea. However, this is like taking what popular journals write and people say as the image of science. Others claim that science has substituted philosophy (Hawking, S. W. and Mlodinow, 2010) without having a specific philosophical background (what was certainly not the case, in the first half of the 20th century, for giants like Einstein, Bohr, Heisenberg, Schrödinger, to quote some) and often ignoring which kind of philosophical questions have been raised across the centuries (or knowing this from what newspapers and popular journals say). This is clearly amazing, since most of those scholars are accustomed in their disciplines to speak only of what they know. However, when they trespass the threshold of their field, most seem to forget this methodological commandment. In such a case, we must agree with Kant when he said that to deal with the ultimate questions is compulsory to human reason (Kant, 1787, for instance the Preface to the 2nd edition). However, I would rather say that the postmodern updating of this is: to human unreasonableness. Also philosophers like to say their word on science and technology, in general with a considerable disregard, since science appears to them to deal with issues that are «low profile», incapable to touch the real high or serious questions (Hegel, 1817, especially the Introduction; Heidegger, 1954), although, again, their knowledge about empirical sciences is mostly grounded on popularization, whose character is often precisely the incapability to grasp the fundamental issues that science raises (Auletta and Wang, 2013). A significant group of philosophers (mostly those who are more sensitive to empirical investigations) simply delegitimize any inquiry on issues like free will, consciousness, and so on, for not speaking of any issue raised by theology. They argue that all of this stuff is the result of human «metaphysical» illusions (Wegner, 2002 and Dawkins, 2006). To support this claim they argue that science has always nullified our beliefs based on common sense. This may be true, and I cannot deny that science has several times shown that assumptions of common sense are not always well grounded. However, it would be even a bigger error to reject any kind of experience on this ground. Science is specific and is not an ideological manifesto. So, if there are specific reasons for rejecting some of our assumptions, we are forced to make it. However, we shall not do it before such evidences have been found. So, although still some aspects of many problems need to be clarified, we are accustomed in our scientific activity to take some facts as facts although we cannot clarify them completely, and not to reject them because we cannot clarify them completely. So the philosopher who likes to do this misses the fundamental sense of science.

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Also theologians are not fully exempt from this temptation. Some try in fact to force philosophical arguments and empirical facts for accommodating what is known to what they presume to be true. They often forget that no believer can have a full understanding of God's word, as it is clearly said in the Encyclical *Providentissimus Deus* with reference to the Fathers of the Church. If this is true, then it is much more difficult to use arguments a priori for dealing with matters that involve empirical knowledge.

- The opposite attitude, as mentioned, is to remain closed and trapped in the field of pertinence but also to raise barrier against any kind of external influence. Let us understand more about the consequences of this behaviour. Philosophers and theologians are particularly good in this strategy especially because they feel that science is more and more subtracting soil for their speculations. It is a strategy of withdrawal that leads nowhere, since one day philosophers and theologians could discover that there is no longer a safe background for their speculations, at least because any human thought, if coherently formulated, can have, sooner or later, some consequences on empirical facts or facts known through other means. Also scientists in general do not like the philosophers or the theologians intruding into their own issues. Obviously, they publicly affirm that science is relevant to everybody and that everybody should learn it. However, if one does not pertain to one of the scientific schools, then he/she should avoid to interfere with the work of the true specialists. What is really amazing is that almost everybody pertaining to one of these three provinces of knowledge (even those who nominally are against) tries to use specialism and the acknowledged peculiarity of their methodology of investigation as a barrier. This is true also for philosophers and theologians: the first group is subdivided in many schools and closed subgroups whose main activity is the quotation of works of other members of the subgroup in a explosion of self-referentiality. Their language is often incomprehensible to people working just in the adjacent field. However, theologians reach here a true climax when use an obscure language and make abuse of the word *mystery*, while true mysteries are such because they are robust to rational speculation, a fact that is impossible, however, to ascertain, if not seriously trying to penetrate them with reason. If otherwise, the suspicion could be legitimately advanced that one masks the limitations of one's own inquiry as limits of the human reason.

It seems much more reasonable to try to interact with people of the other provinces and try to learn something from each other (Auletta, 2013b). This could be of enormous benefit to any of these provinces of knowledge, especially in a time of significant and quick change as our epoch is (Auletta, 2011b, Chaps. 1-2). In fact, there is a single field of investigation towards which any of the three provinces of knowledge could raise legitimate and justified claims of pertinence to their methodology of enquiry and ap-

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proach: anthropology (Auletta, 2011b Chap. 5). And by cause, since humanity is a so complex subject that necessarily requires different approaches and methods. However, we again assist to an amazing show: instead of cooperating, instead of learning from what the others have to say, the three provinces of knowledge try to isolate a subfield, and none considers that, in such a way, we have simply destroyed the object of investigation. There is, however, a partial exception that gives us a hope for the future.

2. Human evolution in short.

2.1. A New Kind of Evolution.

The hope is represented by this circumstance: in recent years scholars trained in biology and scholars trained in cultural anthropology not only started to really interact but even to converge on some fundamental results. This not by chance and can determine a major change in the way in which we consider evolution. In fact, it is likely that the most general law of biological change and therefore of evolution is the following: those changes are preferred that can be made more down streams and therefore superficially, since they provoke less fundamental consequences (resulting less dangerous) and happen quicker, what implies that should be a selective pressure in this sense (Auletta, 2011a Chap. 9, and 2013c). This is today widely acknowledged in developmental studies (Wilkins, 2002). Therefore, we could consider the history of life as an evolution of the mechanisms of inheritance and distinguish three main kinds of variations and inheritance according to the level at which they happen: (1) Variation of the genome that goes together with limitless multiplication of the descendants. Prokaryotes and low eukaryotes have favoured this strategy. (2) Changes in the selection mechanisms, that is, of the interplay between environment and organism as well as between different species (construction of ecological niches) (Laland *et al.*, 2000 and 2008). Multicellular organisms in particular have focused on this second strategy. Here, epigenetic variability (most of the relevant changes and accommodations need indeed to occur during development) is privileged, since it is the phenotype that is involved in niche construction. (3) Variance in the type of transmission, by finding alternative forms of transmission: cultural heritage. Culture is information capable of affecting individual phenotypes' behaviour that they acquire from other conspecifics by teaching or imitation (Boyd and Richerson, 1985; Richerson and Boyd, 2005). As a result, some cultural variants spread and others diminish, leading to evolutionary processes that are as real and important as those that shape genetic variation: in other words, the mechanism is basically Darwinian although with a very specific character, as we shall see. Humans have adopted this third strategy, centred on cultural variability.

I wish to underlie three aspects of this convergence between biological and cultural-anthropological studies: Gene-culture interaction, cultural reuse and embodiment.

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2.2. Gene-culture interaction.

Researchers with diverse backgrounds are converging on the view that human evolution has been shaped by gene-culture interactions (Laland *et al.,* 2010). Theoretical biologists have exploited population genetic models to demonstrate that cultural processes can have a profound effect on human evolution, and anthropologists are investigating cultural practices that modify natural selection. Although genetic and ecological models have proved that niche construction can affect evolutionary outcomes even when culture is absent and only epigenetic factors dominate (e.g. allowing the persistence of organisms in inhospitable environmental conditions that would otherwise lead to their extinction), niche construction due to cultural processes can be more powerful, since it can significantly modify selection on human genes, with resulting effects on evolutionary outcomes. For instance, cultural niche construction may oppose or even nullify the effects of environmental change, protecting organisms against shifts away from environmental states to which they are adapted. In such a way, it buffers selection and helps to explain a lack of correspondence between human allele frequencies and selective environments (this effect is called decoupling). Recent analyses of human genetic variation reveals in fact that hundreds of genes have been subject to recent positive selection, often in response to human activities (Thornton and Clutton-Brock, 2011). Evidence for the relevance of gene-culture interaction is that selection has accelerated greatly during the last 40,000 years (Hawks *et al.*, 2007). A known example is that dairy farming prompted the formation of the selective environment that favoured, in less than 10,000 years, the spread of alleles for adult lactose tolerance. It is also an interesting example of convergent evolution. Indeed, the gene encoding lactase that is associated with the ability to digest milk as adults in European people is called C/T-13910, but the genetic basis of lactase persistence in Africans, is constituted by three single-nucleotide polymorphisms (G/C-14010, T/G-13915 and C/G-13907) (Tishkoff *et al.*, 2007).

This clashes with the hypothesis that the observed age distribution of recent positively selected linkage blocks happens with a constant rate of adaptive substitution during human evolution. In fact, if gene expression changes were neutral they would not tend to accumulate in specific functional categories but, rather, would be randomly distributed (Varki *et al.*, 2008). The brain is obviously a very interesting organ in this context. Several nervous-system genes undergoing adaptive evolution at the protein level have been identified in humans, including genes involved in neurogenesis, hearing and developmental patterning. Since even stereotyped mammalian behaviours considered crucial for species survival, such as effective mothering, seem to require observational learning in primates, we must consider the possibility that hominids in general and humans in particular have partially escaped from classic Darwinian selective control of some aspects of the genome, even in the form of genetic hard-wiring

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of long-standing species-specific learned behaviours. This might in turn help to explain the unusual degree of exaptation (Gould and Vrba, 1982) displayed by the human brain. The advantages of such novel changes are flexibility, plasticity, more rapidly developing population diversity, and greater opportunities –but the disadvantages are that genomes cannot recover irrevocable losses, and cultural advantages can be sensitive to the turn of history and fate.

In fact, interesting functional changes occur for genes involved in language apprenticeship. A point mutation in forkhead box P2 (FOXP2), a gene involved in human speech production, co-segregates with a disorder in a family in which half of the members have severe articulation difficulties accompanied by linguistic and grammatical impairment (Varki *et al.*, 2008). Apparent adaptive evolution of FOXP2 has indeed been reported in the human lineage. During the roughly 130 millions of years of evolution that separate the common ancestor of humans and chimpanzees from the mouse, a single amino-acid change occurred in the FOXP2 protein. By contrast, since the human and chimpanzee lineages diverged about 4.6-6.2 millions of years ago, two fixed amino-acid changes occurred on the human lineage whereas none occurred on the chimpanzee and the other primate lineages, except for one change on the orangutan lineage.

2.3 Mirror neurons and cultural reuse.

When we compare the human brain with that of other animals (in particular primates) we need to consider regions that present important analogies and perhaps homologies with other species. The classical model, dominating until the end of last century, relied on a strong modularization of the brain and therefore ended to assume that Broca's and Wernicke's language areas are specific to language and unique to humans. The consequence was a minimization of the possibility to understand a crucial issue like language origins through studies of animals or other cognitive systems (Auletta, 2011a, Chap. 23). However, neither Broca's nor Wernicke's area is devoted entirely to language processing and, in fact, these substrates might not be human-specific at all (Fisher and Marcus, 2006). It is now generally accepted that language capacity involves a complex network of cortical and subcortical circuits that is broadly distributed across the brain.

This field of study made a considerable progress with the discovery of mirror neurons (Rizzolatti *et al.,* 1990; Fogassi *et al.,* 2005; Auletta, 2011a, Sec. 15.3). It was found that in monkeys' cortex areas F1-F7 there were neurons that discharged when an action was performed and also when it was only observed. Mirror neurons are therefore active when the monkeys perform certain tasks, but they also fire when the monkeys watch someone else performing the same specific task. In particular, the neurons of area 6aβare not influenced by the location of the object, nor whether it was grasped or

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not. The brain activity changed before the arm movement and continued until the end of it. These developments can be understood as a clear evidence for the theory of motor cognition as far as they show that motion control and fine-tuning is crucial for acquiring high cognitive abilities (Jeannerod, 2006).

The suggestion is that in humans we deal with an area here that is more linked to higher order cognitive processes rather than being a patch-like convolution of distinct and distinguishable subregions (Lindenberg *et al.,* 2007). It is indeed activated and co-activated in a variety of different motor and perceptive tasks involved in communication processes, and available evidence suggests that the temporal cortex is an ensemble of areas providing several general performances (Iacoboni and Wilson, 2006). Also from an evolutionary point of view, it is ascertained that the expansion and remodelling of the temporal cortex was crucial for modern humans (Bruner *et al.,* 2003).

Therefore, at the opposite of traditional idealizations, it appears that many structures are activated by different tasks across different task categories and cognitive domains (Anderson, 2010). These results and the suggested new view of the way in which the brain works are the basis of one of the most accredited hypotheses about the origin of language: spoken language could derive ultimately from a previous gestural language. In fact, human beings still have a set of primate calls that remains quite separate from our vocal language (Burling, 2005, 1-47). At the opposite, the rostral part of the monkey ventral premotor cortex (area F5) is the monkey homolog of Broca's area in the human brain (Rizzolatti and Arbib, 1998). Human Broca's area might also become active during the execution of hand or arm movements, during mental imagery of hand grasping movement (mostly area 44), and during tasks involving hand-mental rotations (areas 44 and 45). Sometimes, when the observed action is of particular interest to a monkey, the premotor system will allow a brief prefix of the movement to be exhibited. This prefix will be recognized by the actor. Therefore, this fact will affect both the actor and the observer. The actor will recognize an intention in the observer, and the observer will notice that its involuntary response affects the behaviour of the actor. The development of the capacity of the observer to control his or her mirror system is crucial in order to (voluntarily) emit a signal. When this occurs, a primitive dialogue between observer and actor is established. This dialogue could constitute the core of language, where active (speaking) and passive (hearing) are continuously alternated.

Developing these ideas, Arbib hypothesized that language readiness evolved as a multimodal manual/facial/vocal system with protosign (manual-based protolanguage) providing the scaffolding for protospeech (vocal-based protolanguage), thus representing the «neural critical mass» to allow language to emerge from protolanguage as a result of cultural innovations within the history of *Homo sapiens* (Arbib, 2005, 2009; Arbib *et al.,* 2008). The claim here is that the path to protospeech is indirect, with early protosign providing a necessary scaffolding for the emergence of protospeech. This led to what is known now as the mirror system hypothesis: the parity requirement

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for language –that tells that what counts for the speaker must count approximately the same for the hearer– is met because Broca's should be evolved atop the primate mirror system for grasping, with its capacity to generate and recognize a set of actions. A couple of comments are appropriate here. The parity requirement is certainly crucial for language but seems to be rather the effect of something more fundamental: the possibility that an agent can modify its cognitive state or its behaviour through an action that is appropriate to that started by the partner. This seems to be the main difference between non-human primates and other mammals, which are provided with interactive schemes but do not modify their initial state if not for the specific contextual parameters while the schemes themselves remain unchanged (Auletta, 2011a Chap. 12). Instead, it is likely that it is this ability to allow primates (and cetaceans) to give rise to higher forms of interaction, like local transmission of specific behaviours. Arbib argues that the first creatures who had a language-ready brain did not yet have language –just as he believes that our distant ancestors had brains that could support the ability to read long before any human culture developed a writing system. However, this statement is not fully correct in the light of the cultural recycling theory that I support here. In fact, the transition from monkey-like action recognition (assumed to be shared with the monkey-human common ancestor) to human language, according to the author, should be accomplished in two steps: 1. Biological evolution: from a mirror system to a language-ready brain. 2. Cultural evolution: from hominids with a language-ready brain and rudimentary manual-vocal communication to humans with full language capability. However, we should take more into account the long history that brought our ancestors from an ape-like style of life to modern humans. This is the result of a crucial epigenetics-culture interaction. In fact, although the mirror neuron communication system has a great asset, since its semantics is inherent to the gestures used to communicate, the transition from this system to the human language may turn out to be more difficult than initially thought by the proponents of the mirror system hypothesis. It is likely that the great leap from a closed system still bound to a small set of behaviours to a unlimited communicative mirror system depended upon the evolution of imitation (and related cognitive abilities) and the related changes of the human mirror-neuron system: the capacity of mirror neurons to respond to pantomimes and to intransitive actions that was absent in monkeys (Fadiga *et al.,* 1995; Buccino *et al.,* 2004; Corballis, 2010).

This justifies us to assume that neural circuits established for one purpose are commonly exapted (Gould and Vrba, 1982) (exploited, recycled, redeployed) during evolution or normal development, and put to different uses, often without losing their original functions. That is, rather than posit a functional architecture for the brain whereby individual regions are dedicated to large-scale cognitive domains like vision, audition, language, and the like, or to assume biological adaptations that were accomplished before cultural progresses, neural reuse theories suggest instead

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that already existing low-level neural circuits are used and reused for various purposes in different cognitive and task domains. This suggests that the functional differences between cognitive domains should reveal themselves in the (different) ways in which the (shared) parts are assembled: although different domains do tend to be supported by overlapping neural regions, each task domain is characterized by a distinctive pattern of co-activation among the regions. At least four different and empirically supported theories of neural reuse have appeared. Two of these theories build on the core notion of the sensorimotor grounding of conceptual content to show how it could implicate many more aspects of human cognitive life: the «neural exploitation» hypothesis (Gallese and Lakoff, 2005) and the «shared circuits model» (Hurley, 2008). Two other theories suggest that reuse could be based on even more universal foundations: the so-called «massive redeployment» hypothesis (Anderson, 2007) and the «neuronal recycling» theory (Cohen *et al.,* 2000; Dehaene *et al.,* 2002; Dehaene and Cohen, 2007). I wish in particular to briefly mention the latter studies for their relevance for this paper. The authors showed that writing apprenticeship (that cannot be older than 6,000 years) induces a reuse of a visual region of the brain that was originally devoted to perceive edges and squares. This is very interesting for several reasons:

- The time is very short, what shows that cultural reuse can be very quick (and as I have underlined this is an adaptive advantage). Note that this neural reuse is a developmental process that occurs only for alphabetic people. However, this suggests the possibility that what starts superficially as a cultural phenomenon can with the time be transferred to species-specific biological modifications (affecting foremost the developmental patterns themselves). This is quite the reverse relative to the idea that biological modifications happen always first. The evolution of language could be occurred in this way, especially the relatively recent last step of a vocal protolanguage that should not be older than 200,000 years (Auletta, 2013c).
- There is clearly a certain analogy between the objects that are originally perceived by means of this visual area (edges and squares) and written character. How, we should understand this analogy? Those perceptual elements are certainly deprived of any semantic import and rather represent the way in which we represent our environment. However, as a matter of fact, all the earliest forms of writing that we know about were much more iconic than the writing we use today. Ancient Egyptian, the earliest Chinese writing, and Sumerian, the first well-developed written language of Mesopotamia, all relied on pictographs (Burling, 2005, 105-121). These offered an easy, though only partial, solution to the problem of representing, on clay or papyrus, the huge number of words in a spoken language, and even in the earliest surviving examples of writing, the pictographs were quite stylized. Therefore, written characters emerged from forms deprived of any linguistic meaning as such but par-

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ticularly apt to play the function of conventional signs. Such a (metaphoric or analogic) transfer may throw light on the general mechanisms that allow the emergence of higher cognitive functions from lower functionalities.

2.4. Embodiment.

The latter considerations introduce us to the problem of embodiment. In fact, the embodied approach to cognition is closely related with the cultural recycling hypothesis and places a heavy emphasis on the idea that human mental representations of objects, events and many types of information we encounter arise from (and are linked to) our physical experiences interacting with the world. The first scholar to have clearly pointed out this was the philosopher Merleau-Ponty (Merleau-Ponty, 1942; 1945; Auletta, 2001a: Sec. 24.4.). The starting point of his investigation was represented by the awareness that the organism is not like an instrument that responds to external stimuli (like a machine would do) as it contributes to constitute them: they could not be perceived without the organism's motion and activity. He also understood that all things are always perceived on a background: Any percept is constituted in a context. The empiricist's hypothesis of the constancy of the perception is in conflict with the experience. Ordinarily, one goes from a nebula to a more determined perception as perception is a solution to a previous problem. Therefore, at the opposite of the empiricist tradition, Merleau-Ponty stressed that association is never an efficient cause that provokes the response but it only makes an intention more probable or attractive. Also the similitude with past perceptions is not active without a certain form given by the present perception: the past (i.e. the conglomerate of previous experiences) does not act on the present but is rather evoked by the present consciousness, by an act of the mind. The first operation of attention is to build a perceptive field that one can dominate. These fields are new regions in the total symbolic world built through categorical and conceptual patches. Any new acquisition allows a new integration of the previous facts, and the consciousness builds itself as a synthesis of transitions. What is interesting here is both (i) the idea that there is a high-level cognitive (mental and symbolic) activity that must be acknowledged as crucial for human exploration of the world, and (ii) that this cannot be detached from the biological substrate.

On this background, we can now understand *gestures* as the bridge between biological world and semantics that is required for language. Gestures can be metaphoric when they map abstract ideas onto physical actions or features. The gestures themselves are not metaphoric; they convey physical features, movement or space. Rather, the metaphor is contained in the relation between gesture and speech, where speech communicates an abstract concept and gesture adds a physical element to the concept, often providing a link to an action that grounds the abstract language in physical experience (Cartmill *et al.,* 2012). These considerations can turn out to be crucial from a

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phylogenetic point of view in relation to the problem of the origin of language. Both action and gesture can affect the mental representation of actions and objects, but gesture's ability to represent action offers a way to ground abstract ideas in concrete actions, and therefore could have been an evolutionary bridge. Gestures that represent action are actions performed within an imagined world (or abstract space). When gestures simulate action on or by objects, the objects involved in the event must be represented mentally. Actions, on the other hand, are performed on the physical environment. The objects they act on are present and do not need to be represented mentally. Thus, when we perform actions on objects, we are able to offload some properties of the task onto the environment. However, when we use gesture to represent action on or by objects, we must also rely on mental sensorimotor representations of the objects involved.

Thus, a good deal of thinking happens in interaction of brain and body with the world. The practices of imagination via environmentally coupled gesture permit people to add motion to otherwise static external structures (Hutchins, 2008). What organizes human interactions with the world? The answer to this question is again represented by the high cognitive level: cultural-symbolic practices. Cultural practices organize interactions with the world first by providing the world with the cultural (symbolic) artefacts that comprise most of the structure with which we interact. Second, cultural practices orchestrate our interactions with natural phenomena and cultural artefacts that produce cognitive outcomes. What determines how the dynamics of the world are imagined? The answer partly lies again in cultural practices. The enactment of embodied, non-symbolic (biological) representations, through which phenomena are seen as *instances* of culturally meaningful events and objects, is a cultural practice, not a passive innate process. And this is essential, because the existence of symbolic processes requires both a special set of practices for being aware of symbols as symbols and a set of practices for enacting the representations with which symbols can be associated. Imagining interactions with the world takes place both online (while the interactions are taking place in the present world) and offline in memory and anticipation (when the world is imagined). The offline imagination of enacted representations is a very powerful cultural practice.

Linguists have since long shown that several abstract concepts are indeed metaphoric transpositions out of physical and even spatial representations, in accordance with the theory of embodied cognition (Lakoff and Johnson, 1980; Lakoff, 1987). However, as mentioned, we should not understand this relation unilaterally: there is in fact a huge feedback of the functions on the old ones, otherwise the hypothesis of cultural reuse makes no sense at all. Humans are peculiar, compared with non-human species, in the extent to which they try to «improve» their habitual environment. To make such improvements, particularly in our modern urban environment, we make and use various kinds of tools and technologies, and often the tools themselves are in-

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corporated into the fundamental structure of the environment to create a distinctive human ecological niche: the cultural-symbolic one (Iriki and Taoka, 2012). Humans indeed reshape and even invent environments in which they dwell. When considering tools, we can establish the hierarchical structures of (i) motor tools, (ii) sensory tools, and (iii) brain tools, which resemble the hierarchy of representations from indexical (motor) to iconic (sensory) to symbolic (brain) structures of development. Non-human animals rarely use the class of «sensory tools». In monkeys, previous studies have demonstrated that they can be trained to use a sort of endoscope only after having acquired an ability to use a motor tool (a rake). This training must imply the ability to reorganize the image of the body to one in which the rake is incorporated as an extension of the forearm. The body image is thought to form by integrating somatosensory and visual information relating to the body. Thus, its modification after tool use could be physically observed as changes in the receptive field properties of the neurons that code such images –when the tool was incorporated, the receptive field that codes the image of the hand was elongated to include the rake. This modification seemed to match the monkeys' internal states, whether or not the rake was incorporated into the image of the forearm. Here, an equivalence is established between body parts (hands) and tools. These representations of the body image first comprise an internal model of the bodily structures used to control various movements, as a concrete neural correlate of the «indexical representation». This is the basic level. As the training proceeds further, we might postulate that the monkey's mode of representation may advance to rudimentary «iconic (visual)»: the class of sensory tools comprise a higher layer, superimposed onto previously acquired motor tools as the fundamental layer. Indeed, the history of our own technology suggests that sensory tools appeared much later, after motor tools were incorporated into human cultures.

Is the neural plasticity depicted above limited within the range of the individual's learning capacity, or could it cumulatively evolve over generations? Although the latter has a flavour of Lamarckism –inheritance of acquired phenotypic traits– there may be a biological mechanism that could channel the evolution of adaptations to an environment in which cultural information is embedded (Iriki and Taoka, 2012). Since monkey intraparietal neurons that normally code body image can be trained to code a tool in a way that is equivalent to that for the hand holding it, these neurons are bistable or polysemous for the hand or the tool. This functional plasticity may be an inherent property at the margins of a neural coding system prepared for gradual elongation of the arm during body growth, and which can then also adapt to a «sudden elongation» by using the tool. The posterior parietal areas responsible for these novel forms of cognition are not necessarily clearly segregated, either in monkeys or in humans, and this suggests a trend of gradual expansion towards the lateral sulcus as the level of abstraction increases. Thus, it seems that the parietal area gradually incorporated high-order cognition as it expanded during hominid evolution, while preserving its original principles of operation. This could be an example of exhibiting a novel cognitive niche by reusing the functions that have derived from a polysemic mechanism described previously. This accidentally established equivalence between body parts (hands) and tools in turn leads to additional (iconic) polysemic and bistable interpretations, i.e. hands may be extended into the tool representation (externalization of the innate body) or tools may be assimilated into the body schema (internalization of external objects): this double process of internalization/externalization is constitutive for all symbolic activities (Auletta, 2011a: Chaps. 19 and 24). This newly acquired bistable state enables the reuse of cortical systems for different functions in the future, as in the case of tool use, perhaps in combination with other parts of the brain. This bistability, or «polysemy», could enable the use of metaphors in conceptual structure –so as to comprise a novel cognitive niche. In addition, because hominin species have attained an unusually long post-reproductive lifespan, particularly females, accumulation of knowledge continues over the whole lifespan of an individual, tending to peak in middle-to-old age. Species with a long lifespan –such as primates, and most typically humans– and low birth rate survive through an individual capacity to adapt. We need therefore to correct the spatialization hypothesis (Lakoff and Johnson, 1980): spatial metaphors are only one source (coming from the indexical and most basic stage); the other source is represented by emotional-internalization hypothesis, according to which tools become our own prolongation and extension, corresponding to the iconic stage: a stock as a metaphor of a good leg for walking when too old to make it alone and therefore possessing also a physical equivalence with a human limb.

3. Human intelligence

3.1 From a biological point of view

One central and distinguishing innovation in human evolution has been the dramatic increase in the use of contingent information for the regulation of improvised behaviour that is successfully tailored to local conditions (Tooby and DeVore, 1987). The cognitive niche is a loose extension of this concept, based on the idea that in any ecosystem, the possibility exists for an organism to overtake other organisms' fixed defences by cause-and-effect reasoning and cooperative action –to deploy information and inference, rather than particular features of physics and chemistry, to extract resources from other organisms in opposition to their adaptations to protect those resources. Improvisation puts humans at a great advantage: instead of being constrained to innovate only in (the long) phylogenetic time, they engage in ontogenetic ambushes against their antagonists –innovations that are too rapid with respect to evolutionary time for their antagonists to evolve defences by natural selection (Cosmides and Tooby, 2000). As mentioned, it is selection itself to push more and more towards surface so-

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lutions, i.e. those that require less time and phylogenetic costs to be implemented. Although social interactions may have played a role, according to the Cosmides and Tooby, social competition was the initial driving force behind the evolution of human intelligence, as in the Machiavellian hypothesis (Byrne and Whiten, 1988; 1997): astute selfish behaviour of primates could have been crucial for the establishment of human society. For situation-specific, appropriately tailored improvisation, the organism only needs information to be applicable or «true» temporarily, locally, or contingently. If information, to be useful, only needs to be true temporarily, locally, and situationally, then a vastly enlarged universe of context-dependent information becomes potentially available to be employed in the successful regulation of behaviour. This enlarged universe of information can be used to fuel the identification of a more varied set of advantageous behaviours than other species employ, giving human life its distinctive complexity, variety, and relative success. In other words, solutions are judged for their rationale. But what could possibly be useful about fictive, counterfactual, or imagined worlds –that is, about false or indeterminate information? The issue is to grasp what means information immediately hidden to us (Auletta 2001a: Chap. 18). For instance, we experience only the effects of a force but the latter remains hidden to us and must be therefore imagined and inferred. Another example is to penetrate the minds of the others. Likely, *Homo Heidelbergensis* and its contemporaries (about 500,000 years ago [500 kya]) had already developed these capabilities. In fact, I recall the change in its way of life: the hunt of big mammals, which by definition did not constitute a specific adaptation, jointly with many other consequences (movable camps, clothing, building of spears, figurines, use of pigments, and so on). Summing up, we need to distinguish two related meanings of intelligence (Cosmides and Tooby, 2002). The authors call these *dedicated* intelligence and *improvisational* intelligence. Dedicated intelligence refers to the ability of a computational system to solve a predefined, target set of problems. Improvisational intelligence refers to the ability of a computational system to improvise solutions to novel problems. Improvisational intelligence is achieved by an architecture that is essentially a blank slate connected to general-purpose (content-independent, domain-general) reasoning and learning circuits. Clearly, to be able to recycle brain areas for other, high-level, cognitive functions, intelligence cannot be dedicated.

In general, organisms can evolve two ways of responding to habitat change (Potts, 1998): by mobility or dispersal, i.e. ways of tracking a preferred (specific) habitat or key resource. The second possibility is to broaden the range of conditions in which an organism can live. According to the three forms of variation stated previously, adaptive flexibility can be achieved: (a) by genetic polymorphism, in which alternative alleles confer different phenotypic and adaptive benefits, (b) by widening the norm of reaction (Gould and Lewontin, 1979; Gupta and Lewontin, 1982) (in this case, exposure to diverse environments during growth and maturation elicits a range of epigenetic

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responses and phenotypes from a single genotype); (c) by complex structures or behaviours that are designed to respond to novel and unpredictable adaptive settings. The result is an eventual decoupling of the organism from any one environmental state. Key hominid adaptations, in fact, emerged repeatedly during times of heightened variability.

3.2 What is the mind for?

One of the main issues here is when, how, and where mind could be effective for action (Auletta, 2001a, Chap. 18). M. Jeannerod pointed out that it is a question of when the conceptual import is present (Jeannerod, 2006): In higher cognitive processing only, or already in motor representations. All action representations anticipate the effects of a possible action. However, neurological studies have also questioned the role of mind in its specific conscious modality of action from two points of view:

- Consciousness of action is a slow and lengthy process, which can only appear if adequate time constraints are fulfilled. As such, consciousness is not likely to play a causal role in triggering the action, simply because it comes too late.
- In the context of the actual action execution, the latter is bound to signals arising from the completion of the action itself, not to central signals that arise prior to the action. It is therefore tempting (and to a certain extent also right) to say in accordance with Haggard that consciousness is an immediate consequence of the brain processes which prepare action, so that intention is a conscious correlate of preparatory neural activity (Haggard, 2005).

We can take the following result of these studies for granted (Blakemore and Frith, 2003): being aware of a goal is not being aware of how it is reached. Visuomotor representations involved in motor acts lack conceptual contents and are not conscious. Interesting studies show that intentional and conscious processes tend to temporally shorten the time delay between the onset of the cause (for instance, pressing a certain key) and the onset of the effect (for instance, an auditory signal) (Haggard *et al.* 2002). However, this is a natural consequence for mammals, since our perception of causality is rooted in understanding the consequences of our own actions, which shows that the problem is likely to be not with consciousness as such. It is also well known that we may feel a stroke or a contact on a rubber arm that we see instead of our hidden arm (Botvinick and Cohen, 1998).

As a consequence, the forms of disambiguation can be complex and the issue of consciousness can be very tricky. Kinesthesia or haptic cues in some cases tell us about ownership (this moving arm is mine) but not agency (I am the one who is making this arm move) (Jeannerod, 2009). This is nicely shown by a series of experiments origi-

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nally performed by Nielsen (Nielsen, 1978), in which subjects believed that they were following the motion of their own hand, while in fact (thanks to a mirror reflection) they followed the movements of the hand of an experimenter, which deviated more or less from the subject's instructions. Actually, subjects, to compensate for these deviations, deviated their own movements in a direction opposite to that of the hand which they could see. However, they were unaware of their compensatory movement. Similar results were found in experiments on the control of voice.

Since the sense of discrepancy in the attribution of movements is fundamental in this kind of experiments, all these data could be sufficiently accounted for in terms of a default configuration in which motion is self-attributed if the effects are exactly those that have been expected given certain previous action planning. However, when there is a certain discrepancy, the subject must search for another explanation. As a matter of fact, it would be difficult to attribute a concrete movement to a certain agency given that the effects discussed above are related to the unconsciousness of intentions in action.

Further experiments performed by Fourneret, and Jeannerod have confirmed that subjects may be conscious of a goal but not of motor performances and therefore they would not be conscious of the way to achieve it or of the needed performance (Fourneret and Jeannerod, 1998): It is a dissociation between the planning level and the executive level. Slachewsky *et al.* pursuing this line of study, showed that subjects may become aware of an abnormal deviation from the willed trajectory (due to distortion effects) only when the discrepancy passes a certain threshold, for instance an angle >14β when tracing lines with a pen on a paper (Slachewsky *et al.* 2001). This confirms the fact that consciousness is always triggered by some failure originating in the sensory data or in the accomplishment of a movement. Conscious experience about one's movement deals with the later matching of two sorts of data: Central and peripheral signals.

In conclusion, it seems that the conscious mind is not a causal agency at all. If we are speaking of the production of programmed movements, this conclusion is justified. However, the distinction between primary or prior intentions and intentions in action (Anscombe, 1957; Searle, 1983) allows for a different evaluation of consciousness even in its anticipatory quality. Indeed, if consciousness is bound by prior intentions and long-term plans, it presents itself as an integration system able to frame different specific actions into a wider context of planning. If so, it may be able to determine the *general conditions* in which a specific act (and therefore an intention in action) comes into play. Top-down causation of endogenous cognitive processes requires in fact that some representation of the goal precedes the action that is aiming at achieving the goal, as suggested by Jeannerod's studies showing a hierarchy of body motions, such that the subsegments are nested in larger motor segments (like Russian dolls) (Jeannerod, 2006; 2009; Auletta *et al.,* 2013). However, it does not require a dynamical intervention from the higher level into the lower level of the hierarchy (Auletta *et al.,* 2008; Auletta,

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2012). In this way, the will can determine the equivalence class to which several concrete actions (and intentions in action) and means belong. This equivalence class is determined by the general goal of the primary intentions and by its subgoals. Then, when dealing with goals and intentions it does not matter how they are executed, it is only their final *outcome* representing the goal that is of concern. Thus, the specific way in which an action is performed is not controlled by consciousness, but its functional value is. In other words, prior intentions are teleologic, while intentions in action are based on teleonomic circuits that do not need to be explicitly purposeful or even goal-directed (Auletta, 2013b). If I am right, consciousness could be a causal agency of actions but only in an indirect and constraining sense, and not in a direct and dynamic sense, as J. Searle still assumed. Moreover, this constitutes the conscious self as an actor able to plan for relative long time spans.

If I am right, a mentalist description would very easily account for facts like turning a page when reading (and understanding) a book, since the page is turned (a physical action in itself) according to the ability to follow semantically (rationally and consciously) what is written; or actions like running out of a building believing (a conscious interpretation, at least in some cases) that it is on fire. So, these acts represent what can be physically performed in infinite different ways (equivalence class of executions), where each combination of an action's sub-segments would give an entirely different causal chain as a result. Nevertheless, those physical actions are still considered as instances of the *same* purposeful act. From this point of view, we can say that, to a certain extent, all physical events are intrinsically ambiguous unless they are not inserted in some semantic context.

3.3 What Do Symbols Mean

There is a crucial difference between signs (used by all known living creatures, human included) and symbols. Communication signs (like the gestures that accompany our speech) are associative and not voluntary but directly connected with biological (perceptual and motor) schemata and representations: in general they have been phylogenetically selected (Auletta, 2001a, Chap. 12). At the opposite, the main characters of symbols are (Auletta, 2001a, Chap. 18):

1. They provide no direct representation. This is why they need to have a biological substrate and be socially shared.
2. Are codified: a small and fixed number of units like letters, numbers, gestures constitute the pool out of which communicative sequences are generated. The elements of the code need to be physically implemented.
3. Are recursive and hierarchically organized (relative independence of each level of containment) (Hauser, 2009).

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4. As a consequence of the latter two aspects, we have the property of discrete infinity, which is exhibited in its purest form by the natural numbers (Chomsky, 2000; Studdert-Kennedy, 2003), i.e. the capacity to produce infinite «sentences» by combination of discrete units (phonemes, words, ritual gestures, etc.). This is what grounds the cumulativity of human culture.
5. They are contrastive. For instance, the concept of finite can only be understood in opposition to that of infinite and vice versa.
6. They have 3 components: pragmatic (social-cultural practice), syntactic (rules for combination), semantic (networks of meanings).

Symbols could not exist without the rich biological substrate of categories that we basically share with other primates. This is what makes the essence of embodied cognition. In fact, without such an embodiment, symbolic systems (and especially semantics) could be closed worlds unable to be helpful to our species. Then, according to the view proposed here (reuse and cognitive development of a neural-biological substrate that we share with other primates) the actual symbol structures of a given language add cognitive value by complementing (without being replicated by) the more basic modes of operation and representation rooted in the biological brain (Clark, 1997; 2006). We should try to think in terms of a kind of complex dynamics in which the forms and structures of a language understood as a material symbol system play a key and irreducible role. In fact, the symbolic dimension is strictly connected with a system of material elements playing the role of codifying units. Understanding language as a complementary cognitive resource is an important part of understanding human cognition as involving a complex interplay between internal biological resources and external non-biological resources in terms of an extended mind. In over words, the external world appears here as the receptacle of information that can be used by humans. A critical issue then is how to mediate between inside and outside, between things in a pure form, and «mind» as it emerges out of and constrains processes in the brain (Roepstorff, 2008). The idea is that the symbolic environment (very broadly construed) can sometimes impact thought and learning not by some process of full-translation, in which the meanings of symbolic objects are exhaustively translated into an inner code, a mentalese, but by something closer to coordination. On the coordination model, the symbolic environment impacts thought by activating such other resources and by using either the objects themselves (or inner image-like internal representations of the objects) as additional fulcrums of attention, memory and control. In the maximum strength version, these symbolic objects quite literally appear as elements in representationally hybrid thoughts.

The fact that symbols have a pragmatic component (social sharing) allows the connection between the other two dimensions of symbols, semantics and syntax (Auletta, 2001a, Chap. 19):

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- Semantics consists in the (class) relations among concepts and eventually class elements. Semantics is based on both linearity and hierarchical principles since each semantic unit is connected with many other semantic units according to those hierarchical class relations (Deacon, 1997, 69-101). Moreover, to linearly add (without making use of syntactic relations) semantic units is a way of getting new higher-level semantic units (like: Lion sleep forest), as is evident in pidgin languages, in the way children speak, or also when adults try to express themselves in a language they do not know very well. Semantically interpreted items are easier to remember.
- Syntax is related to the hierarchical combinatorial principle of which I have spoken above. For instance, in natural languages syntax tells you that a way of getting a correct proposition is to combine a subject, a verb, and a predicate in a certain way. It is very important to stress that a semantic combinatory of items like concepts does not exist (a phrase is not a semantic unit!). All combinatory are rather of syntactical nature. It is obviously possible to combine concepts in order to give rise to fictional entities. However, any such combinations (e.g. science fiction novels), if it is not meaningless (a random patchwork), is only so because we have inserted notions whose source is ultimately experience and not semantics (as it happens when we linearly add words). This is an important difference relative to syntactic combinatory, which is fully independent from experience.
- Through pragmatics we get the connection with the representational aspect and in this way we eventually relate concepts (which are types) to tokens. In other words, symbols do not refer directly to objects but to representations (without expressing their content), and only through representations are they connected with objects. They are therefore meta-representational in their fundamental nature. Moreover, in evoking representations in the partner (through an interactive dialogue), they are intrinsically active and interactive in the sense that they stimulate decisions in the partner. Pragmatics is based on the linearity principle, since it shows that a certain sequence of symbols (phonemes, letters, and so on) that is concretely uttered is mapped to semantics, and that their specific uttered combination is made according to a syntax.

3.4 Intentionality and Projectuality

It is very difficult to understand symbol using without intentionality (Auletta, 2001a, Chap. 20). Brentano introduced the concept of intentionality into modern philosophy and psychology (von Brentano, 1874). He understood intentionality as being related to an object and its properties. Since properties express the conceptual way in which we understand something, it was also assumed that the intentional object is immanent to the intentional act itself (it is not an external reality). Through the phenomenological school, intentionality was considered in increasingly psychological

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and inter-subjective terms (Chisholm, 1957; 1976). In this way, intentionality assumes the characteristics of a symbolic activity, since I have said that symbols are socially referred to representations and not directly to external objects: they are meta-representational. To avoid any confusion, I use the term *reference* to express the (biological) relation that organisms maintain with external objects when they represent them, whereas *intentionality* specifically means the symbolic sharing of actions and representations among humans, so that through these a reference to objects is also established. Intentionality is therefore the foundation of the pragmatic aspect of the symbolic activity.

A significant progress was done by J. Searle (Searle 1983), who was relatively isolated in the community of cognitive scientists, most of them skeptical towards intentionality. Searle also noticed that intentional states represent objects and states of affairs in the same sense as speech acts do; both in fact have conditions of satisfaction and a direction of fit. Indeed, according to Searle, every intentional state consists of a representational content in a certain psychological mode:

- A specification of the content of intentionality is already a specification of the conditions of satisfaction (the conditions under which there is a fit between mind and world).
- The direction of fit is mind-to-world, while the direction of causation is world-to-mind.

Intentional components and conditions of satisfaction can also be separated, as happens in hallucinations, anesthesia, electric stimulation of a certain cortical area, and so on. According to Searle, when we have true intentionality, the prior intention causes the whole action, which also comprehends the intention in action and the bodily movement, even if this relationship of causation is not immediately perceived and does not constitute the object of these experiences. However, this is not necessarily the case, so that we can still have intentionality playing a causal role even if motor aspects do not depend on it.

Primates understand both relational categories and third-party social relationships. However, this does not necessarily mean that chimpanzees are able to understand all of the following elements that are required for intentionality (Tomasello, 2008):

1. Others have different relationships to the same object, for instance being able to see or not see a given object (behavior understanding),
2. Each of these perspectives can be gained by imagining how things would be when being in the place of others (empathy),
3. Others have beliefs about things that may differ from our own (mind-reading).

Indeed, intentionality is not only the understanding of others' intentions but the ability to cope with the other's intentions in order to actively produce some joint ef-

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fects (Fogassi *et al.,* 2005). As a matter of fact, when children start to speak (when they are about one year old), they follow always the gaze of the person who is speaking in order to converge on a common object or actively search for eye contact.

3.5 Self-canalization

Once a true codified symbolic system has arisen, other further possibilities of codification and information-preserving and -sharing become feasible in principle, like a written language, internet, and so on. All these forms may have significant back-effects on dealing-with-information and therefore represent a process of self-canalization (Auletta, 2011b; Sec. 5.4). By *self-canalization* I mean the particular process by which human beings voluntarily subject themselves to rules, practices, learning processes, and so on, that are able to direct their development along a certain path as well as to canalize future generations. This is the way in which we humans continuously generate variety and search for novelty by simultaneously accepting constraints that ultimately restrict that space of possibility. Such a process goes much further than the material or educational aspect of culture and touches the intellectual and moral sphere very deeply. Indeed, this high level of integration is what constitutes the mind and its operations, whose most perfect example is language. It is very important to understand that culture is the first system of self-canalization of a biological species that we know. In fact, phylogenetically, only teleonomic processes are at play. Instead, in this new form of phylogenetic inheritance, teleologic processes are also deeply intermingled with teleonomic ones, as is evident with teaching.

We can envisage the human mind as an emergent process from biological evolution according to emergent monism (Auletta, 2011b; Sec. 3.3). This means that the mind cannot be a sort of detached substance, or a «super-instance» relative to the brain. Indeed, brain processes are *not* generated by the mind: as we have seen, most of our operations are performed in a spontaneous way by our brain without any rational planning or conscious intervention. What the mind can do, instead, is to establish rational plans, concepts, values, and so on, as *general frameworks* in which those spontaneous operations take their course. In other words, the mind rather than generating such processes can impose certain limitations and even block them thus redirecting their spontaneous course. The way in which the mind is able to canalize the brain operations is by resorting to physical events occurring outside the brain and by treating them in informational terms thanks to the pragmatic dimension (Auletta, 2011a; Chap. 24): vocal emissions, gestures, physical objects, or any other kind of structure or item can be combined by the mind in pure physical terms but according to syntactic rules that are not physical themselves. This means, as understood by Merleau-Ponty, that the mind throughout the whole of the person's brain and body takes an

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active part to the dynamical interactions occurring in the physical world to which the person pertains as a material entity and uses this as a way of conditioning its own neural processes.

However, this is achieved without violating the closure of physical laws and, as said, by having rather a constraining influence on the physical dimension (self-canalization): the human mind is both the highest result so far of a process of growing complexification and canalization of nature, and the way for exerting a new, original, *active* canalization of the physical world. This is also the manner in which a new connection between the physical and the mental worlds is established as well as a connection between the formal and the mental dimensions is realized. Let us consider the latter point.

Within the general cognitive interest of the present paper, we may say that whenever one has to admit that the results of an intellectual research are not depending solely on human efforts, that the natural world's features encountered or discovered show universal validity, one also acknowledges (at least implicitly) the limit of our knowledge. In fact, the mind is able to establish a unique connection with the formal world of ideas and concepts. The way in which we humans arrive at certain conclusions is contingent, but when particular results of general validity have been found, we are no longer in the position to change something in these formal constructs according to our arbitrary will. It is true that we can excogitate new classes of objects that do not obey acknowledged laws or possess unexpected characters. However, this or that new class of objects also exerts certain constraints (simply due to the fact that these objects share certain properties), so that the game goes on. Yet, it may still be legitimate to ask: what forbids us to think that it is precisely this never-ending process that shows that contingency is the last word, and that the constraints we always find are themselves contingent and provisional? In a word, the fact that, in this game, our understanding grows, science continues, new formal aspects and new elements of reality are revealed. And this knowledge grows because the results found on the path have an objective value and can therefore be integrated into further knowledge not only by ourselves but also by others: knowledge is public, is shared. Only in this sense are they true acquisitions, although this integration cannot be understood in terms of positive accumulation only but as a continuous process of self-correction and updating. The paths leading to some results may be different but they represent the form of inferential-hypothetical reasoning that is the way in which the mind accommodates to the relations that exist between cognitive principles and results, between universals and particulars (experiences).

In other words, the results of an investigation that is freely undertaken show their autonomous validity with respect to the investigators, who therefore may recognize knowledge as being ultimately founded on something else, which is in a strong sense ulterior and not totally knowable, but only partially perceived during one's cognitive

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journey. Such an apparently paradoxical state of affairs may be seen as the virtuous circle through which human beings progressively realize their very own nature: in longing for universality, we transcend our biological constitution and individual perspective, yet we discover the truth that we were looking for as something that is independent of our own personal efforts (Peirce, 1902).

Properly speaking, self-canalization is the activity through which both the connections between the mental and the physical world, as well as between the mental and the formal ones are strictly entrenched in the *intersubjective* dimension that constitutes the whole of human culture. Human culture essentially consists of a process of symbolic sharing and information interpretation through which we are able to canalize our own development (thanks to education and transmission of culture to the next generations) and, to a certain extent, even our own evolution (through our ability to reshape the environment and to give rise to new forms of artificial contexts playing the role of frameworks for our species). Then, culture is the ecological niche of our species (or of our genus) (Auletta, 2013c).

This clearly shows that, although conventional, culture is never arbitrary, being another manifestation of the fundamental connection between contingent paths of exploration and results endowed with universal validity that is the quintessence of humanity. This process of transmission is only possible when the new generations to be educated trust the previous generations and believe in their traditions in order to reach further, more pondered and grounded beliefs, so that the process of self-canalization can be seen as a dynamical integration of tradition and novelty starting from a lower belief and ending in a higher belief or also going from empirical, less rational assent to higher and socially shared rational assent.

4. Some lessons

Resuming, the new image that current scientific developments give of man is a being in which (i) biology and culture are more entrenched than it was though before, (ii) mental and bodily dimensions cooperate in a form that leads us very far away from traditional dualistic or even monistic (and often reductionist) approaches, as it is evident in the case of action's choice, (iii) the studied continuity but also specificity of humans relative to other primates helps us to understand the emergence of humanity as a complex process in which (iv) embodiment with neural reuse, «improvisional» intelligence and a cultural niche have played a crucial role, (v) the inter-subjective dimension offers a way out from solipsism that has dominated most of philosophical schools. I think that these results constitute a robust basis for developing a robust philosophical-anthropological reflection.

In particular, we can focus on some very important lessons that can be drawn from what has been previously said:

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- Humanity is a genus and not a biological species. In other words, humanity cannot be identified with *homo sapiens*. This is evident by the fact that Neanderthals, who likely are not our direct ancestors (although there can have been some forms of interbreeding), had a cult of dead, used symbolic objects, had a neural capacity higher than ours. So, we cannot deny that they are humans although they are not *sapiens*. I would enlarge these reflections. I would suggest that we can speak of humanity in the precise moment in which our ancestors (about 6.2-6.5 Millions of years ago [Mya]) have separated from other primates. It is clear that for a long time our ancestors had no scripture (which started about 6 kya), no modern spoken language (likely started 60-70 kya), even no symbolic communication (likely started 200 kya), no advanced cognitive abilities (a revolution that took place likely 400-500 kya), no capability to produce artefacts according to previous plans (symmetric bifacials are about 800 kya), no capability to work systematically on stones for producing very rough tools (about 2,5 Mya). Nevertheless, I see no reason to deny that we deal here with a growing humanity. In fact, all these changes and mutations are specifically human and are not shared with any other species. Moreover, we need to consider their accumulation. It is clear that basic structural or biological-functional modifications came first. In fact, higher cognitive functions and even fine-tuning in those biological functionalities themselves can only rely on a more basic biological substrate. It is like for children during development. A child is a human being from its conception (it presents from the start characters that are unique to our species), but it acquires several capabilities across its development and in conjunction with several biological transformations that somehow in part «recapitulate» phylogenetic ones. We now have the intellectual capabilities to understand the universe as originated from the Big Bang and what are the rules of an inferential process. However, if our ancestors (400-500 kya) had not discovered the fire, we certainly could not do that. We are on their shoulders and we are their heritage, in a sense that is very different from the phylogenetic thread that connects us with other biological species.
- In fact, what is unique to this evolution is the transcendence of the biological dimension towards the constitution of a cultural niche, a symbolic and mental dimension, in general towards a growing autonomy from the pre-given environmental substrate of our life (improvisational intelligence). In other words, humanity is characterized by a process of self-transcendence. This is why biological changes have accelerated during the cultural epoch (the last 40,000 years). In other words, we are not a species biologically fixed and relative stable as the other ones, but our cognitive and cultural niches pushes us to a constant process of physical, intellectual and spiritual elevation.
- In this process, our biological substrate, our body is not removed or eliminated but integrated in such a process, somehow «transfigured».

5. The current turn

5.1 What are the current developments in biology and biotechnologies

We assist now to a major turn in the history of our race. Many countries of the world (especially the US and those pertaining to the European Union) are investing growing quantities of funds in the new technologies for enhancing humanity. A reference document of the EU on these issues is *Making Perfect Life: Bio-Engineering (in) the 21st Century, Interim* Interim Study - Monitoring Report of the European Parliament.[1]

Among the most important current technologies concerning human enhancement I recall:

a. Prosthetic devices of Information-Technology (IT) kind for improving biological-neurological capabilities;
b. Bio-engineering (redesigning and rebuilding biological systems, from engineering of tissues up to interventions in the genetic and epigenetic pathways) with the aim of bettering biological-neurological capabilities, lengthening human life span, regenerating organs or parts of the body thanks to (non-embryonic) stem cells (this allows to pass from a «repair medicine» to a «regenerative medicine»);
c. Neuromodulation and brain-computer interface for stimulating neurological-mental capabilities.

The collective name for this field of studies is NBIC (Nanotechnology, Biology, Information, Cognition). These technologies represent an important turn in the history of civilization: for the first time we are developing technological means for addressing the human body not only for medical purposes (curative practices, elimination of dysfunctions or impairments, which are still included in the agenda of regenerative medicine), but rather for enhancing the capabilities of the human being as such. Such a turn will obviously raise several fundamental anthropological issues about the nature and the destiny of humanity also because of the influences that it will unavoidable have on future generations and their lifestyle. A number of crucial environmental as well as social and cultural issues are also involved.

Already this sparse information let understand that something really very important is going on. It is likely that our societies and humanity as a whole are making choices that will have effects on our descendants for the next centuries. Choices from which it will be very difficult if not impossible to step back. No philosopher or no theologian

[1] http://www.europarl.europa.eu/RegData/etudes/divers/stoa/2011/471570/IPOL-STOA_DV(2011)471570_EN.pdf.

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can remain indifferent to this. To do not intervene in one way or the other is also a choice and this can also have very long-ranging consequences.

5.2 In which sense they represent a challenge to humanity

These developments represent both a continuity and discontinuity with the previous history: on the hand, they reinforce the tendency of our race to self-canalization. In fact, if it is question of engineering our body, this means that we shall have the practical means fro programming our own evolution. On the other hand, there is an evident discontinuity: culture imposed biases on our biological evolution only in an indirect way. On the contrary, if we are able to plan our evolution, this means that we can transform ourselves purposefully. It is clear that such a situation may present very big dangers for the individuals and the society, especially considering the huge amount of interests of economic, political and military kind that are beyond these developments. However, we need here a careful and objective analysis. I stress here some points that deserve the highest attention:

- The idea that technology can be cured with technology. In other words, we cannot step back from technological developments but can try to improve them along directions that make technology more human- and environment-friendly. In fact, on our backs there is also an important responsibility towards future generations and still emerging countries in a double sense of the word: certainly we should avoid a too bigger impact on the environment and society but we should also try to improve economy in order to favour the well-being of the whole world population. Obviously, this also raises several problems of distribution and about the maximal level at which this growth can be sustained.
- The great stress that these technologies have on the improvement of life. This is something that cannot leave us indifferent. The promotion of life is always positive in itself. Moreover, to improve life duration will help greatly our species. It is proved that one of the main differences between our ancestors and the Neanderthals was not the degree of encephalization (in fact, as mentioned, the Neanderthal had a bigger brain than the *Sapiens*), but the fact that our ancestors, making use of the division of labour, left in the camps children together with women and elder people. Now, the fact that elder people were there was a consequence of the choice that only a small group of selected hunters (young males) dealt with the hunt of big mammals, a very dangerous activity, sparing, in this way, to the rest of the population injuries and allowing an elongation of life. Now, the contact between children and elder people allowed the former to grow in a protected environment in which they could assimilate the lessons and the traditions accumulated in long time span, therefore favouring their intellectual development. In our society, there is a characteristic

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underestimation of elder people. This may be connected with the fact that in the last centuries active life lasted until few years before the death, so not allowing elder people (who in general were weakened physically and intellectually by their previous work) to update their knowledge with current progress. Now, we have a generation of elder people who live much more after their retirement but the society has found so far no way to profit of their capabilities, with the consequence that most of them live their time in the mean as «free time». It is likely that a further improvement of life duration will offer new possibilities to have novel kinds of social and cultural engagement for helping the new generations. The next generations cannot throw away such a treasure of experiences and capabilities. But obviously, this also supposes people in a perfect state of mental and physical health, and here is where the technologies of human enhancement can make an important difference.

- The great emphasis on the further intellectual (cognitive) development of humanity. This is crucial, since the cognitive development has up to now represented a bridge between the bodily-biological substrate and the higher spiritual manifestations of humanity. Although we cannot expect a linear evolution in this sense in the future, it is clear that in the mid-long time span an empowerment of the cognitive faculties of humanity will also make easier to deal with the highest scientific, philosophical and theological speculations. In other words, human enhancement can, in long time, help very much a substantial progress of the spiritual life of humanity.
- The connection between information and biology is crucial (Auletta, 2011a). In fact, one of the questions I shall raise here is the notion of biological, psychological and social *control*. At any level of complexity, control is generally related to top-down processes, which is one of the main concepts introduced in NBIC: indeed, in order to exert control, a system must have the possibility to choose at least between operations that are accepted and those that are rejected. This strongly connects the issue of control and the issue of information (in fact, to control a system demands to be able to monitor its changes).

It is clear that there are also some dangers. These developments were prepared since a long time by a visionary philosophical-cultural movement called transhumanism (Auletta, Colagè and D'Ambrosio, 2013). Since their own view have changed with the time and the movement finds itself in a still magmatic process, the best is to make reference to their website that is updated and gives links to further documentation (http://humanityplus.org/). The most relevant of these critical points appear to me to be:

1. The goal of transhumanism is to overcome humanity. The name of the web site (Humanityplus) is characteristic: should this «plus» mean to make an enhanced humanity or to bring humanity to a post-humanity? In general, the main tendency seems to be the second one. I have stressed that our ancestors are not less humans than we are,

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notwithstanding the immense progresses that we have made in between. So also, for the future, I would suggest that whatever our descendants will be or do, they will always be *human*. In other words, as I have stressed, humanity is characterized by self-trascendence. I think that to say differently, would allow a dangerous development: to distinguish between super-humans who have been biologically engineered and humans (but actually, under-humans) who have not.

2. Another critical issues is that many transhumanists expect from technology new ways to take decisions, as super-intelligent devices with which we are connected could take better decisions than ourselves. I think that this is a huge misunderstanding about the ways in which decisions are taken. In fact, one thing are the computational capacities. Already current computers can compute better than us, and it is likely that future generations of computer can score much better. Another thing is to take decisions. The specificity of human decision making (what makes so relevant to have a consciousness) (Auletta, 2011a, Chaps. 18 and 22) relatively to all other animals and also to computer is that we can take decisions when the data at our disposal are insufficient. This is crucial for the very complex world in which we live. Since this is a matter of principle, no computational technique alone can circumvent this problem. Moreover, any decision, especially when it concerns whole societies, demands the evaluation of so subtle questions (and especially of ethical aspects and consequences) that decisions cannot be taken in the same way in which we can choose a pen. This is why we need to improve the cognitive and moral capabilities of humans and not dream of machines that could replace us, although they can obviously assist us.

3, For this reason, the emphasis put on the fusion between humanity and IT is too big (the so-called cyborg). Certainly, many IT can be very helpful. But we cannot move towards a direction that would make humans dependent on devices. This would be a regress and not a progress.

4. Another critical point is the following: many transhumanists still think that we need to change the social and religious structures. In particular, some are clearly anti-religious. I think that this in unnecessary, and if transhumanism will really become a view that everybody could share since it works for the progress of humanity it would be suitable to remove all ideological accessories.

5.3 How Philosophy and Theology can deal with them

Summarizing, under many different points of view, these developments put in question what to be or to become human could mean. I think that philosophers and theologians should follow very carefully these developments. We cannot make violence to these developments or hinder them even in the case in which we would seriously envisage this possibility. The progress of humanity needs to be spontaneous and demands a lot of time (likely many centuries and perhaps some thousands of years)

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and patience. The cultural modifications are the most difficult ones to introduce and to stabilize.

I think that philosophers and theologians could be very helpful from two different points of view:

1. Trying to focus on the most relevant aspects of humanity involved here. The present paper can be considered a contribution into this direction, but still further work needs to be done.

2. We should help the society to find some criteria for dealing with these developments. The fundamental criterion seems to me to be the capability by the individual and the society to assimilate these transformations. Neither the individual, nor the society can lose the self-control on its own processes. No transformation should be approved that makes the individual or the society more dependent on whatsoever agency. Briefly speaking, any new technological development needs to be understood and judged in reference to its intrinsic capability to keep top-down control on the involved processes by both the individual (at several levels of complexity and containment, from cellular control through control related to whole organs up to neural and psychological aspects) and the society (again at several levels of complexity and containment, from specific social groups or layers up to national and supranational wholes).

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