Revista de Humanidades de Valparaíso, 2019, No 14, 139-170 *Humanities Journal of Valparaiso*
DOI: https://doi.org/10.22370/rhv2019iss14pp139-170 eISSN 0719-4242

The question of animal technical capacities

La cuestión de las capacidades técnicas de los animales

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Abstract

The ability to use and make technical artifacts has been considered exclusive to human beings. However, recent findings in ethology in light of observations made in nature and in laboratory show the opposite. In the area of philosophy of technology there are few exceptions that take into account the ability of some non-human animals to manufacture and use tools. In this paper I want to show some reasons to reconsider other possibilities. It seems that capacities such as intentionality, culture or even the complexity of the structures of manufactured object are not exclusive to human beings. I will suggest a different way of analyzing objects created by non-human animals, one that tries to explain the gradualness of the structure, but also the plasticity of the behavior exhibited by non-human animals. These two elements (structure and behavioral plasticity) allow a deeper understanding of the great variety of objects that other animals also manufacture and use.

Keywords: artifact, animal tools, intentionality, ethology, behavioral plasticity.

Resumen

La habilidad para usar y hacer artefactos técnicos se ha considerado como una actividad exclusivamente humana. Sin embargo, recientes descubrimientos realizados en estudios etológicos tanto en la naturaleza como en cautividad en el laboratorio han mostrado que esto no es del todo cierto. En el área de la filosofía de la tecnología hay muy pocas excepciones que tiene en cuenta la habilidad de animales no humanos para manufacturar y usar herramientas. En este artículo se pretenden mostrar algunas razones por las que merece la pena reconsiderar este asunto. Al parecer, capacidades tales como la intencionalidad, la cultura o incluso la complejidad de las estructuras de los objetos creados no son característi-

Received: 01/09/2019. Final version: 03/10/2019

cas exclusivas de los seres humanos. Se sugerirá una forma diferente de analizar objetos creados por animales no humanos, que intente explicar la gradualidad en la complejidad de la estructura, pero que también tenga en cuenta la plasticidad del comportamiento que desarrollan esos animales. Esos dos elementos, estructura y plasticidad del comportamiento permiten una mejor comprensión de la gran variedad de objetos creados y usados por otros animales.

Palabras clave: artefacto, herramientas animales, intencionalidad, etología, plasticidad del comportamiento.

1. Introduction

Research on the behavior of non-human animals is a flourishing scientific area and an attractive topic of media attention. Almost every month, new information is published on the capabilities that humans seem to share with other species. Just a few examples: dolphins (*Tursiops truncatus*) use "learned identity signal" as labels when addressing conspecifics, i.e. they use names to refer to each other (King and Janik 2013); Wild bearded capuchin monkeys (*Sapajus libidinosus*) in Brazil deliberately break stones, producing flakes and cores that have the characteristics and morphology of intentionally exhibited in hominid tools (Proffitt et al. 2016); dogs (*Canis lupus familiaris*) can understand both words and intonation of human speech (Andics et al. 2016); pigeons (*Columba livia*) can learn to distinguish real words from non-words by visually processing their letter combinations (Scarf et al. 2016); sheep recognize familiar and unfamiliar human faces from two-dimensional images (Knolle et al. 2017); ravens (*Corvus corax*) can plan for events unrelated up to 17 hours, exert self-control, and consider temporal distance to future events (Kabadayi and Osvath 2017).

These new scientific discoveries support good reasons to believe that, characteristics such as awareness or sensitivity, self-awareness, knowledge of the mental states of others, sense of humor, sense of the past or future, language, intentionality, personality or even the ability to develop a culture, or to make artifacts (Glock 2009, 160), are no longer exclusive to human beings. Actually, the thesis of the continuity of capacities between non-human animals and human beings could be considered a good explanation of the existence of those capacities.

Taking into account recent developments and discoveries in studies on animal capacities, the definition of what an artifact is, a central theme in technology philosophy, must be reconsidered. Artifacts are considered the cornerstone of the ontology of technological productions, and since the distinction of Randall Dipert (1993) between instruments, tools and artifacts, many other definitions and categories have been suggested. Almost all definitions assume an anthropocentric point of view, considering that only human beings make artifacts or, in other words, because they are an artifact, the object must be made or manufactured by a human being. The arguments to defend human agency are based on the necessary “intentionality” and / or “cultural” or “social” human singularity.

The ability to use and make tools, considered exclusive to the human repertoire, has also been reconsidered in ethology in light of observations made in nature and in the laboratory. However, from the philosophy of technology there are few exceptions that take into account the ability of some animals to manufacture and use tools. Among those exceptions stand out the contributions of Beth Preston (1998), James L. Gould (2007), and Stefano Borgo, Noemi Spagnoletti, Laure Vieu, and Elisabetta Visalberghi (2013).

Here I will analyze these contributions and explore a new way of understanding objects created by non-human animals. The first part of the document summarizes the main definitions of artifacts in philosophy of technology so far, to distinguish the main characteristic that an object must have to be considered a technological artifact. The second part is dedicated to analyzing the contributions of Preston, Gould, and Borgo et al. about no-human animal capacities for making artifacts, and we will discuss its main merits and weaknesses. The third section analyzes whether anthropomorphism is necessarily a fallacious argument, as well as some criticisms of the uniqueness of intentionality and cultural features as human capabilities. The last section will be dedicated to developing an alternative interpretation, based on the behavioral plasticity of non-human animals for the manufacture of complex tools and structures.

2. Artifacts in philosophy

The idea that human beings are exceptional for making and using tools is linked to another attempt to identify the specificity of human characteristics: the uniqueness of the structure and capabilities of the hands. The pre-Socratic philosopher, Anaxagoras, considered that the prehensile hand preceded and gave rise to the development of human mind. Centuries later but in the same vein Ernst Haeckel (1889) upheld that the uprising of the human beings ancestors left the hands free for manipulating or handling the environment, causing the increasing of brain size. Friedrich Engels even considered that the development of the ability to manipulate objects and manufacture tools was prior to the manual labor which is the basis of human society. The thesis of incremental brain size and the manipulation and manufacture of tools was discussed in anthropology, and many British anthropologists (Landau 1993) supported the hypothesis about the priority of large brains before the ability to use and manufacture tools. The debate is still ongoing and there are good reasons to state that “large brains followed the tool”. At the same time, the connection between the tools and the evolution of the brain and the specific capabilities in paleoanthropology is on the basis of distinguishing between different stages in the evolution of human ancestors, and even between different stages in the evolution of human history.

This historical connection between human hands and the development of technology leads to the definition of technological artifacts as a human (and only human) result. It is not surprising that the definitions of tools and, in general, of artefacts in philosophy of technology take human agency for granted.

Several definitions of artifacts in philosophy of technology have been raised over the past three decades. After a long period of focusing on the (exceptional) nature of technological knowledge, or the analysis of the relationships between science and technology, some philosophers turned their attention to the ontological realm and tried to identify what technological creations are. There is a general agreement to refer to these objects as "artifacts", using the term in a general sense and labeling with it a broader and confusing set of concepts, such as tools, machines or instruments. This section focusses on a brief analysis of the most representative proposals.

Almost all definitions of "artifact" in philosophy assume human agency and the intentionality of that agency. Randall Dipert (1993; 1995) distinguished between instruments, tools, and artifacts.

An "instrument" is an object that does not need to have been modified but has a property (recognized by someone) and can be used intentionally as a means to achieve a goal due to that property. "Tools" are objects with intentionally modified properties whose objective is to fulfill a goal, or to make them more effective in fulfilling that goal. Tools have a relational content: the new modified features must be recognized by an agent different from the one who made the modification. "Artifacts" are sophisticated tools that share properties with tools and the ability to communicate their properties. The difference between tools and artifacts is less common in more recent philosophical definitions, where tools are generally considered as a simple type of artifacts.

Riso Hilpinen considers that an object is an artifact if and only if it has an author (Hilpinen 1993, 156-157). The object must be produced by someone. In 1993 Hilpinen the "producer" has to be a human being, with intentions and concepts. However, in 2011 Hilpinen opens the possibility for some animals, using the example of Betty, a New Caledonia crow known for its ability to make hooks using wires. Nevertheless, Hilpinen does not delve into the question and in the rest of the paper continues to deal with artefacts produced by human beings. Amie Thomansson expressly defines artifacts as the result of human intentions to produce something of a specific type (Thomasson 2007). And, in the same vein, defenders of the "dual nature" of artifacts insist on the relevance of human intentionality: technological artifacts are defined by their physical structure, designed for specific purposes, but at the same time, they have functional capabilities. related to human Intentionality (Vermaas and Houkes 2006). Ruth Baker suggests that the uniqueness of the artifacts depends on the intentionality of those who produce them with a specific function (Baker 2006, 132). Functions define and constitute the identity of artifacts and make them as recognizable and distinguishable objects. On the other hand, these functions cannot be reduced to the material properties of the object.

Another group of definitions emphasizes the social aspect of artifacts, a characteristic that is generally considered exclusive to human beings. According to Trevor Pinch and Wiebe Bijker, artifacts can only exist in social collectives (Bijker et al. 2012). In their famous example of the development of bicycle design, they show how the construction of technological artifacts is the outcome of a social process that is affected by the interests of different social groups: users, designers, producers, etc. John Searle (1995) defended that a physical entity has a status of artifact if and only if its institutional state is accepted, which is based on the intentional use of its functions. Marcel Scheele (2006) suggests that in order to understand the functions of artifacts we need to include the social environment, otherwise it is difficult to distinguish between proper and accidental use of artifacts. And Maarten Franssen (2006) analyzes social aspects of artifacts from a normative point of view: an artifact is a good artifact if it works correctly and can be used for the purposes for which it was designed. The normative judgment for being a good artifact depends on an institutionalized fact.

According to these definitions, the main requirements for an object to become an artifact are: (i) some mental abilities (mainly intentionality) of those who create those objects; (ii) social or cultural organizations that allow a normative interpretation of the functions of these objects; (iii) and a production process (in the sense of a chain of actions) that results in the object. That said, are those characteristics exclusively related to human beings?

3. Non-human animals artifacts

There are very few exceptions to this traditional consideration about technological artifacts as products of human agency. In this section I will analyze the contributions of Preston, Gould and Borgo et al.

3.1 Preston: equipment

Preston (1998) considers the definitions of "tools" and "use of tools" as they are conventionally used among ethologists, and suggests a different theoretical framework based on the notion of Martin Heidegger's equipment (*Zeug*) as a substitute for which she considers "popular categories". Preston maintains an explanation that does not isolate the object or behavior associated with the use of the object, but rather connects them with a history and context of use (Preston 1998, 516). For example, identifying a stone as a tool will depend on the previous use of the stone. If someone takes a specific stone and uses it to open a nutshell or nail a nail, the stone has become a hammer. As soon as the stone is discarded, it becomes a natural object again. However, if the user decides that the stone meets some requirements and maintains it for future use, the stone will remain a hammer, because "the actual use determines what kind of tool it is" (Preston 1998, 517). In the case of artifacts, to the extent that they are manufactured, designed for a specific use and with a standardized form, they can be identified as tools, even if they are never used. But, to identify those objects in the category of artifacts (to *individuate* them, in Preston's terms) it is necessary to know what people do with things of a certain type.

Preston criticizes the definition of tool use proposed by Benjamin Beck in 1980, well known among ethologists[1]. From Beck's perspective, the use of tools is a behavior that involves an external object that must be manipulated and effectively oriented by the animal when using it. However, from Preston's perspective, the notion of tool use is not a good starting point. She suggests a different possibility, based on Heidegger's framework of *equipment* and *practical activity.* Heidegger strongly opposes the distinction between subject and object that comes from the Cartesian tradition, as well as that some mental abilities such as intentionality or representability close the gap between subject and object. From Heidegger's perspective the subject-object relationship has to be understood in terms of being-in-the-world. *Being* is divided into two: human-being (*Dasein*), and non-human being. The non-human being in turn is divided into *Zuhandenheit* and *Vorhandenheit,* "readiness-at-hand" and "presence-at-hand". Those things that human beings encounter in everyday practical activities, like tools or materials, are called in Heidegger terms *Zeug,* commonly translated as "equipment". The equipment is functionally constituted, is something useful and is used to do something.

So, there is nothing like an *equipment*, or a *useful* thing, but "useful things always are *in terms of* their belonging to other useful things. […] A totality of useful things is always already discovered *before* the individual useful thing" (Heidegger 1927/2010, 69). In order that an object actually functions as a useful thing, it has to fit into the context of a meaningful activity. Things become equipment on the basis of their functionality, therefore functionality is a defining feature of equipment, and equipment is what it is only when is actually used.

Function can only be understood by manipulation, and for Heidegger to understand something is impossible without the prior use of a thing. Therefore, "even though the

[1] Beck, in a more recent reedition of his 1980 book (2011), has slightly changed the definition: "Our present definition of tool use is: The external employment of an unattached or *manipulable attached* environmental object to alter more efficiently the form, position, or condition of another object, another organism, or the user itself, when the user holds *and directly manipulates the tool* during or prior to use and is responsible for the proper and effective orientation of the tool." (Shumaker, Walkup and Beck 2011, 5) (in Italics the differences)

functioning of a piece of equipment becomes available through manipulation, our understanding of equipment also depends on social norms and conventions for how things are normally used" (Susi and Ziemke 2005, 10).

Preston is aware that the application of Heidegger's proposal of equipment to non-human animals has to face some difficulties. First of all, Heidegger's *Dasein* refers only to human beings, setting aside (in the same category) stones, plants, or non-human animals. Secondly, the "they" responsible of cultural norms are other human beings. And, even if today the idea that animal culture exists is controversial, in Heidegger's works it is not even a possibility. However, Preston considers that Heidegger's notion of equipment can also be applied to the case of other animals, because the difference between human beings and animals is a matter of degree and not an absolute difference. (Preston 1998, 537-538). Actually, many ethological studies have shown that "at least some non-human animals may have rudimentary cultures in exactly the same sense that humans do" (Preston 1998, 538). And, about norms, Preston points out that philosophers and scientists in biology and behavioral sciences often use the concept of function, a normative term.

On the other hand, if something can be part of the equipment, to the extent that it is used that way, and the notion of equipment is not limited to portable things, then if a hammer is part of the equipment, the anvils are too. But Heidegger was thinking about Dasein, so the equipment is always relative to the functions attributed to manipulation and culture, and those things that animals use are not equipment in the same sense. An anvil is always an anvil, even when an elephant uses it as a hammer (Preston 1998, 542).

Another consequence of the notion of equipment is that everything that is used for a purpose is part of the equipment, therefore, if houses are equipment, then nests are equipment. So far so good. But if trees are used for climbing, then "the ground you walk on and the air you breath must also qualify as equipment on this account. This difficulty is due to the tendency of any function-based theory to generate continua" (Preston 1998, 543).

3.2 Gould: Artifact

Another author who deals explicitly with artifacts and animals is Gould (2007). In a collective book about the creations of the mind, Gould begins his contribution by asking "What is an animal artifact?" Gould does not use any of the different definitions proposed, but he raises his own definition "I will take an artifact to be any creation on the part of an animal, using/or modifying available material, which is useful to it or its offspring." (Gould 2007, 249). Not every kind of creation is taken into consideration, but those "that most human find impressive" (Gould 2007, 149). All of them "creations of the mind", or better said, "created by instinct" (Gould 2007, 149).

Gould distinguishes between three main categories depending on the purpose of the animals (common among the ethologists' classifications of "tool use"): (i) artifacts used for hunting, foraging, or processing food; (ii) artifacts employed for protection or as homes; and (iii) artifacts used to attract members of the opposite sex. Gould's classification also addresses two other criteria in addition to the purpose: the phylogenetical order, and the materials used for constructing the artifact (animals' secretions like silk, wax, saliva; stones, shells, dried mud/clay; and vegetation). But those criteria are used carelessly.

It also includes tools such as a different category among artifacts used to hunt and search for food, again using the Merriam and Webster dictionary for the meaning of "tools".

He does not consider the definition anthropomorphic (although the instrument must be used or worked by hand, or at least used to perform an operation or necessary to practice a vocation or profession). Gould concludes that eyes, fingernails, teeth and Wernike's area in the brain qualify as tools. Actually, as Gould points out:

> […] if we hold tool artifacts to a stricter standard for animals […], and require that the tools be modified in some non-trivial way […], then the list becomes dramatically shorter. […] I know of only one clear case: the hook and the step-cut tools carefully crafted by the crows on New Caledonia for removing insect larvae from branches. (Gould 2007, 252)[2]

Gould's examples are controversial and are generally discarded by many ethologists, to the extent that they can be slippery slopes, leading to accepting as artifacts some hard-to-classify by-products.

For example, Gould considers a spider web or the cocoon of silkworm as artifacts, one for hunting and the other one for protection. These things are not considered artifacts or even tools among ethologist, as far as the object has to be inanimate, not internally manufactured, and unattached to the environment, to be a tool. If we consider spiders' web or caterpillar cocoons as artifacts, then the nails could be considered artifacts when they are used for screwing, or the eggs shell, or even the placenta, are artifacts for protecting the embryos.

Another problematic question on Gould's paper is his consideration about the cognitive capabilities of those animals able to use and made artifacts. Whereas he considers that "methods of artifact production in animals and in humans are to some degree linked, rather a result of a separate creation" (Gould 2007, 266), he deals merely in the conclusions with the difference between innate and inborn instructions, and more flexible, goal-oriented systems. Arranging into the same broad category every kind of artifact manufactured or used by a non-human animal.

[2] Actually, the list is longer than Gould presupposes, and at the list ethologist have add chimpanzees (*Pan troglodytes*), orangutans (*Pongo pygmaeus*), and woodpecker finches (*Camarhynchus pallidus*), that will be discussed latter.

3.3 Borgo et al.: Naturefacts

Borgo et al. (2013) explore if a philosophically-inspired definition of physical artifact developed by human could be applicable for some tools used by Capuchin monkeys (New World monkeys of the subfamily *Cebinae*). Those monkeys are famous for their ability to use hammers and anvils to open nuts. Borgo and Vieu (2009) suggest a definition for physical artifacts that goes beyond the usual definitions of artifacts, including "objects of nature" as those objects intentionally selected for use with a purpose, while to be an artifact, the object must be physically modified. Spagnoletti and Visalberghi study Capuchin monkeys on the wild and in captivity as well. The main argument of the paper is that the notion of artifact is not specific to the human being, a conclusion reached on the basis of behavioral studies, since capuchin monkeys show behaviors that could be interpreted as intentional.

The main limitation, in their own words, is the "behavioral" point of view. If the essence of the artifacts depends on the intentionality, necessary when selecting, modifying and using objects for a purpose, then it is necessary to face the problems associated with the attribution of intentionality to non-human animals.

Capuchins are well known for their use of hammers and anvils to break shells, however, they generally do not manufacture those objects: they choose among the different possibilities those that are most suitable for the operation. Among the monkeys they are the best tool users, their abilities being similar to those of chimpanzees. (*Pan troglodytes*). Actually, and as Borgo et al. point out, they have been shown capable of transferring relations from one situation or set of objects to a different one, using analogical reasoning, applying relational structures in tool using tasks and being sensitive to the function properties of the tools (Borgo et al. 2013, 378). The observations of tool use by capuchins in the wild suggest that "the ability is acquired, requires intentionality and can be taken as cultural trait of some groups" (Borgo et al. 2013, 379). And even more than that: anticipate future needs, remember items that are out of sight and plan the course of action (ibid). The evidence of the intentionality of Capuchins comes from the observed behavior, for example, when they select stones of the appropriate material and the weight considering the purpose: cracking open nuts, or other encased foods, less resistant than the nuts. Capuchins need to acquire these skills during their lives, that is, these are not innate behaviors: Capuchins have to learn by practicing to select the right object.

Among them "efficiency in cracking nuts with tool varies widely among wild capuchins" (Visalberghi and Fragaszy 2013, 210). They are able to classify artifacts, distinguishing between anvils and hammers, and between them by functional and non-functional characteristics, by their purpose and even by the context.

In this sense the theory of naturefacts upheld by Borgo and Vieu of *attributing* capacities to objects and not necessarily *manufacturing* them could be applied to the case of the Capuchins. However, they say, there are other characteristics of the artifacts that are lost in the case of the Capuchins, such as the transmission of skills information among the conspecifics, that is, teaching, essential in the case of human artifacts.

On the one hand, both Preston and Gould maintain a very open categorization of non-human animal artifacts: all kinds of objects used by them with a function, including some parts of the organism or parts of the environment. In that big category Preston and Gould do not distinguish, for instance, those objects that are crafted from those that are just used without modification; or those that are crafted or mastered after long periods of trial and error learning process from those that are made instinctively in a parsimonious way; or those that are crafted by a community instead only by a single individual. On the other hand, Borgo et al. (2013) apply the notion of naturefacts in a very limited way. This characterization, based on the observation of the behavior of Capuchins using tools, is restricted to a single species and to those objects selected and not designed to perform a technical action.

4. Exclusive features?

With the exception of these three papers, philosophical definitions of artifact avoid the consideration of those objects used or made by non-human animals. This oblivion, more or less conscious, shows an anthropocentric prejudice, originated by the philosophical assertion that the behavior of animals, however complex, is never the result of a mental process. On the ethologists side the situation is slightly different: the strategy of including every object used or made by non-human animals in the same broad category, probably tries to avoid an accusation of anthropomorphism. In any case, the defense of the human exclusiveness of certain characteristics it is being challenged. The following sections summarize the main arguments in favor of the supposedly human capabilities that seem to be shared with other species.

4.1 Anthropomorphism and Anthropocentrism

The claim that anthropomorphism is a fallacious argument was made in order to identify and rule out anecdotalism, such as when Darwin and Romanes were trying to establish the continuity of human and non-human traits and proposed that some non-human traits should be understood using traits possessed by humans. Anthropomorphism is defined as "the attribution of human traits, specifically human psychological traits, no non-human." (Fitzpatrick 2008, 235), or more precisely "the attribution of human psychological, social, or normative properties to non-human animals" (Andrews and Huss 2014, 711).

However, in principle there is nothing wrong with attributing human properties to nonhuman animals. As Keeley (2004) has pointed out "we simply cannot know a priori whether a given human trait is or is not uniquely human, or whether a given species shares any human traits" (Keeley 2004, 533). In the same vein Fitzpatrick points "This [anthropomorphism] in itself, is not a mistake, since humans surely do share many psychological traits with other species." (Fitzpatrick 2008, 235). The problem arises when we attribute human psychological characteristics to non-human animals with lack of evidence, that is, when it is possible to maintain a better explanation backed by non-anthropomorphic evidence.

On the other side, considering that human mental properties are not shared with of other animals has received different names: anthropocentrism (Fisher 1996, 7), reverse anthropocentrism (Keeley 2004, 535), anthropodenial (Sober 2005, 85), theoretical conservatives (Fitzpatrick 2008, 228), and anthropectomy (Andrews and Huss 2014, 720). Fisher identifies Donald Davidson as a tough anthropocentrist, as far as Davidson suggests "those who are inclined to ascribe thought to animals on the basis of their purposive behavior are anthropomorphic." (Fisher 1996, 7). All of them agree with cognitively sophisticated anthropomorphic explanations instead of accepting cognitively unsophisticated explanations that can be equally backed by data. (Sober, 1998).

Morgan's Canon was suggested to avoid the anthropomorphic fallacy. It is widely defended in animal psychology, and states that: "In no case may we interpret an action as the outcome of the exercise of a higher psychical faculty, if it can be interpreted as the outcome of the exercise of one which stands lower in the psychological scale" (Morgan 1894, 53). The Canon has generally defended by the simplicity it poses. However, some authors (Fitzpatrick 2008; Sober 1998, 2005) have criticized by arguing that Morgan's canon is not really a principle of simplicity. The Canon cannot connect with the principles of parsimony (posting fewer things): "Morgan's Canon, however, asks us to prefer theories that posit processes that come lower in the hierarchy of cognitive sophistication rather than theories that posit fewer things" (Fitzpatrick 2008, 230). On the other hand, Morgan argued that the simplest explanation for the behavior of an animal is the most anthropomorphic one (Morgan 1894, 53-54), since it is simpler to explain animal behavior in the same terms as we would do if the behavior were exhibited by a human being. Another criticism against Morgan's Canon comes from the idea that there are "higher" and "lower" psychical faculties. Today, modern theorists prefer to refer to the relative sophistication of the cognitive processes (Buckner 2013).

As an alternative to Morgan's Canon, Fitzpatrick suggests evidentialism:

> in no case should we endorse an explanation of animal behavior in terms of cognitive process X on the basis of the available evidence if that evidence gives us no reason to prefer it to an alternative explanation in terms of a different cognitive process Y –whether this be lower or higher on the psychical scale. (Fitzparitck 2008, 242)

And Buckner proposes to recover Hume, when he detected the bias in rationalists like Descartes. Buckner names Hume recommendation "Hume's Dictum", which argues that when assessing whether a certain psychological capacity is shared between humans and animals, we must adopt competence criteria that can be applied fairly to both (Buckner 2013, 865).

4.2 Intentionality

Philosophers have usually argued against the mental capabilities of non-human animals. The main argument about the lack of intentionality in other animals depends on our unique capacity for a symbolic and articulated language. Davidson (1985, 1999)[3], argues that in order to have intentional states it is necessary to be able to have internal representations, i.e. intentional states happen in an intensional context. Therefore, since animals cannot have propositional attitudes, they cannot have intentional states.

Malcolm, in a classical defense of the attribution of intentional behavior to another animal (Malcolm 1972-1973, 13), suggested the following example: let's suppose that we see the dog of our neighbor chasing our cat. The cat runs at full speed to the garden's oak, but suddenly and surreptitiously she changes her trajectory and climbs to a close maple. The dog does not see the maneuver and when he arrives to the oak puts his front paws on the oak and barks to the branches over him. Malcom defends that if we have been seeing the scene, then we are justified to think, "the dog believes that the cat has climbed the oak". Nevertheless, Davidson admits it could look like a plausible explanation, but insists that *sensu stricto* the dog cannot believe anything, because he has not language.

Other philosophers, as Daniel Dennett and Fred Dretske, have claimed the intentionality of the behavior of some animals. Dennett distinguishes between different orders of intentionality or intentional attributions, going from zero-order intentionality, when the creature does not have any intentional states like beliefs or desires at all; first-order intentionality, when the creature possesses beliefs, desires or hopes, but the content of the states does not contain intentional components —i.e. they are only about behavior—; second order intentionality, when the creature has beliefs and desires about beliefs and desires; and third order intentionality, when the systems have intentional states like "a wants b to believe that a believes that he is alone". Dennett adopts the strategy known

[3] "Neither an infant one week old nor a snail is a rational creature […] we may say of the infant from the start that he is a rational creature because he will probably become rational if he survives, or because he belongs to a species with this capacity. Whichever way we talk, there remains the difference, with respect to rationality, between the infant and the snail on one hand, and the normal adult person on the other […] The difference consists in the having of propositional attitudes such as belief, desire, intention and shame. This raises the question how to tell when a creature has propositional attitudes; snails, we may agree, do not, but how about dogs or chimpanzees? The question is not empirical; the question is what sort of empirical evidence is relevant to deciding when a creature has propositional attitudes […] language is a necessary concomitant of any of the propositional attitudes […] belief depends on having the concept of objective truth, and this comes only with language." (Davidson 1982, 317)

as "intentional stance", which consists "of treating the object whose behavior you want to predict as a rational agent with beliefs and desires and other mental stages exhibiting what Brentano and other call intentionality." (Dennett 1981, 151). Dretske considers that some animals are agents because they act, not just behave. He uses the example of some foraging birds that distinguishes some nasty tasting butterflies, and even they can mistake different species of butterflies because of their similar appearance. Dretske maintains that to explain the bird's behavior in terms of what it believes:

> it is natural because memory about some previously experienced object is so obviously implicated in why the birds behaves the way it does […] Unlike the thermostats or the Scarlet Gilia [a kind of plant] things that happens to the particular system relating to the success of its behavior is relevant to its future behavior. (Dretske 1999, 28)

Hans-Johann Glock has also discussed Davidson's radical proposal, and he suggests another cannon (less demanding than Morgan's cannon): "we only should attribute higher order capacities to an animal if that is the best explanation of its behavioral capacities. That cannon rests on a gradual classification of the mental capacities, which go from those of higher order to the lower ones" (Glock 2009, 79). Glock prefers to refer to "thoughts" instead of "propositional attitudes", and defends that some animals without language may have concepts, these being of a simple type. And instead of "mental representations", he suggests using "cognitive abilities", among which the cognitive ability to "discriminate" stands out, something that many non-human and languageless animals have. The Malcolm example dog recognizes the tree and distinguishes it from other objects, and this is where the concepts arise in the Glock argument: if the dog is able to recognize the tree (taking into account some of its features), it is because he has a "tree" concept. On the other hand, if an animal has the capacity to be right or wrong about the world, it is because that animal has beliefs. Since animals have no language, they cannot offer expressions that express their beliefs, but we can infer those beliefs on the basis of some behavioral attitudes, even some facial expressions that some animals share with us. Concepts are discriminatory principles (between different possibilities), therefore having concepts is the same as having the capability to recognize between different kinds of things (Price 1953, 355; Dupré 1996, 331), something that we can confirm with observations of animals' behavior in the wild and also in captivity. Animals have the ability to distinguish between colors, flavors, noises, shapes, quantities, types of creatures, etc., skills they need to learn, they are not innate (Tomasello and Call 1997, caps. 4-5). On the other hand, we must establish gradual differences between different species. Although some species have the ability to distinguish between different objects, this does not mean that they all have the same abilities to possess discriminatory or classifying concepts (for example, bees have the ability to distinguish between different flowers, but it is not the same as saying that they have the concept of different flowers).

The difference between the ability to distinguish and the ability to discriminate conceptually between different things can be useful to understand the difference between the use of objects and the manufacture and use of artifacts by some animals. The ability to use objects that distinguish between different possibilities could be explained as simple mechanisms, innate dispositions or skills acquired by trial and error or more complex learning processes.

4.3 Culture

The other main reason to defend that artifacts are the exclusive result of human agency is the social and cultural uniqueness of human beings. Culture has traditionally been considered as one of the most important characteristics of humankind, and as intentionality, exclusive of human beings. However, the thesis on the existence of animal culture has attracted some adherents. The tradition of considering some animal capacities as social has a long history. For example, Aristotle points out that birds learn socially to sing. Charles Darwin on *The Decent of man* (1871) argues that animals learn by experience, but also by imitating the behavior of other animals. And in the same vein, C. L. Morgan, believes that organisms can survive in challenging environments because they acquire knowledge and skills learned from others. However, the real debate about animal culture begins in the mid-twentieth century, when some Japanese researchers began to document traditions among free-living animals[4]. Since then, the number of documented examples of socially learned behaviors among non-human animals has increased exponentially.

Nevertheless, there is no agreement between specialists if the capacity for social learning is sufficient to establish that a group of animals of a species has culture. As Laland and Galef (2009) suggest, there are several reasons for different opinions. “Part of the disagreement over animal culture reflects definitions issues. Biologists […] seemingly tend to employ less exacting definition that do anthropologists […], and psychologists often take an intermediate position between the two” (p. 9). For instance, John Tyler Bonner defined culture as “the transfer of information by behavioral means” (Bonner 1980, 9), and considered that invertebrates exhibit rudimentary culture. Another example of this broad consideration of culture is the one advocated by Charles Lumsden and Edward Wilson (1981), who attributed culture to some 10.000 species (including bacteria). On the other hand, there are researchers (such as Galef or Tomasello) who demand traits similar to those exhibited by humans, such as teaching, specific group norms or even ethnic markers to have a culture. With such demanding requirements, it is difficult to maintain that there are other species, different from human beings, with culture.

[4] Such as Imo, a Japanese macaque that started to wash sand-covered sweet potato in freshwater on Koshima Island. Twelve years later, other macaques from the Imo’s group showed the same behavior, a clear example of socially learned behaviors.

Another reason for disagreement:

> concerns the kinds of evidence sufficient to establish that differences in the behavior of geographically separated populations of species result from social learning rather than from genetic differences between populations or differences in the way diverse ecologies shape behavioral development of individuals. (Laland and Galef 2009, 9)

For instance, McGrew and Tutin (1978) were the first to show different cultural patterns between a troop of chimpanzees in Kasoge (western Tanzania) and another troop observed at Gombe, 50 kilometers from Kasoge. Years later, McGrew with some other colleagues, edited *Chimpanzees Cultures* (1992), where they showed a large number of examples of variations in chimpanzee behavior repertoires. In the same line, but with other species, go Schaik, Ancrenaz et al. (2003) (orangutans); Perry, Panger et al. (2003) (white-faced capuchin monkeys), or Krützen et al. (2005) (bottlenose dolphins), showed evidence of behavioral repertoires of many large-brain mammals that lived in different places, which they explain with the hypothesis of being species with culture. But, in any case, there is enough evidence to maintain, that there are at least many other species capable of learning and imitating socially, and human culture and animal behavior traditions, if not homologous, are at least analogous (Galef 2009).

5. Animal tools

Of the three characteristics that an object has to fulfill in order to become an artifact, the materiality of the object remains essential: the result of the production process must be an object. In the case of objects produced by non-human animals, specialists refer to them as “tools”.

There are several definitions and classifications of “tool use” in ethology. Everyone agrees that the tools have to be external objects to the animal that uses them, avoiding the possibility of using the animal’s own organs, even when they use them functionally (like, for example, aye-aye’s amazing finger *Daubentonia madagascarensis*, used as a hook to hunt worms inside tree barks). Boswall and Beck explicitly say so: tools have to be an unattached (or manipulable attached) environmental object (Boswall 1977a; 1977b; 1978; 1983; and Beck 1980). Most definitions agree that the object has to be dynamic (Van Lawick-Goodall 1970, 195; Alcock 1972, 464; St. Amant and Horton 2008, 1203; Bentley-Condit and Smith 2010; Shumaker, Walkup and Beck 2011, 5), i. e. the animal has to use it dynamically. However, those who wish to include things like bird or insects nests do not agree with this feature (Pierce 1986, 96). Similarly, there is a general agreement that internally produced objects, such as spider webs or silkworm cocoons, cannot be considered tools *sensu stricto* (except Gould 2007, which defend otherwise). The most comprehensive classifications of “tool use” have been done by Bentley-Condit and Smith (2010), and Shumaker, Walkup and Beck (2011). Bentley-Condit and Smith suggest a classification of ten categories, which distinguishes between different activities that can be done with these tools. Therefore, tools are classified taking into account their function and not their shape, structure or physical characteristics. Similarly, Shumaker, Walkup and Beck, classify using the same argument, but their classification is broader and suggest 22 ways to use tools.

There is a general agreement between the different definitions and classifications: an object becomes a tool when used with a purpose and a function. Nevertheless, considering the purposiveness of an action creates many difficulties. Is it possible to distinguish between the "use with a purpose" of a chimp and the "use with a purpose" of an ant or a wasp? Is purposiveness the same as intentionality? And, in that case, is every "tool use" behavior be intentional?

But there is another way to address this problem: consider the relationships of living beings and their environment on an ongoing basis. All living things are part of an environment and exchange energy, as well as other products and by-products with their environments. In that sense, each living being is an agent in their respective media. In those exchanges, the media and the agent modify each other[5]. In some cases, these exchanges with the media are carried out using and modifying the media for a specific purpose. Establishing whether the purpose is technical or not is a matter of the agent, how this agent uses the object and for what purposes. For example, the difference between a technical artifact and an artistic artifact depends mainly on the use of the object: a ceramic vase can be a container for transporting liquids, or a work of art if the same vase is contemplated inside a cabinet in a museum. The environment of use of the object has changed, and also the agents that use the object. In that sense, the physical object can be the same, but the relationship of the object with the agent or agents, as well the purpose of the object, are different.

Here I would like to explore this approach, taking into account the idea of the agency of living beings in their media, to have a better understanding of the artifacts used and manufactured by non-human animals. Based on this explanation, I suggest a gradual differentiation between the different types of objects used and manufactured by non-human animals. This gradual differentiation is based on two axes: one is the "complexity of the structure" of the object and the second the "behavioral plasticity" of the agent to modify

[5] Just two examples to illustrate those changes: "the origin of oxygenic photosynthesis in Cyanobacteria led to the rise of oxygen on Earth ~2.3 billion years ago, profoundly altering the course of evolution by facilitating the development of aerobic respiration and complex multicellular life." (Soo et al. 2017, 1436). Or the modification of the landscape by beavers: "beaver dams can create a series of impoundments in streams that stretch for kilometers in otherwise dry landscapes, dramatically altering streamside and floodplain vegetation." (Pilliod et al. 2018, 58). Human beings also altered the environment, in larger scale than beavers but not than Cyanobacteria.

the environment. Some artifacts may exhibit a very complex structure, but they have been manufactured on the basis of a fixed and innate behavior, while other artifacts with a simpler structure are produced by a more flexible behavior developed by the agent.

5.1 Axis 1: The structure

Taking into account the first axis of the structure, for an object to become a technical artifact, it is necessary for an agent (or a group of agents) to identify that object by its special structure to perform a specific function. There are three possibilities: (i) the object is not structurally modified, that is, it is only discriminated between other objects due to its special characteristics (a naturefact in terms of Borgo and Vieu); (ii) the object is an artifact created by the modification of materials found in the environment; (iii) the object is an assembled structure that uses different types of materials (nests).

(i) Examples of objects used as artifacts but non structurally modified:

- Small pieces of soil or small pebbles thrown by the two-colored Conomyrma ants at the entrance of their rival ants' nests.
- Small pieces of soil thrown by the ants *Tetramorium caespitium* to the entrance of the *Nomia melanderi* bees' nests that are attacked and eliminated when they go out of the nest.
- Stones that sea otters (*Enhydra lutris*) put in their thorax to open mollusks like mussels (observed by Hall and Schaller in 1964).
- Rock used as an anvil to open a cockleshell by black spot tuskfish (*Choerodon schoenleinii*) (Jones et al. 2011, 865).
- Stones, pieces of land, branches and grass that elephants (*Loxodonta africana and Elephus maximas*) throw to attack, explore and, perhaps, play.
- Pieces of bread or other discarded food (which humans throw away) that herons (*Butorides virescens and Butorides striatus*) use as bait to fish for fish (in this case, these objects have been made by another species, Riehl 2001).
- Sponges from the bottom of the sea that the dolphins in western Australia select and put on their rostrum for foraging on the sand looking for food (Krützen et al. 2005).
- It is worth mentioning those naturefacts that are used repeatedly by the same animal, and saves it for future use. Tai chimpanzees, for example, use some stones to break nuts, and those that fit especially well for that purpose are kept for future uses. (Boesch and Boesch 1990, 97). And similarly, those capuchin monkeys analyzed by Borgo et al. 2013.

(ii) The second type of objects are the result of materials that have been modified (manufactured) to be used for technical purposes. So far, ethologists have identified four species of non-human animals that can manufacture tools: chimpanzees (*Pan troglodites)*, orangutans (*Pongo pygmaeus*), New Caledonian Crows (*Corvus moneduloides*), and Woodpecker finches (Cactospiza pallida).

- Chimpanzees were the first non-human animals observed in freedom using objects made by themselves. Goodall in 1964 saw a group of chimpanzees in Gombe using modified tree branches to fish termites. Later, other groups of chimpanzees (in Gomeb, Mahale, Täi, Bossou and Goualougo) were also observed using other kind of tools, like stone hammers and anvils, tree branches for dipping honey, or leaf sponges for drinking water (Sugiyama and Koman 1979; Boesch and Boesh 1990; Sanz et al. 2004). There are differences between the groups in terms of the type of tools used, depending on the family and the environment in which they live. Some researchers (Boesch 1996; Möbius et al. 2008) conclude that these differences are based on cultural features.
- Another species that have been studied are the orangutan (van Schaik et al. 1996). A population of Sumatran orangutan modify and use trees branches to access to insects and to the Neesias seeds (a kind of fruit with hard and irritating shell).
- Hunt and Gray (Hunt 1996; 2000; Hunt and Gray 2002; 2003; 2004) have studied the Crows of New Caledonia, impressive users and creators of tools. They have the ability to make some objects to extract worms from bark trees. They select among the branches and leaves of the trees and give them three-dimensional shape. They are able to perform these actions in a very similar way to hominids, with a high level of standardization in manufacturing, high levels of skill in production and cumulative changes in the design of objects:

  > They (i) selected a fork formed by, usually, two twigs; (ii) broke off one twig just above the junction (side twig), then discarded it; (iii) broke off the remaining twig just below the junction (tool twig); and (iv) carried out fine sculpting of the hook on the tool twig with the bill, in between removing the compound leaves. The sculpting removed small pieces of wood from the hook, which refined and sharpened it. (Hunt and Gray 2004)

- The Woodpecker finches also manufacture objects. In this case, those birds modify twigs and prickles for extracting arthropods from holes or cracks in the barks. They shape these objects, shortening or cleaning them from the lateral branches that prevent proper and efficient use (Tebbich and Bshary 2004). 50% of the food that they eat during the dry season is obtained with the use of those hooks.

(iii) As I mentioned, the most common classifications of animal tools do not include nests. The reason argued is that "nests are not manipulable" (Shumaker et al. 2011, 9). I agree that to consider an object as a "tool", it must not only be used for a purpose, but must also be manipulable to modify the environment with it. However, if we expand the category to include sets of materials, which have a specific structure to fulfill some functionalities, then nests must be included. Opening the door to nests as artifacts built by non-human animals results in a large number of cases in many different subgroups: from the best-known examples of nest built by birds and insects, but also by mammals, amphibians, fishes, reptiles, and spiders. An interesting feature that the nest can have —and almost none of the tools mentioned so far— is that many nests are built by more than one agent. Nests generally involve the collaborative work of more than one agent and, in many cases, a large number of agents. Only a few examples are described below:

- The Potter wasp (in the family of *Eumeninae*) are solitary wasps that can build nest with the shape and appearance of pots. Those nests can have one or several individual brreding cells. The building material usually is mud made of a mixture of soil and regurgitated water, but other species also use chewed plant material. "Their nests have unusually thick outer walls that might function both as waterproofing and as fortification against predation and females will assiduously repair experimentally induced damage" (Matthews et al. 2018, 93).
- The nest of the honey bee (*Apis mellifera*), is built by the workers of the colony, and the internal structure is very complex: a densely packed group of hexagonal prismatic cells made of beeswax. Those cells are used to store food (honey and pollen) and to house the brood. "The honeybee hive retains heat and moisture and, during winter, can maintain a temperature differential as great as +59º" (Pierce 1986, 100).
- The nests of Macrotermes termites of Africa:

> the labyrinthine internal structure of these termitaries has been designed in the course of evolution to guide a regular flow of air from the central fungus gardens, where it is heated and rises by convection […] the architecture is so efficient that the temperature within the fungus garden remains within one degree of 30º and the carbon dioxide concentration varies only slightly, around 2 .6 percent. (Wilson 1975, 11-12)

- The Leaf-Curling Spider (*Phonognatha graeffei*) weaves a leaf or other object in the center of its nets as a hiding place for birds and other predators. The leaves curl to form a funnel that the spider uses to hide inside (Thirunavukarasu et al. 1996, 187).
- The male of the three spine stickleback fish (*Gasterosteus aculeatus*) builds nests with small pieces of plants woven into round nests with an opening on one side. They are held together by a secretion of the male's kidneys. Sometimes the nest is built on plants that are fixed to the substrate (Sargent 1982).
- Among non-human animals, birds are among the most impressive nest builders: "Bird nests include the best and the most highly evolved nests known among vertebrate animals" (Collias and Collias 1984, 3). In a recent paper of 2016 Alexis J. Breen, Lauren M. Guillette, and Susan D. Healy asked: "What Can Nest-Building Birds Teach Us?", where they pointed out that:

> The techniques with which birds build their nests […] range from the sculpting of burrows or cavities from substrate excavation, through the moulding of mud or salivary mucus by vibrating head and/or shaping breast and feet movements, the piling up of materials where subsequent bill manipulations, coupled with side-to-side shaking movements, may be made in order to entangle or intertwine nest components, to the weaving of hanging nest baskets using intricate tuck, looping, interlocking, winding, and knotting bill-made stitches to fasten and secure grassy materials. (Breen et al. 2016, 84)

- Just a few examples to illustrate the many possibilities that birds can display as nest builders: "The nests built by the Hornero birds (*Furnarius rufus*) have an elaborated architecture." (Zyskowski and Prum 1999). Those nests are made with a mixture of clay, leaves and grass. The Hornero couple builds an oven-like nest every year, the enclosed space is U-shaped, with a hall separating the nest chamber from the outside. The incubation chamber is safe from inclement weather, particularly storms and winds.
- The long-tailed tit (*Aegithalos caudatus*) construct their nest from four materials —lichen, feathers, spider egg cocoons and moss— with over 6,000 pieces used for a typical nest. The nest is a flexible bag with a small entrance on top. The structural firmness of the nest is provided by moss and spider silk netting together.
- The colorful displays built by Bowerbirds males (*Ptilonorhynchidae*) to attract females. Those bowers usually "include stick towers up to 3 m high or huts up to 4 m in diameter, decorated with as many as several hundred or thousand flowers, fruits, mushrooms, snail shells, butterfly wings, stones, and other natural objects." (Diamon 1986, 31). Males can spend hours arranging

the display, and it takes "several years before males build typically adult bowers. During these years […] males may learn how to build bowers by watching older males, and females may learn which males to choose by watching older females." (Diamon 1986, 33-34).

- The Sociable Weaver (*Philetuirus socius*), a species of gregarious bird, that built a massive nest together that can work for many years:

> The nest mass can be divided into two main structural regions: the superstructure or roof, and the substructure or living area which contains the chambers. A typical well-established nest mass which has been in use for several years consists of an extensive superstructure of small sticks 10 cm to 30 cm long and often thorny, and an even more extensive substructure of grass straws extending below the supporting branch on which the mass is built. The number of chambers varies with the size of the nest mass from five to 50. Each chamber consists of an entrance tunnel up to 25 cm in length and 6-7 cm diameter leading vertically into a nest chamber measuring some 15 cm in diameter and set to one side of the tunnel. The chambers are all separate and do not interconnect with one another inside the substructure. (Maclean 1973, 194)

- And for finishing this list of examples, just some made by mammals:

> Prairie dogs (genus *Cynomys*) excavate their nests by digging burrows from the ground. Their habitat, the Great Plains of North America, has extreme variations in the weather from one season to another, and for that reason the nests are built to withstand extreme temperatures, as well as floods and fires (Hoogland 1996, 6). The internal structure of the nest is composed of different cameras located at different depths and serve different purposes. There are cameras used as a refuge for predators, other cameras for storing food or listening to predators, and there are also nurseries, usually located deep in the ground where temperatures are more stable. The size of the loan varies, but it can be as large as 65,000 square kilometers (discovered in Teas in 1900 and the home to an estimated 400 million prairie dogs).

- Beavers (genus Castor), modify the environment using massive logs, branches (cut by themselves) and mud structures to block streams and create ponds where they build their shelters, also built with branches and mud. These shelters are usually found in the middle of the ponds and can only be reached by underwater entrances. Beavers build dams in areas with shallowand mobile waters. They avoid currents of more than 60 cm deep or strong currents, and place the dams where there are restrictions in the flow of the current. They usually use objects such as rocks or tree stumps to secure their prey. Sometimes they can dig channels to bring water to their favorite trees and swim near the trees. Once they have built the dam, the family builds a shelter. The lodge is made of sticks, mud and rocks. They do not apply mud to the top of the shelter, creating a ventilation well.

5.2 Axis 2: Behavioral plasticity

Another feature that must be taken into account is the ability to exhibit adaptive phenotypic plasticity, defined as "the ability of a genotype to vary its phenotype across environments, and thus maintain high performance across that environmental gradient" (Snell-Rood 2013, 1004). Here I will use the distinction proposed by Snell-Rood between "developmental and activational behavioural plasticity":

> Developmental behavioural plasticity corresponds to the traditional definition of phenotypic plasticity, where a genotype expresses different behavioural phenotypes in different environments as a result of different developmental trajectories triggered by those environments. Developmental behavioural plasticity encompasses all of what is generally defined as 'learning', or any change in the nervous system as a result of experience […] Developmental behavioural plasticity is different from 'activational' behavioural plasticity […] Here, the external context results in the expression of a particular behaviour such that a individual expresses different behaviours as it encounters different environments or conditions. […]. Activational behavioural plasticity is an immediate response to the environment. Developmental behavioural plasticity, by definition, requires developmental changes such as neuron or muscle growth. These processes take time. (Snell-Rood 2013, 1004-1005)

Not all users of nest tools or builders show behavioral plasticity of development, but even the most basic type of agents can guide their behavior and react to external inputs (active behavioral plasticity). Here I suggest a gradual classification:

(i) Agents with activational behavioral plasticity: agents can identify similar stimuli (even during time), discriminate between (some) different stimuli and manifest similar behaviors after similar stimuli. The answers are innate behavioral responses: responses that are invariably induced by a particular stimulus. (Dupré 1996, 328). A type of physical stimulus produces a fixed type of behavioral response. With Dupré we can say that these behaviors are "mere differential reaction to causal inputs." (Dupré 1996, 328). They develop actions that can be described as active behavioral plasticity based on internal models, typically oriented by evolution. We can rephrase this with Saidel:

> if it is performed in the right environment, it will lead to a goal. A representation of the goal does not play a role in causing goal-oriented behavior. […] If evolution had

> so structured the organism that it lacked distinct representations of its goals and the means to achieve those goals, then the organism would not be able to abandon a particular behavior – a means to a goal – while retaining the goal. (Saidel 2009, 38-39)

Although at the most basic level, they even show the capacity of learning: "some learning does not implicate representation, of means or of goals, at all. […] They are merely filling in gaps in an evolutionarily pre-programmed behavioral pattern" (Saidel 2009, 39). Here, the appropriate environment would be an environment with favorable (positive) conditions for the agent, and the actions of that agent would produce unintentional changes in the environment.

Examples of this type would be the females of the *Ammophilia* and *Sphex* wasps that dig:

> […] subterranean burrows to deposit eggs and a prey insect (a cricket like in the next example) for their larvae to feed on as they develop. When the female pace prey in the borrow, she fills the entrance with pebbles and soil. When the burrow is closed for the final time, the female sometimes holds and object in her mandibles and uses it to press the soil, compacting it and making it less conspicuous. (Shumaker, Walkup and Beck 2011, 24)

Sphex's behavior is a complex routine that is invariably caused by a particular stimulus.

(ii) Agents with basic behavioral plasticity of development: agents that can classify (not only discriminate) into positive and negative actions (so that they know something about the current state of the environment). Some of them show "(1) the capacity to identify and reidentify objects and properties, (2) the (relative) independence of stimuli, and (3) the fact that an adequate level of abstraction is involved in the classification" (Newen and Bartels 2007, 295).

They have the ability to learn and improve their actions. Therefore, some agent responses to a certain stimulus may be "driven" by that stimulus, but may generate a generalization of the stimulus. These agents develop actions aimed at achieving a goal. In some cases, agents may even create desirable conditions, therefore, if the environment is not favorable, they modify it to create the possibilities of meeting some objectives.

Living beings that fit this type are, for example, some kind of ants, termites, many kinds of birds, and Beavers (genus Castor). They all build nests, which can vary greatly between species in their shape, size and composition (Healy, Walsh and Hansell 2008). These animals perceive the environment in terms of positive and negative situations, and change the environment to build a new one more suitable for their interest, build nests or even, as in the example of beavers, build dams with water to a level that allows the construction of the nest.

(iii) Agents with medium developmental behavioral plasticity: agents that develop flexible response behaviors (Allen and Hauser 1991) aimed at achieving a goal that is considered and conceptualized as desirable.

> Having distinct representations allows an organism to abandon one behavior and to adopt another while still retaining the goal that the previous behavior was aimed at achieving, and toward which the new behavior is now directed. Having distinct representations of goals and means to achieve them is thus a prerequisite for behaving in a goal-directed fashion. (Saidel 2009, 39)

They have the capacity to form new associations of objectives and the means to achieve those objectives. It is a type of learning that cannot be explained by conditioning or by filling behaviors in evolutionarily present patterns.

In this case, agents can create new conditions to meet some objective. The main difference with the previous group is that these creations are based on an internal utility function that tries to agree with external performance, that is, they can identify some parts of the environment as prototypes and modify them to create new conditions. Chimpanzees, orangutans, New Caledonian crows, woodpecker finches, and capuchin monkeys, fit in this type.

New Caledonian crows have impressive plastic manufacturing capabilities (Hunt 1996, 2000; Hunt and Gray 2002; 2003). For example, they appear to have diversified and cumulatively evolved the objects that form from the edges of Pandanus spp. leaves (Hunt and Gray 2003).

Chimpanzees demonstrate complex plasticity in the use of tools and can easily use complex sets of objects when necessary. Some of the sequential actions include:

> an appreciation of the quality of the raw material, sometimes before even being at the food source; material selectivity; transport of raw material and tools; reduction and shaping of raw material before use (reduction in length, removal of lateral branches and leaves, and intentional shaping of brush in some cases); retouching during usage; a notion of order when using sequential tools; a notion of geometry; uniformity of tool forms; and an important cultural component in tool use (e.g., Loango chimpanzees live in a forest full of Coula edulis and Panda oleaso nuts, but do not crack them open with tools as Taı¨ chimpanzees do in Coˆte d'Ivoire). (Boesch, Head and Robbins 2009, 567)

Wild capuchin monkeys generally open fruits, nuts and invertebrates with a hard shell, and for this they can use stones and anvils (Fragaszy, Izar, et al. 2004). In the laboratory they can develop a very complicated use of objects.

> Capuchins possess behavioral characteristics that are less widely shared with other primates and that are particularly relevant to using objects as tools. Both wild and captive capuchins reliably and spontaneously combine objects with substrates and with other objects by pounding and rubbing; they also insert their hands and objects in holes and crevices. (Visalberghi and Fragaszy 2009, 546)

Carpenter's finches are famous for their spontaneous behavior when they use objects in nature. They use twigs or cactus spines to remove arthropods from cracks and use this ability more than any other species other than humans. Tebbich and colleagues (Tebbich et al. 2001) discovered that young woodpecker finches developed competent skills in the use of implements even when raised with adults who do not use tools. Young finches showed a strong spontaneous tendency to use sticks, and refined and consolidated the habit by their own experience.

If we want to analyze the complexity of artifacts made and used by non-human animals, these two axes (structure and behavioral plasticity) must be taken into account. Establishing all tools and nests in a large category does not allow us to understand the variability of complex structures and behaviors that nonhuman animals show as agents in their environment. The strategies to modify their environment are very diverse and, in many cases, can be carried out in a flexible way. Many non-human animals learn during their lives how to make these artifacts in a more appropriate way. The manufacture of an artifact can also be a collective problem, where many agents of the same species perform a specific task during the manufacturing process. Therefore, differences with human-made artifacts are more a matter of degree.

There are strong differences between artifacts manufactured by humans and non-humans. Human beings have exceptional capabilities that result in highly complex technology. Among those capabilities stands out several abilities: (i) the ability to reason in terms of non-observable and / or hidden causes (Waldmann and Hagmayer 2005; Kushnir et al. 2005; Saxe et al. 2005), (ii) the ability to distinguish between "genuine" and "spurious" causes (Lien and Cheng, 2000); (iii) the ability to reason the link between the effects and their possible causes (Waldmann and Holyoak 1992) and planning their own interventions in a quasi-experimental way to elucidate ambiguous causal relationships (Hagmayer et al., 2007). On the other hand, human beings can learn from the conspecifics by perceiving their goals and then try to reproduce the strategies that the other being uses to try to achieve those goals.

> This difference in learning process leads to a huge difference in cultural evolution; specifically, only cultural learning leads to cumulative cultural evolution in which the culture process artifacts —both material artifacts, such as tools, and symbolic artifacts, such as language and Arabic numbers— that accumulate modifications over historical time. Thus,

> one person invents something, other persons learn it and then modify and improve it, and then this new and improved version is learned by a new generation —and so on across generations. (Tomasello 2000, 38)

The ratchet effect seems to be exclusive to humans: "some individual or group of individuals first invented a primitive version of the artifact or practice, and then some later user or users made a modification, an "improvement," that others then adopted perhaps without change for many generations, at which point some other individual or group of individuals made another modification, which was then learned and used by others, and so on over historical time in what has sometimes been dubbed "the ratchet effect" (Tomasello, Kruger, and Ratner 1993). The process of cumulative cultural evolution requires not only a creative invention but also, and most importantly, a faithful social transmission that can function as a ratchet to prevent backward slippage, so that newly invented implements or practices retain their new and improved form at least a little faithfully until a new modification or improvement arrives (Tomasello 2000, 5).

6. Conclusions

Artifacts have generally been considered objects created by intentional human actions. Objects manufactured by non-human animals have been excluded from that category. However, this separation is based on a limited and anthropomorphic perspective on the capabilities of nonhuman animals. In this article I have shown some reasons to consider otherwise. Capacities such as intentionality, culture or even the complexity of the structures of the manufactured object are not exclusive to human beings.

I have suggested a different way of analyzing objects created by non-human animals, one that attempts to explain the gradualness of the structure, but also the plasticity of the behavior exhibited by the non-human animal. These two elements (structure and behavior of plasticity) allow a deeper understanding of the great variety of objects that other animals also manufacture. Humans create amazing technological structures, but that does not mean they are the only animals with technical capabilities.

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