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How the Evolutive Continuity of Cognition Challenges 'Us/Them' Dichotomies

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1. 'Us/Them' – Mankind

One's social identity depends on an ensemble of group memberships, like nationality, religion, age, language, and gender, to make some examples. Such attributes are independent of one another, but often perceived as correlated by virtue of a cognitive bias that can give rise to stereotyping. Although stereotyping might be a good strategy when used to assimilate either new or a lot of information, it might slip into prejudice, thus paving the way to ingroup/outgroup distinctions, which in turn suffer from a negative orientation towards the outgroup, and a positive one toward the ingroup. This is a universal human tendency: humans distinguish and differentiate people depending on socioeconomic status or ethnicity, for example, in which the discriminanda is "compared to one own's" *vs.* "different from one own's". In other words, us *vs.* them, with "us" being a very heterogeneous set of elements with maximal good qualities, and "them" being a more homogeneous set of undifferentiated elements paired with negative features (Allport, 1954).

But how is it possible to study ingroup/outgroup issues? Psychological investigations face the obvious problem of open self-reports, because these are susceptible to social desirability effects. One test that has been devised to overcome this problem is the Implicit Association Test (IAT), which has been repeatedly used as a measure of racism and other ingroup/outgroup biases (Greenwald *et al.*, 1998). In humans, the IAT detects the strength of an automatic association between mental representations (like White and good) by using an objective behavioural measure, namely the response time in pressing a button when we are asked to categorize words and names (like names used for White people with respect to names used for Black people) alongside with pressing a button in response to pleasant *vs.* unpleasant words. Research has shown that White people are usually faster to press the button (i.e., to take a decision in making a judgment) when the same button must be pressed to categorize a word like "Black" and an adjective like "unpleasant", thus demonstrating that cognitive associations are present although not available to awareness.

Of course, also the IAT shows intrinsic shortcomings, which are related mostly to what is exactly measured with this test (i.e., the cultural knowledge rather than the prejudices), and whether it reveals real behavioural discriminations rather than mental attitudes without a true effect on social conduct. However, it has been shown that affective and semantic implicit associations can be separated, and people may not be able to deliberately control their prejudices[1].

In addition, what we do know is that because ingroup/outgroup divisions are arbitrary, they are subject to continuous changes: quite easily an element can be shifted from one category to another, and post-hoc justifications are used to explain the fluid modification of the inclusion criteria or to accommodate exceptions within the ingroup members. Changes are related to previous experiences, and can be easily manipulated. It has been shown that we are fast and accurate in detecting own-race faces by early visual analysis (Huges *et al.*, 2019). This may have effects on other categorizations (and important impactful social implications) related to the fact that it is easier to extend negative experiences to entities that we perceive as interchangeable. However, much depends on the expertise (the extent to which we are exposed to other-race faces) and can be influenced by external cues (like the colour of a t-shirt) that are independent of race – if better predictors of racial social groups (Pietraszewski *et al.*, 2014).

Nevertheless, over the centuries the 'us/them' distinctions have repeatedly supported racist behaviours, so that, for example, Europeans advocated they supremacy as group, and exploited it to subjugate minority populations. Darwin argued that the cognitive difference is minimal between tribal and "civilized" populations, but his claims have been often misunderstood and misused in support of racist theories. Indeed, the concept of contingency, the fortuitousness of geographical and ecological pressures that are fundamental

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[1] For a review on the issue, see Amodio, 2008.

in shaping populations' abilities, went overlooked. Not all world populations, for instance, had the urge or the possibility to start agriculture, either because animal abundance and flourishing wild plants would suffice, or because it was not possible to tame the animals available in the area. This, in turn, modeled a series of differences related to the practice of agriculture, as a reduced presence of wild animals due to intense hunting, but also an increased risk to get infectious diseases from domesticated species which, in a domino effect, implied a relative immunity to illnesses that resulted in lethal epidemics to populations of new territories. The technological development required to manage agriculture along with all necessary activities to manage early exchanges, entailed a corresponding better organized society which represented a greater advantage for Europeans when they reached new corners of the World (Diamond, 2001). These aspects alone are sufficient to explain the Europeans' success, without the need to invoke any intellectual superiority, as no innate biological factor would confer to White people any supremacy, whereas different continental environments promoted a different fate. Still, cultural racism persists, probably rooted in known cognitive biases. One of such biases is represented by the mental shortcut called *availability heuristic*, which relies on cases that come easily to the mind (Chapman, 1967). The fact that such cases can be easily recalled is assumed to be proof of their relevance, and thus weighed more in order to make decisions, evaluate situations or people. Moreover, human beings have the tendency to remember more supportive than opposing evidence, which is a *confirmation bias* that increases the strength of the 'us/them' dichotomy[2]. Such biases, along with the use of subjective categories, filter experiences, valuing some more than others and determining the kind of features that will be considered as relevant.

The tendency to treat individuals categorically is so inevitable that we may think that this process is hardwired in our cognitive system. In agreement with this possibility, our five-month-old infants prefer people talking in their parents' language, with native accents (Kinzler *et al*., 2007). Furthermore, three-month-old infants, with minimal prior experience with other-race individuals, prefer faces looking similar to their own ethnic group (Kelly *et al*., 2005). If this tendency to categorize Us *vs*. Them is so pervasive and precocious, which seems to be a precursor for a race-based bias, one might ask which could be its evolutionary reasons. An explored possibility is that infants need to acquire information. This drive to learn would guide attention toward social partners that more frequently would convey relevant information, which *per se* would provide a survival advantage. By means of exposure and imprinting to specific caregivers, infants will preferentially attend to own-race adults (Begus *et al*., 2016), an asymmetry

2 For a review see Nickerson, 1998.

that would propel the development of intergroup bias. This fits well with the idea of a "natural pedagogy" proposed by Csibra and Gergely (2011), which assumes that for the hominine lineage an important adaptation has been the evolution of mechanisms favouring cultural transmission. Mechanisms of this kind would explain why no differences in child-rearing practices of different human cultures are detectable.

However, as a matter of fact all organisms pragmatically need to order an otherwise chaotic nature: making dichotomies to include entities in certain categories and not others, i.e., distinguishing members from nonmembers, preys from predators, is essential in learning, in making predictions, and in taking decision, in other words, is essential to survival. We can then trace back and ground the need for classifications in more basic ecological forces. This is not surprising considering that, during the evolutionary time, for adaptive reasons, the function becomes hardwired in the brain in response to specific and constant environmental features or pressures (Spencer, 1855; Lorenz, 1941). The comparative psychology perspective, focusing on data obtained by examining the behaviour of other animal species, helps to shed light on this matter. We know from ethological observations that antecedents of ingroup/outgroup divisions can be recognized in nonhuman primates, since they are capable of bloody retaliations against neighboring groups (Wilson *et al*., 2014). Where does this processing ability come from? All living creatures are predisposed to classify experiences in discrete categories in order at least to divide stimuli between familiar and novel ones. When elements are limited in number, their categorization can depend on how each separate item has been memorized on the basis of its perceptual features. By contrast, for a larger set of elements, an economic strategy is that of memorizing a specific feature common to the exemplars of the same kind. This would be in part similar to creating a concept: we can recognize and then label a certain thing as a chair even when it displays very ample local variations. Hence, it does not matter if the exemplar has or not the armrests, has a short or tall backrest, is a single-form Verner Panton "Stacking Chair" or an evocative "Butterfly Chair", as in all cases it would still belong to the same category, "chair".

Experimental observations conducted in the laboratory demonstrated that pigeons, for instance, can be trained to discriminate two-dimensional images of trees, not by remembering every single image, but rather by learning to select as "trees" also instances never seen before. The pioneering study was presented by Herrnstein in 1985 and, since then, the finding has been replicated several times, using different categories, and including "exotic" categorizations like that between distinct art movements, asking pigeons to correctly attribute paintings to Cubism *vs.* Impressionism (Watanabe *et al*., 1995). Pigeons master successfully the task, but although concept learning is made possible by perceptual similarity, this is not the only way to achieve categorization. Concept learning is also based on the creation of arbitrary and associative functional equivalences on the basis of a common event or outcome, by the relationship between objects that requires a comparison – and its status will change accordingly –, and by relations between relations, a second order relational concept with an abstract connection between classes of stimuli. Nonhuman animals have proved to be able to discriminate objects and events on the basis of all levels of conceptual learning[3], and, most notably, even invertebrates like bees possess the same ability[4]. Such an organization of incoming information allows extreme flexibility in behaviours as, for instance, when it helps to decide whether an action has to be taken or not, thus saving energy and, sometimes, life.

Let us consider female monkeys, who can recognize their babies from the voice; they turn the head more frequently toward the acoustic source (a hidden loudspeaker) when they hear the cry of their own baby. This response has been exploited to investigate, in semi-natural conditions, whether monkeys can reason about social relations between components of different family groups. When females of vervet monkeys are presented with the cry of other baby-monkeys, they will look at the mother of the crying baby whenever the female is present but unaware of and/or un-responsive to the cries (Cheney & Seyfarth, 1980). In a similar fashion, long-tailed macaques tested in the laboratory proved to be able to associate the image of an offspring to the picture of the mother presented before, with respect to the image of a different baby of the same sex and age (Dasser, 1988), thus easily recomposing correctly each mother-infant dyad. In a similar vein, nonhuman primates discriminate kinship relationships also in cases of redirected aggressiveness and reconciliation. In both situations, the response, of either attack or grooming, is extended to the closest associates to the aggressor (Cheney & Seyfarth, 1990a). Moreover, if an individual has the possibility to eavesdrop on a member of its own family fighting against an individual of a different family, it increases the probability of attacking a different member of the same new family, suggesting that the choice is guided by a judgment of the family relations and the relative dominance rank that exists among others in their group (Cheney & Seyfarth, 1990b).

In a fashion comparable to what has been observed in human infants, it has been shown that naïve monkeys prefer to look at individuals of their own species, and also that their treatment of the observed images depends on exposure and expertise of the members of the other category (Humphrey, 1974). Indeed, monkeys first distinguish between specific individuals within the category

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3 For a review see Zentall *et al.*, 2008.

4 For a review see Avarguès-Weber & Giurfa, 2013.

"monkey", whereas making only raw distinctions between specific individuals of other categories (like domestic animals), and then after prolonged exposure to images of the new category, they end up making fine distinctions also between individuals belonging to the new category, becoming able to tell each of them apart. Their categorization depends on the improvement of discrimination made possible by mere exposure, and such process affects the way in which they remember and treat the objects.

Thus, comparative results lead to conclude that the ingroup/outgroup bias is independent of human language, and does not rely on human social categories like religion or race. Rather, it has more to do with phylogenetically ancient mechanisms allowing early humans to reason about coalitions and alliances by using simple core categories: a cognitive architecture tailored by natural selection to augment our survival chances.

2. 'Us/Them'– Animals

How much would the general public be willing to accept that comparative research, like that conducted on pigeons and monkeys discussed above, can explain our human nature?

A further dichotomy within the 'us/them' division, indeed, concerns the distinction between Us, the human beings, *vs.* Them, the animal species. Only rarely people think of themselves as an animal; rather, they consider the mankind a living creature which is distinct from, and preferably better than, all other animals[5]. In such representation, it is evident the *Umwelt*[6] in which we are stuck, as our mind mandatorily processes information within the inescapable boundaries of our mindset. It neluctably confines us in a specific cognitive and sensory framework. Part of what we can call the 'anthropocentric' view comes from the idea that animals act like automata. Animals would be machines that work on the basis of known mathematical principles and mechanical rules[7]. Despite this machine-like nature, it would still be possible for animals to cope well with the environmental challenges, even though rigid responses to stimuli do not allow any flexible behaviour. Hence, nonhuman animals would be apt to live in a predisposed way and without any 'ratio' – *logos* or *rational soul*. In this sense, the (im)possibility to choose how to respond and behave is an operational

5 See *supra* Chapter 1: Wolfgang Proß's contribution to this volume. *Ed. note*.

6 Uexküll 1957 pp. 5-80.

7 See for example *Le Canard Digérateur*, the automation of digestion in the form of a duck by Jacques de Vaucanson in 1739, France.

criterion that helps to differente human beings from the rest of the animal realm. In Descartes' terms, the *res cogitans* represents the supremacy of the human being over beasts' limited range of instinctual responses to environmental challenges[8]. This Cartesian approach is echoed in Kant's 1784 definition of the human being as the only rational creature on earth: "Reason in a creature is a faculty of extending the rules and aims of the use of all its powers far beyond natural instinct, and it knows no boundaries to its projects" (Kant 2007, 109).

Part of the anthropocentric view stems from the *Great chain of beings*, or the Aristotelean *Scala Naturae*, which classifies inferior and superior animals, with only Angels and God placed above humans, the pinnacle of cognitive complexity. In the linear organization of the organisms on the ladder, each category can be divided even further, with animals subdivided on the basis of features like domestication, ability to move and sense, and so forth. This would show that, as for the ingroup/outgroup classification discussed above, the shaded borders of each category allow a continuous shift of the elements depending on situational factors. However, the ladder-like view of nonhuman animals on the part of nonspecialists has been repeatedly experimentally confirmed (Batt, 2009; Urquiza-Haas & Kotrschal, 2015). Organisms are commonly classified on the basis of increased complexity both in terms of zoological structure (a worm

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8 In his *Discourse on the Method* (1637) Descartes wrote: "I made special efforts to show that if any such machines had the organs and outward shape of a monkey or of some other animal that lacks reason, we should have no means of knowing that they did not possess entirely the same nature as these animals; whereas if any such machines bore a resemblance to our bodies and imitated our actions as closely as possible for all practical purposes, we should still have two very certain means of recognizing that they were not real men. The first is that they could never use words, or put together other signs, as we do in order to declare our thoughts to others. For we can certainly conceive of a machine so constructed that it utters words, and even utters words which correspond to bodily actions causing a change in its organs (e.g. if you touch it in one spot it asks what you want of it, if you touch it in another it cries out that you are hurting it, and so on). But it is not conceivable that such a machine should produce different arrangements of words so as to give an appropriately meaningful answer to whatever is said in its presence, as the dullest of men can do. Secondly, even though such machines might do some things as well as we do them, or perhaps even better, they would inevitably fail in others, which would reveal that they were acting not through understanding but only from the disposition of their organs. For whereas reason is a universal instrument which can be used in all kinds of situations, these organs need some particular disposition for each particular action; hence it is for all practical purposes impossible for a machine to have enough different organs to make it act in all the contingencies of life in the way in which our reason makes us act" (Descartes 1986: 139-140). Note that according to Descartes, *mens humana illorum* [scil. of the animal] *corda non pervadit* and we could conjecture about the existence of an animal's rational mind only from external signs and empirical evidence (Descartes' Letter to More, February 5, 1649; AT V, 276-277). Descartes' notion of *mens* is characterized by the spontaneous capacity to making use of general signs for universal ideas. To deny the spontaneity and abstraction of rational thinking to animals did not mean to consider animals as "bare machines" devoid of sensibility (Locke's charge to Descartes in *Essay*, Book II, Chap. XI, §11). Indeed Descartes ascribed *sensus* to them (AT V, 278). On the issue of language see Descartes' Letter to the Marquise of Newcastle of November 23, 1646 (AT IV, 573-576). *Ed. note*.

is simpler than a fish) and in terms of psychological complexity (a crayfish is not able to perform the same behaviours as our cat). There is no question that worms have a minimal number of neurons with respect to humans: the nematode *Caenorhabditis elegans* has exactly 302 neurons in its nervous system, whereas our brains contain nearly 86 billion. But how much do these numbers tell about a successful *cogitatio*? *C. elegans* is perfectly apt in its environment, showing all forms of individual learning, benefitting from experience and from contextual information, to the point that it can be argued that "instead of asking 'what can a worm learn?' it might be better to ask 'what cannot a worm learn?'" (Rankin, 2004, R617). The nematode has been of paramount importance as a model system for the study of genetics and developmental biology, but nowadays it is also used to study important issues within the fields of neurobiology and cognitive sciences. However, the general public would never suspect this, likely because it is extremely difficult to reckon worms' abilities: the worms are not even under our eyes (the entire *C. elegans* is about 1 mm in length) and their responses are too different in shape from the form of responses we display in comparable situations. Anthropomorphic lenses augment *anthropocentric* positions.

Note, however, that this should not imply any "anthropodenial" (de Waal, 1999, 258), i.e., any aprioristic negation of commonalities between human and nonhuman animals. Sometimes, when one applies too rigidly an objective description of nonhuman animals' overt behaviour this produces a descriptive artifact that misses the true nature of the observed response. The Morgan's canon (considered to be the psychological Ockham's razor), is a principle of parsimony formulated to avoid the fallacious temptation of describing nonhuman animals' behaviour with higher-order forms of cognition when more primitive ones satisfy what observed. However, it conceives a corollary to point out that "there is nothing really wrong with complex interpretations if an animal species has provided independent signs of high intelligence" (De Waal 2001, 62).

The beliefs that evolution implies linear progress and growth in complexity, and that higher mental capacities are linked to increased complexity persist even though no one today would believe that the computational power of a computer depends on its size (Chittka & Niven, 2009). Indeed, bees for instance, have proven capable of quite sophisticated processes[9] from observational learning to the mastering of relational concepts, as discussed above (Avarguès-Weber *et al*., 2012), which is the prerequisite for classifying objects and events – and very likely the basis of 'us/them' divisions.

The problem with the naïve eye of ordinary people is that they 'reason' showing several fallacies. Let us take dogs. We admire those dogs' behaviours

9 For a review see Chittka, 2017.

that we easily recognize: a dog that follows our ostensive signals (like the gesture of pointing or the gaze oriented in a certain direction) thus showing a basic mind-reading ability, something that for instance apes are not able to do, is easy to acknowledge because it is, anthropomorphically speaking, what we as humans usually do in the same circumstances. But we forget that dogs fail miserably in other simple tasks, like bringing back a stick if they have to pass through a fence. They are not able to orient correctly the stick hold with the muzzle and almost inevitably they quit very soon any further attempt to solve the task, whereas at the same time they are extremely good at looking you pleading for a help. Other species excel in the very same physical problem, as in the case of the squirrel, who can turn around the obstacle without hesitation. In addition, a squirrel can lessen the leash and retrieve some food placed out of reach, whereas dogs tested in the same condition insist to reach straightforward the reward without being able to momentarily go away from it to reach the food container via a different route in a second moment (Barash, 1977). Such a difference depends on the evolutionary pressures that shaped differently the two species (one escaping from predators, the other communicating with us) but these abilities have barely anything to do with a “general intelligence” that could authorize us to order them as one more or less intelligent than the other and more or less intelligent than other species. We also forget that dogs live in a world very different from ours, which is made of smells, and have a spatial mental representation that we cannot even imagine (again, we are in a different *Umwelt*).

There are many instances of nonhuman animals that are plainly superior to humans. For example, even after extended training human beings cannot compare to chimpanzees in eidetic memory (Inoue & Matsuzawa, 2007) or to pigeons in mental rotation (Hollard & Delius, 1982). Arguably, the neural tissue enrolled in eidetic memory or mental rotation in nonhuman animals is recruited for linguistic abilities in the human being. Chimpanzees, pigeons, and humans, each evolved unique abilities depending on the specific need of their evolutionary niche. For humans, the manipulation of symbols has been far more important than being able to remember visual details of a scene or mentally rotate the tridimensional shape of objects, but each of these abilities is an evolutionary adaptation, human language included. In this sense, Descartes missed an important aspect in his claim about the discontinuity between humans and animals (see more on language in Section 3)[10]. In Searle’s words “It is a mistake to treat language as if it were not part of human biology” (Searle 2007, 8). Moreover, this also implies that an animal may appear less capable than others in a domain by virtue of an excellent capability in another domain.

[10] See *infra*, Chapter 12: Susana Onega's contribution to this volume. *Ed. note*.

Even most notably, the ladder-like representation falters in front of results showing that nonhuman animals understand the consequence of their behaviours, because when the value of the goal changes, the behaviour changes as well. A sort of "mental experiment" maintaining the presence of logic in nonhuman animals was used by Sextus Empiricus in his *Outlines of Phyrronism* by reporting that Chrysippus argued that, after having chased an animal and having missed which way the animal went in front of a trivium, the dog would decide which path to follow by sniffing at the first and the second road and then going directly to the third way without further smelling: "The animal went either by this road, or by that, or by the other: but it did not go by this or that, therefore he went the other way". The belief that the dog has "*incredibilis ad investigandum sagacitas* [...] *tanta alacritas in venando*"[11] is an ancient one, and very likely the special logical status of the dogs can be ascribed both to the similarity of behaviours with our responses, and shaped by the domestication (as the ability to interpret the ostensive signals discussed above), and to the need for the dog to understand us and to be understood, in other words to the social pressures that modeled it in our image and likeness[12].

However, the first experimental demonstration in support of rational animals emerged in the 1980s from studies with rats trained with the paradigm of reinforcer devaluation (Adams & Dickinson, 1981). The rats learned to press a lever in order to obtain a food reward and, after the devaluation of the reward (by chemically inducing a mild stomachache in the presence of the reward), they significantly reduced the number of lever pressures to obtain the reward in a later session, thus showing that they expected that the lever-press action had a certain outcome (and should be avoided). If the animals were automata and their pressure of the lever was a mere response automatically elicited by virtue of previous training, then the simple presence of the lever should elicit the pressure response, but this was not the case. Such an elegant and seminal experiment demonstrates that nonhuman animals can respond flexibly to a changing environment.

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[11] Cicero 1972, 2.158.

[12] See Sorabji 1993, 86-89: "Some Stoics [...] denied rationality to animals, but without ascribing their skills to unconscious instinct. There was a certain consciousness of their own persons, liabilities and powers which nature had implanted in them, but which none the less fell short of rationality [...] Why is Chrysippus' dog at the crossroads only virtually reasoning (*dunamei logizesthai*)? It cannot be urged that since the Stoics deny words and concepts to animals, an animal cannot have an 'if-then' appearance [...] Why then do animals not infer? The Stoics' best answer might be that they define reason (*logos*) as a collection of concepts, and they deny that animals have any". See on the point also Floridi 1997 and Ferrini 2002. *Ed. note*.

3. Core Cognitive Continuum

It is easy to list another series of ingenuous obstacles at play when we sort humans from nonhuman animals. The first stringent sign of irrationality attributed to nonhuman animals is that they cannot speak. This is something that animates the minds of both common people and thinkers, like Descartes and Wittgenstein, who based the idea of a rational life on the extensive use of symbols. No matter that most of the species have their own language, whereby they use differential signals to refer to food, or to alert their mates when a predator is approaching either via sky or via ground. The point about language is twofold. On the one side, it is true that nonhuman species did not evolve a communicative system with properties like those that very likely make human language unique (an example is the syntactic recursion (Hauser *et al*., 2002)[13]. Still, antecedents of human language are recognizable in strategies used by other species (Fitch, 2014), and one should ask how much is language responsible for the representation of the world we reconstruct in our minds. To say it with Wittgenstein "If a lion could speak, we couldn't understand him" (Wittgenstein 2008, 190)[14], an idea that Nagel applied to bats when wondering "What is it like to be a bat" (1974) and again refers to the already mentioned *Umwelt*: what it feels like to be a dog, a spider, a cow? All creatures possess senses adapted to their own lifestyle, inaccessible to us, although we share the same environment.

Despite the heterogeneous and disparate perceptual experiences, none is capable of producing a better grasp of reality. All animals, humans included, can only live in a "perceived word" recreated by the brain on the basis of the information collected through the senses; however, although we all live in a representation of the world, such representation is sufficiently realistic to allow the organism to interact with the environment and to face survival challenges. We are all prisoners of the limitation of our cognitive system, and to the best of our knowledge humans are the only species that can share impressions about this world throughout the verbal language; whether the language *influences* our thoughts (a soft version of the Sapir-Whorf hypothesis) is a matter of debate[15]. Then, the possibility exists that, if Wittgenstein's lion could talk, we would

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[13] For a different perspective on the issue see Pinker & Jackendoff, 2005.

[14] By contrast, according to Descartes, we should be able to understand a speaking lion: "And we must not confuse speech with the natural movements which express passions and which can be imitated by machines as well as by animals. Nor should we think, like some of the ancients, that the beasts speak, although we do not understand their language. For if that were true, then since they have many organs that correspond to ours, they could make themselves understood by us as well as by their fellows (Descartes 1985, 140-141). *Ed. note*.

[15] For a review see Kay & Regier, 2006.

certainly understand him, but his mind would no longer be that of the real lion (Budiansky, 1998).

On the other hand, language could be essential to report our internal mental states, and this would, in turn, make it impossible to study nonhuman animals' cognition. Note, however, that infants at the preverbal age present the identical problem of being unable to respond verbally to our questions, or to let us know how they came up with a task solution. To circumvent this problem, developmental psychologists devised some paradigms to test their ability before the linguistic development – even a few moments after birth – discovering that babies possess intuitions about the surrounding environment and act accordingly. In some cases, the tests used with infants inspired comparative psychologists who adapted the same testing situations to other animal species. In this regard, Wittgenstein claimed also that animals and children live in a kind of eternal present. If this would hold true, planning for a future motivational state would be a major discontinuity between human and nonhuman animals. Many times this principle, the so-called Bischof-Köhler hypothesis, has been proposed in the field of comparative psychology[16]. Nowadays, we know that nonhuman animals are not stuck in a world made of one temporal dimension, but they can "mental time travel" in order to select the most appropriate behaviour to succeed in front of the specific occurrent challenge. By way of example, scrub jays are able to provision a compartment otherwise empty the day after or to provision with diversified items two different compartments insuring all kind of food to be available the next morning (Raby *et al*., 2007); bonobos and orangutans can select and keep in a safe place a tool that will be useful in the future to grasp an out-of-reach bottle of fruit juice (Mulcahy & Call, 2006).

There is also a broad consensus on the fact that organisms have no built-in mental content at birth. The influential empiricist notion, of Lockean legacy[17], *tabula rasa* or blank slate (Pinker, 2002) deeply affects people's perception of 'our/their' intelligence. Experience and training would fill in an otherwise empty container: from a purely behaviourist stance, it has been proposed that

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16 For a review see Roberts, 2002.

17 As is well known, in his *Essay Concerning Humane Understanding* (London: 1700[4]) Locke argued that all ideas comes from sensation or reflection by starting to suppose "the Mind to be [...] white Paper, void of all Characters, without any Ideas. How comes it to be furnshed?" (*Essay*, Book II, Chap. I, §2). He also uses the metaphor of the (human) Understanding as a closet wholly shut from light with only some little openings left: "That external and internal Sensations, are the only passages that I can find, of Knowledge, to the Understanding. these alone [...] are the Windows by which light is let into this *dark room*" (*ivi*, Book II, Chap. II, §17). Note that according to Locke "we cannot deny" animals to "have some reason", but only as to particular ideas "just as they receiv'd them from their Senses" (*ivi*, Book II, Chap. XI, § 11), though "the power of *Abstraction* is not at all in them" and they cannot make use of general signs for universal ideas (*ivi*, §10). *Ed. note*.

the behaviour of *all* animals (i.e., including that of humans) can be controlled and shaped throughout the manipulation of environmental factors, as claimed by behaviourism (Skinner, 1938). By appropriately using shaping procedures, nonhuman animals can display complex responses that are modelled by the trainer and really resemble human-like activities; however, soon after such chain of responses has been displayed, the animals' behaviours drift to instinctual species-specific responses, much more adapt to the context, demonstrating that there are patterns of behaviours which are innate and that guide animals' performance and learning (Breland & Breland, 1961). This observation is not limited to instincts in the strict sense of basic reactions to specific external stimuli; rather, it applies to higher forms of cognition coping with a set of ecological challenges underlying nearly all ecological niches. Indeed, animals must interact with other organisms, irrespective of whether they are conspecifics or preys and predators; they must sort living from non-living objects and anticipate the behaviour also of inanimate entities; they must navigate and re-orient in order to find resources and return to biologically relevant places; they must also take quantity-related decisions to detect the largest possibilities for foraging and least risks for rivals' attacks. All these abilities belong to a set of core predispositions that can be ascribed to four domain-specific systems with the following features: they are phylogenetically shared, ontogenetically early, independent from language, culture, and formal training, and at the basis of higher forms of cognitive abilities to the point that deficits in the set of core abilities would affect the typical development with direct consequences on higher abilities.

Almost two decades have elapsed since the proposal of the "core knowledge hypothesis" (Spelke, 2000) which, evolutionary speaking, emphasizes that natural selection prompted not just morphological changes, as we are used to think, but also mental traits variations. When Kant, echoing Leibniz[18], claimed that all our knowledge begins with but not derives from experience,

[18] In his *New Essay* Leibniz had stated the view, *contra* Locke (see *supra* note 17), of the *a priori* principles of certain knowledge actualized by experience in the following way: "Our disagreements concern points of some importance. There is the question whether the soul in itself is completely blank like a writing tablet on which nothing has yet been written – a *tabula rasa* – as Aristotle and the author of the *Essay* maintains, and whether everything which is inscribed there comes solely from the sense or experience, or whether the soul inherently contains the sources of various notions and doctrines, which external objects merely rouse up on suitable occasions, as I believe and as do Plato and even the Schoolmen and all those who understand in this sense the passage in St. Paul where he says that God's law is written in our hearts (Romans, 2: IS). The Stoics call these sources *Prolepses*, that is fundamental assumptions or things taken for granted in advance. Mathematicians call them common notions or *koinai ennoiai*. Modern philosophers give them other fine names and Julius Scaliger, in particular, used to call them 'seeds of eternity' and also 'zopyra' – meaning living fires or flashes of light hidden inside us but made visible by the stimulation of the senses, as sparks can be struck from a steel" (Leibniz 1996, 48-49). *Ed. note*.

psychology was not yet mature to be an independent scientific discipline and to deal successfully with the notion of *a priori* and innate grounds in the subject for representations related to objects which are not yet given in experience[19]. Nowadays, the "core knowledge hypothesis" has gained growing consensus based on evidence from a highly heterogeneous ensemble of scientific fields, including those belonging to the cognitive sciences, a modern label that encompasses also traditional psychology (Lakoff & Johnson, 1999). For instance, it is now well-established that a series of innate competencies support the discrimination of agents from non-living objects (Gelman *et al*., 1983); these include face recognition, dynamical indices of agency and biological motion detection (Spelke & Kinzler, 2007; for a review see Rosa Salva *et al*., 2015). As claimed by the "core knowledge hypothesis", these abilities are essential to cope with the social problems of our environments, co-occurring with the degree of sociability of the single species considered (wasps that have multiple queens – and all compete to become queens – are capable of face recognition whereas species with single-queen colonies are not, provided that they show comparable learning abilities in other visual learning tasks (Sheehan & Tibbets, 2011). And indeed, preliminary evidence already exists that disfunctions in these *a priori* competencies affect developmental trajectories, as shown in this domain for the autistic spectrum disorder (Di Giorgio *et al*., 2016).

The psychological forces subtending agent recognition are complemented by the physical forces ruling, instead, the motion and behaviour of inanimate entities when interacting. The *Gestalt* school of psychology labelled "naïve physics" those untrained common intuitions of the observed physical phenomena that we simply cannot avoid in our everyday reasoning (Bozzi, 1990; Smith & Casati, 1994). To exemplify the myriad of implicit and common sense assumptions accompanying our interactions with objects, we can think of the moment in which we lay our cup of tea over the table (*support*) – not on the edge, lest it falls off (*gravity*): it will move as a single object (*cohesion*), following a linear trajectory (*connectedness*), and we will then need to pull it far away (*force*) to create some space for our pencil since they cannot be in the very same place (*solidity*). The list does not end

[19] See Kant 2001, 312: "The Critique [*scil*. of pure Reason] admits absolutely no implanted or innate representations. One and all, whether they belong to intuition or to concepts of the understanding, it considers them as acquired. But there is also an original acquisition (as the teachers of natural right call it), and thus of that which previously did not yet exist at all, and so did not belong to anything prior to this act. According to the Critique, these are, in the first place, the form of things in space and time, second, the synthetic unity of the manifold in concepts; for neither of these does our cognitive faculty get from objects as given therein in-themselves, rather it brings them about, a priori, out of itself. There must indeed be a ground for it in the subject, however, which makes it possible that these representations can arise in this and no other manner, and be related to objects which are not yet given, and this ground at least is innate". *Ed. note*.

here, but these examples attest that although assumptions of this kind may be over-simplifications, nevertheless they predict the exact outcome of each single physical action; sometimes they could lead to erroneous predictions and are resilient to experience (e.g., Caramazza *et al*., 1981), a reason for the difficulty we may experience with (true) physics understanding. However, these basic features, which are innate (Chiandetti & Vallortigara, 2011), prompt further learning as shown in preverbal infants and children, even while acquiring new words later on during ontogenetic development[20]. The presence of such beliefs in childhood would also explain why it is difficult for infants to understand scientific subjects. Indeed, there is evidence that infants as young as 2.5 months attribute specific physical properties to objects by reasoning in terms of naïve physics (Aguiar & Baillargeon, 1999).

In the domain of spatial and numerical cognition, the finding worth stressing here concerns the performance of Amazonian and Mayan indigenous populations. The Mundurukú, an Amazonian group lacking of formal instruction and specific lexicon to refer to space and numbers, made spontaneous use of concepts like parallelism, angle, and sense relations in geometrical maps when tested for core Euclidean geometry (Dehaene *et al*., 2006); moreover, when tested for basic mathematics, Mundurukús' performance was good when they had to compare and estimate large quantities *via* approximation, whereas it dropped to chance only when they had to compute exact calculations using specific number labels that surpassed their naming range (Pica *et al*., 2004). In a comparable vein, the preliterate and prenumerate Kaqchikel and K'iche' indigenous Mayan groups, when tested for probability estimations, were able to predict the correct outcome using information, proportions and raw combinatorial arithmetic, thus performing in a similar way to Mayan school children and Western controls (Fontanari *et al*., 2014). These results taken together show that there are universal inherited intuitions to cope with spatial and quantitative problems; other studies have demonstrated that gross estimations of the same kind are available to several nonhuman species[21]. Furthermore, at least in the numerical domain, an association has been shown between developmental learning disabilities (like dyscalculia) and an impaired "number sense" supporting judgements of non-equality between sets of elements (Piazza *et al*., 2010; but see Butterworth, 2010). Hence, all criteria posited by the Spelke's "core knowledge hypothesis" have been substantiated for all four domains.

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[20] For a review see Stahl & Feigenson, 2019.

[21] For a review see Vallortigara, 2012.

Man's anthropocentrism has been undermined by recent findings supporting the idea that a soft modularism *sensu* Fodor, like the one described by the "core knowledge hypothesis", defines our neural architecture, and now the time is ripe to increase people's awareness of the cognitive continuum that characterizes all living creatures. I have myself made an attempt in this direction, by devising with some colleagues a short questionnaire in which people were first asked to rate the perceived intelligence of a marine animal, and then they were shown a brief videoclip taken from experimental studies, and demonstrating that the same species possesses a sophisticated ability. Finally, people were asked to rate again the perceived intelligence of the same animal. The results on the first rating confirmed what the past literature has already shown: people believe that organisms are ordered from the simplest (in our survey, the hermit crab) to the most complex (the dolphin). By inspecting the ratings obtained after watching the videoclip, for the first time we have shown that people significantly increased the rate of perceived intelligence, and changed the organization of the species considered from a linear and distributed (ladder-like) to a more compact (tree-like) representation (Chiandetti *et al*., 2018). After realizing what the animals are able to do, people changed dramatically their idea about of how smart these animals can be. We have applied the same strategy to domesticated animals with comparable results, and we are now investigating the role of previous experience by testing students with different backgrounds.

We are convinced that at least over the short term, people can benefit from experiences like those we explored, and future research will unveil whether watching a short videoclip may have longer lasting effects. For sure, our result shows that there is room to overcome dichotomies, along with the idea discussed above for monkeys (Humphrey, 1974) that stereotyping can be targeted by operations that expose adults and infants to the "other" category, being it represented by other animal species, or by other human populations. The possibility also exists that showing nonspecialists the core innate mechanisms, environmentally modulated and at the basis of our ordinary learning, we would exploit a complementary starting point for raising public awareness on animal intelligence.

Discussing natural advantages linked to and evolved for dichotomizing events in no way means to justify any ingroup/outgroup division. But the awareness of all the cognitive limits and the associated risks is a first step to defy stereotyping and slippery discriminations as recently shown in committees' promotion decisions when not openly acknowledging the potential of biased evaluations (Régner *et al*., 2019). It is noteworthy that these implications extend to artificial intelligence, too. Indeed, the machine has to be trained to sort entities into categories; it learns by means of the large number of examples presented, but programmers face the practical peril of instilling prejudices directly into their systems. Only conscious effort to select proper examples would limit the possibility of training machines with biases in order to create technology that will bring real progress and true equality instead of facilitating pervasive discriminations. Whether the strategy used in our survey may apply also to the racial biases discussed above is an intriguing possibility that scientists should explore. Studies where participants confronted human abilities to modify their perception of the 'us/them' dichotomy and overcome prejudices resulted controversial. However, we know that the manipulation of human-animal similarity affects speciesism-related concepts and prejudices (Everett *et al*., 2019). This points to a fundamental collaboration among different disciplines, like comparative and social psychology, that should blend and commingle one another for a unified scope (see Dhont *et al*., 2019 for the role of social psychology).

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