1

The Tool With a Capital T

Scientists in the field have an unparalleled fascination with tools[1], you know, those objects that we most often manipulate with our hands. It can be a hammer, screwdriver, fork or branch, as long as it is used to interact with the environment. It is true that tools reflect an important part of our materiality. However, should we consider that such a fascination is justified? I think you anticipate my answer to that question: no. No, the tools are not the only reflection of our materiality, far from it. Worse, being so fascinated by these tools that we consider them as the only subject of study of human materiality can lead to a lack of understanding of the underlying cognitive mechanisms.

Let us do a fairly simple exercise. Take a quick look around you. What do you see? Certainly a pen, a computer, books, furniture, a desk, walls, maybe even a road, if you are near a window, with cars and trucks driving on it. Leave your house or apartment, and imagine yourself now on a plane, near a window, looking at the ground – if you are not already there after all. What do you see? Again, roads, buildings, bridges, even cities. Let us now travel back in time. Think of the Middle Ages, Antiquity, or Ancient Egypt.

1 The observation of this fascination comes from my expertise in the field, where I rarely meet researchers interested in tool making or construction behavior in humans. Nevertheless, this observation reflects an objective view of what is really going on. For example, I had fun searching with the "PsycINFO" search engine for the number of occurrences of articles in the field of psychology published in international journals containing the terms *Tool Use* and *Cognition*, *Tool Making* and *Cognition* and *Construction Behavior* and *Cognition*. I deliberately added the term cognition to reduce the search, at the risk of reducing occurrences. The result obtained is unequivocal. *Tool Use* appears in 550 articles, *Tool Making* in 36 articles and *Construction Behavior* in four articles.

What are you thinking about? Castles, carriages, arenas, pyramids, wooden boats, etc. This is a trivial exercise, I admit. However, the answers provided are irrevocable. We are not only tool users, we are also builders, and we excel so much in this field that it is even possible to see some of our constructions from space (the Great Wall of China for example). How can scientists then justify the need to focus so much on tools while neglecting the most important traces of our materiality? We are constantly changing our physical environment. We are building, constructing, demolishing, only to rebuild again. The result of this appetence is staggering. However, scientists are not interested in this. They are interested in understanding how we manipulate tools – usually with our hands – and rarely focus on our ability to make them. For me, this excessive fascination is detrimental to understanding what characterizes us as humans, precipitating generations of researchers toward the quest for the famous motor programs useful for manipulating tools, as if a human were only a tool manipulator, and not a maker or a builder.

My positioning will be different, and you will have understood that. In this book, I defend the idea that tool use, tool making and construction behavior are the three sides of the same piece that I call the Tool with a capital T. And it is only by understanding the cognitive bases of the origin of these three behaviors that it is possible to develop a new field of research on the Tool, thus escaping from this fascination for use or, rather, for manipulation – or even for the hand. This first chapter is intended to expand on this point. I will begin by defining the three behaviors mentioned above, characteristics of our materiality. I will then discuss the epistemological reasons behind scientists' fascination with tools. I will continue by discussing the implications of this fascination for the choice of useful animal models, and for the idea that specific cognitive abilities could be associated with each of these three behaviors.

1.1. Defining the Tool: the behavioral reality

Traditionally, the notion of tool refers to any manipulable physical object that is used to cause changes in other objects in the environment. A nail is not a tool, unlike the hammer used to drive it in. Similarly, a house is not a tool, unlike the trowel used to build it. Table 1.1 summarizes the definitions proposed by major authors in disciplines around anthropology, psychology and neuroscience. As can be seen, all these definitions agree on a major

criterion, namely that the tool is what is *manipulated* during use. I will refer to this criterion as the criterion of manipulation.

Field	Author(s)	Definition
Primatology	(van Lawick-Goodall 1970, p. 195)	[Tool use is] the use of an external object as a functional extension of mouth or beak, hand or claw, in the attainment of an immediate goal.
Psychology	(Gibson 1979, p. 41)	When in use, a tool is a sort of extension of the hand, almost an attachment to it or a part of the user's own body, and thus is no longer a part of the environment of the user. But when not in use, the tool is simply a detached object of the environment, graspable and portable, to be sure, but nevertheless external to the observer.
Ethology	(Beck 1980, p. 10)	Tool use is the external employment of an unattached environmental object to alter more efficiently the form, position, or condition of another object, another organism, or the user itself when the user holds or carries the tool during or just prior to use and is responsible for the proper and effective orientation of the tool.
Neuropsychology	(Ochipa *et al*. 1992, p. 1063)	A tool was defined as an implement for performing or facilitating mechanical operations, such as a screwdriver. An object was defined as a thing to which mechanical action is directed, such as a screw.
Ergonomics	(Baber 2003, p. 8)	A tool is a physical object that is manipulated by users in such a manner as to both affect change in some aspect of the environment and also to represent an extension of the users themselves. The manipulation is directed toward a specific goal or purpose, and the associated activity requires a degree of control and coordination.
Cognitive neuroscience	(Frey 2007, p. 368)	Tools [are] manipulable objects that are used to transform an actor's motor output into predictable mechanical actions for purposes of attaining specific goals (i.e., *motor-to-mechanical transformations*).
Computer science	(St Amant and Horton 2008, p. 1203)	Tool use is the exertion of control over a freely manipulable external object (the tool) with the goal of (1) altering the physical properties of another object, substance, surface or medium (the target, which may be the tool user or another organism) via a dynamic mechanical interaction, or (2) mediating the flow of information between the tool user and the environment or other organisms in the environment.

Table 1.1. *Major definitions of tool use*

If we follow this behavioral definition of the phenomenon, a number of observations of animal behavior can be categorized as tool use (see Table 1.2), whether in non-human primates, non-primate mammals, or birds, and even, more unexpectedly, in fish or insects. In some cases, the repertoire may be relatively varied, such as in chimpanzees, in which nearly 40 behaviors may have been listed throughout the species (Whiten *et al.* 1999). In other species, this may characterize a single behavior, sometimes observed in an isolated individual, such as the observation of a gorilla using a branch to probe a pond before entering it (Breuer *et al.* 2005).

Species	Tool	Function	Activity
Insect, fish			
Ant	Sand	To throw	Projected with the head
Archerfish	Water	To throw	Water sprayed on prey
Bird			
Egyptian vulture	Stone	To pound	Held in the beak
Galápagos finches	Twig	To probe	Held in the beak
Seagull	Rock	To throw	Released in flight
Non-primate mammal			
Elephant	Branch	To whip	Held by the trunk
Polar bear	Rock	To throw	Held between the claws
Primate			
Chimpanzee	Twig	To probe	Held between the legs
Chimpanzee	Branch	To pound	Held between the legs
Chimpanzee	Branch	To split	Held between the legs

Table 1.2. *Animal tool use*

Tool use is to be differentiated at the behavioral level of tool making and construction behavior. The definitions associated with each of these behaviors are provided in Table 1.3 based on the categorization provided by Shumaker *et al.* (2011), which lists all of these behaviors in the animal kingdom. In short, construction consists of assembling objects in order to build a semipermanent entity, without this entity being manipulated during its use. Nest building is a prime example of this behavior and is frequently observed in the wild. Tool making shares with construction the criterion of assembling objects, although making may also refer to other modes (see

Table 1.3). However, unlike construction, the generated entity is manipulated directly after its design, so that this behavior refers to a tool. It should be noted that the criterion of manipulation is again central to classify a behavior as tool-related or not. If there is no manipulation after the making[2] of an object, then it is a construction behavior. If there is manipulation, then it is a tool-making behavior.

Label	Definition
Tool use	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 (p. 5).
Construction	Two or more tools and/or objects physically linked to make a functional, semipermanent thing that, once completed, is not held or directly manipulated in its entirety. A construction itself is therefore *not* a tool. Nor is it tool manufacture, because the product is not a tool (p. 19).
Tool making	Structural modification of an object or an existing tool by the user or a conspecific so that the object/tool serves, or serves more effectively, as a tool (p. 11).
	Method of manufacture
Detaching	Remove the eventual tool from a fixed connection to the substrate or another object (p. 14).
Subtracting	Remove and discard a portion of a tool or an eventual tool so the tool can be used or used more efficiently (p. 14).
Adding/ Combining	Join or connect two or more objects to make one tool that is held or directly manipulated in its entirety during its eventual use (p. 14).
Reshaping	Fundamentally restructure material to make a tool. It may include detach, substract and add/combine (p. 14).

Table 1.3. *Definitions of tool use, tool making and construction according to Shumaker et al. (2011)*

Tool making can also be observed in non-human animals, sometimes taking very complex forms. For example, in the case of New Caledonian

2 In Chapter 6, I will come back to a distinction I wish to make between making, manufacture and crafting.

crows, the making of a stem to reach insects in small cavities consists of a sequential cutting of Pandanus leaves, the tip being tapered to allow better insertion into the cavities, while the base is left wider for better spinning (Hunt 1996). Similarly, chimpanzees can perform up to four or more making steps, including extracting branches from a tree, removing small branches from the main branch, and trimming one or both ends of the main branch (Pruetz and Bertolani 2007).

1.2. Blinded by tools

As stated at the beginning of this chapter, human materiality is not limited to tools alone, but also includes a set of entities including constructions. In this context, the challenge for scientists should be to understand the human cognitive bases that have enabled these manifestations to emerge. Why, then, do researchers have this unfortunate tendency to focus mainly on tool use, leading them to model how an individual manipulates a hammer, not how she/he makes it – whether mentally before use or physically by assembling material – or how she/he builds a wall with it?

This fascination has its origins in the fundamental discovery that the oldest trace of human materiality involves tools and not construction. With their minds tainted by this discovery, scientists seem to have sought the challenge of understanding how the first Homininae were able to manipulate tools and not build constructions. However, this approach to the question of human materiality is not neutral, because it is not the same to model at a cognitive level how humans manipulate a tool as it is to model how they can use or make tools, or build structures, in order to solve physical problems in the environment. In the first case, the theoretical model is likely to focus on specific manipulation capabilities and, therefore, on the potential existence of specific motor programs for this manipulation. This is the case with most cognitive models of human materiality, an approach that I will criticize throughout this book. In the second case, the model is predisposed to explain how physical problems are solved, with the criterion of manipulation being considered secondary and ancillary. This is the approach I will defend in this book.

The oldest trace of tools on Earth dates back about 2.5 million years (Ambrose 2001; but see Harmand *et al*. 2015 for a recent discovery of tools

dating back 3.3 million years). These tools were made by gradually removing a succession of fragments using a hammerstone, making it possible to obtain a tool with a specific shape, useful in particular for cutting meat (see Figure 1.1). It should be noted that this technology is the oldest form not only of tool use but also of tool making.

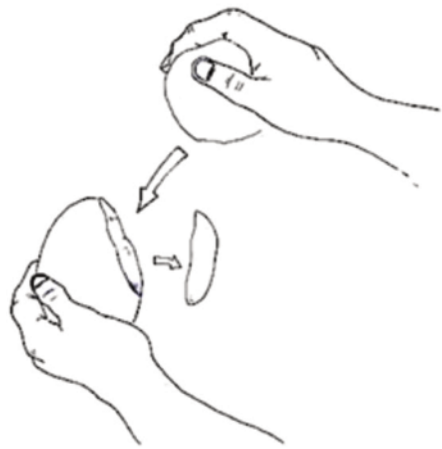

Figure 1.1. *Making of stone tools (Oldowayan lithic industry, about 2.5 million years BC). The method consisted in gradually removing a succession of fragments using a hammerstone (source: Noël Cédric)*

The important question is whether these stone tools correspond with certainty to the very first form of physical modification of the environment by the human species. There are several indications that this is unlikely, although there is no clear evidence to support it. First, these tools were already of a relatively complex design, suggesting some technical mastery on the part of the maker, a technique that required several hours of intensive practice (Bril *et al.* 2010). The corollary is that these tools are unlikely to be the first form of use and making, but rather the result of a gradual evolution of less complex designed tools. The fact is that if such tools may have preceded those we know, they could remain invisible in the archaeological collection because of our inability to distinguish them from stones accidentally fractured by some natural phenomenon (see Box 1.1). Another argument abounds that they were certainly not the first used by our ancestors. More precisely, these tools do not simply correspond to making

instances, but more precisely to instances of using one tool to create another, a rare phenomenon attributed solely to the human species (Gibson 1993). In this sense, they also reflect a certain form of complexity, consisting in producing a recursive behavior (i.e. the use of stone A makes it possible to create stone B, which can then be used with an object C). Similarly, it seems unlikely that our ancestors would have started making and using tools directly at this level, otherwise this phenomenon would also be easily found in other animal users. Finally, it is commonly accepted that other tools may have been previously made from consumable materials (e.g. wood). However, once again these tools could not leave any trace in the archaeological collection (Panger *et al.* 2002)[3].

A recent study published in *Nature* reported that capuchins in Serra da Capivara National Park, Brazil, were able to produce stone fragments with characteristics relatively comparable to some of the tools of the Paleolithic period (Proffitt *et al.* 2016). This production is done unintentionally, as the capuchins break the stones so that they can lick the inside of the stones, which are rich in silicone, an important nutritional element for the species. This study has generated considerable interest, since it suggests that the interpretation of the archaeological collection should be revised by perhaps seeking new criteria to allow us to distinguish these accidentally cut stones from those produced intentionally. Nevertheless, we must not be mistaken as to how to interpret this study, which does not call into question the idea that the oldest traces of stone tools were indeed the responsibility of our ancestors. There is also indirect evidence, such as traces of cuts found on bones from the same period, which confirms that these tools were used intentionally. It should also be noted that the use of these tools to cut meat is difficult to interpret as belonging to another species, since no animal has ever been observed performing such behavior (i.e. cutting meat).

Box 1.1. *The question of evidence in archaeology*

In short, even if no direct evidence can be provided in this sense, it seems very likely that the oldest stone tools we have in the archaeological collection are not the oldest trace of human materiality. If we accept this idea – again not proven, although highly probable – then it leads us to question more

3 This aspect applies not only to tools preceding the first stone tools but also to all tools used or created afterwards, as long as they were made of consumable materials. In other words, we must be vigilant about interpretations of technological change based only on the tools in the archaeological record because they were made using time-resistant materials.

broadly the idea that the first traces of human technology were necessarily tools and not constructions – or that at least the two forms of behavior could have appeared together. In other words, the discovery of these tools does not exclude that our ancestors may have produced useful constructions to facilitate survival (for example, "couchettes" made of leaves or branches) perhaps concomitantly with the use and making of tools (for example, wooden poles to reach fruits too high in trees). It should be noted that construction behaviors are relatively frequent in animals, much more so than tool use, which, without providing direct evidence, presupposes that the human species was also able to achieve construction behaviors at an early stage.

Although the scenario I propose remains speculative, since we have no trace of human materiality prior to the first stone tools, it cannot be invalidated either. This scenario being possible, it leads us to question the specificity of human materiality. After all, let us imagine that we discovered that the first Homininae built bunks. In this case, the emphasis placed on the manipulation inherent in tool use would become secondary, since Man would then define himself as a builder. This would modify the cognitive models of human materiality, since models might finally emerge on the cognitive bases of construction. This would also change the issue of animal models useful for understanding human technology, i.e. that builders would then become the best animal models, not users (see section 1.4). In short, if we abandon the idea that what characterizes a human is the manipulation of tools, then it becomes possible to imagine another scenario for the human species, in which the ability to use/make tools and build constructions becomes central (i.e. the Tool), leading us to question the reasons that led us to produce this behavior.

1.3. From analogy to specificities

As mentioned in the previous section, scientists are inclined to overestimate the role of the use – and therefore manipulation – of tools to the detriment of making and construction behavior. This perspective leads them to neglect the appetence that humans have for changing their environment. Focusing attention on use is not in itself detrimental to understanding the cognitive specificities underlying human materiality. After all, it is possible to study these specificities only by investing in how humans behave when using tools, as tools here are only one way to approach the more general

problem of materiality. Most of my research follows this path, since most of my work is devoted to how humans use tools, rather than how they make them or build constructions. However, any human cognitive specificity tends to be erased when it is considered that tool use in humans does not really differ from what is observed in animals. You understand the logic well, and I think many of you agree with it. This logic is as follows: human materiality is essentially reflected in tool use; however, tool use is not specific to humans; therefore there is nothing really specific in human materiality. In the following lines, I will present several arguments that demonstrate that there are many human specificities in tool use – specificities that can easily be transferred to tool making and construction behaviors. In other words, my point of view is that the analogy often advanced between tool use in humans and animals is fragile, and in reality tends to feed a scientific bias, namely the thesis of continuity.

The thesis of continuity is based on the *argument by analogy*, an argument initially developed by Darwin and Romanès, two authors considered to be the founders of comparative psychology. This argument suggests that if two behaviors are considered analogous, then the underlying mental processes are analogous as well. This argument is based on a principle of parsimony, also known as *Occam's razor*. According to this principle, it becomes logical that human tool use results from cognitive processes that are relatively comparable to those involved when non-human primates, for example, use tools. This thesis was recently supported by Haidle (2010), who argues that the complexity of human tools in prehistoric times was only due to an increase in working memory capacities[4]. However, according to her, the basic cognitive skills needed to use tools should not be distinguished from those employed by chimpanzees, for example, when using tools. Here, we find the famous principle of continuity between humans and non-human animals in the cognitive processes involved. In other words, there would be no qualitative leap in cognition between humans and other species of animal users.

The problem with this argument by analogy is that it does not clearly specify which reading grid to use to design two behaviors as analogous. In fact, it seems that authors inclined to support the thesis of continuity tend to

4 Working memory can be defined as the ability to maintain and manipulate information in the short term. For Haidle (2010), this ability is essential to make tools whose sequence is becoming more and more complex. I will come back to this hypothesis in Chapter 5.

minimize differences and focus on similarities, leading them to characterize behavior on a very short time scale. Let us take the example of a chimpanzee fishing for termites. It is true that this behavior is like that of a human using a fishing rod. In both cases, a tool is introduced into another entity and then removed to extract a possible target. If we focus our analysis on this brief episode, it is true that the two behaviors appear to be highly similar. However, we are not required to use this relatively short time scale.

Now imagine that we are observing the behavior since its initiation. At this level, it is possible to see that only humans reuse a tool stored for this purpose, which is not done by chimpanzees or any other animal (Mulcahy and Call 2006). It will also be possible to observe that this human could use another tool (for example, a useful clamp to tighten weights) to create another (a phenomenon also called the use of a secondary tool; for example, leaded fishing line), a behavior that is also absent in chimpanzees and other animals. If we further increase the time scale by taking into consideration the individual over her/his entire life, we will see that only humans frequently engage in object–object manipulation (Gibson 1993), have a vast repertoire of tools (Frey 2007), use tools that go beyond simply increasing the natural biomechanical capabilities of the hand (e.g. use of a pole, i.e. simple tools), but which also transform the action of the hand into another mechanical action (e.g. the use of a knife, i.e. complex tools, Frey 2007), or store tools to reshape them later. At this level, the analogy is beginning to become difficult to support. Finally, if following the example of Wundt's *folk psychology*, we assume that what is visible at the species level reflects what each individual of the species is able to do, then we can see that only humans are able to transform and improve their techniques from generation to generation (Tomasello *et al.* 1993). At this level, the analogy is no longer tenable.

At this point, you have two options. The first is to maintain an analysis based on a relatively short time scale and, consequently, to perpetuate the idea that tool use in animals is strongly analogous to that of humans, thus assuming that cognitive processes are common between species. If you follow this path, then you are a strong advocate of the thesis of continuity and it is very likely that you will not fully accept the thesis I am defending in this book. The second is to admit that the argument by analogy is fallacious and tends to simplify the problem under the guise of being governed by a principle of parsimony. In this case, the differences become more pronounced than the similarities, and this may lead to starting to reflect on the possible cognitive origins of these differences. If this idea appeals to you

more, then it assumes that you are ready to debate around the thesis of discontinuity. Table 1.4 lists the specific human characteristics that will be discussed in more detail in this book.

Label	Definition
Transfer	The ability to transfer a mechanical action learned in one situation to another.
Using a tool to create another one/secondary tools	The ability to use one tool to create another.
Use of complex tools	The ability to use a tool that does not simply extend the user's biomechanical capabilities (unlike the use of simple tools).
Tool storage	The ability to set aside a tool for future use.
Tool making	The making/improvement of a tool that is then stored for future use.
Functional fixedness	The ability to assign a specific function to a given tool, gradually generating a tool repertoire.
Cumulative technological culture	The accumulation and improvement of a tool or technique over generations.

Table 1.4. *Human-specific behaviors*

1.4. The select club of animal users

Beck (1980; Shumaker *et al.* 2011) has made a significant contribution to the referencing of tool behaviors in non-human animals. In fact, the second edition of his book *Animal Tool Behaviour* in collaboration with Shumaker and Walkup is the most comprehensive catalogue available to date on the subject. To carry out this work, it is obvious that practical definitions must be generated in order to organize the referencing. I am not criticizing this aspect in any way, quite the contrary, since the work carried out by Beck and his collaborators does not aim to interpret the cognitive bases of the behaviors described, but rather to provide an encyclopedia of the phenomena studied based on a clearly established and behavior-oriented lexicon. I emphasize the behavioral aspect of Beck's distinctions between tool use and construction in particular because Beck himself warned readers not to consider these definitions as part of a biological or psychological reality, but as practical definitions. In a way, for Beck, it should not be considered that

the distinction between tool use and construction presumes the existence of different cognitive levels.

However, as Hansell and Ruxton (2008) have mentioned, this warning does not seem to have been well understood since, over the past two decades, a certain enthusiasm has emerged for the desire to bring certain animal species into the very select club of animal users[5]. For example, the observation of a beaver using a booster seat allowed this species to enter the club (Barnes 2005). Similarly, the gorilla was also admitted to this club following the observation of a behavior consisting of manipulating a branch to probe a pond before entering it (Breuer *et al.* 2005). The elephant also had its right of entry following the observation in this species of the manipulation of a branch using the trunk to whip the buttocks in order to make the insects fly away (Hart *et al.* 2001). For Hansell and Ruxton (2008), this desire to bring animals into this club is the result of an anthropocentric perspective that sees tool use as a defining feature of the human species – the famous parallel with the first stone tools (see section 1.2) – and therefore, to lend these animals a form of intelligence common to them. However, the construction of dams by beavers is more elaborate than the use of a booster, so it seems surprising to focus on the latter to characterize the intelligence of beavers. Similarly, tool use in birds is rare, involving only about 20 of 8,600 known species, and generally consists of observing behavior in an isolated or captive individual (Chappell and Kacelnik 2002). On the other hand, the vast majority of birds build nests, sometimes following complex sequences of actions.

The existence of this select club of tool users is based on the idea that Beck's arbitrary behavioral distinction between tool use and construction can

5 If you have followed me correctly, there is a certain form of incoherence in the thinking of some scientists in this regard. On the one hand, as mentioned above, there is a tendency to minimize differences between humans and animals in the ability to use tools. This tends to diminish the particularity of human materiality by criticizing any anthropocentric thinking that would require human behavior to be distinct from that of animals. On the other hand, human behavior remains the gold standard and is associated with a higher form of intelligence, encouraging researchers to allocate animals using tools to higher classes on the cognitive criterion. This way of proceeding is paradoxically based on an anthropocentric vision, since Man is considered as the standard. In short, instead of perceiving what is different between humans and animals without value judgment, these two movements tend to erase the specificities of human cognition by assimilating other forms of cognition to it (i.e. anthropomorphism).

be considered as reflecting a cognitive bijection, i.e. that tool use is reflected in one type of cognitive process, the construction in another. This hypothesis has never been formulated as it stands in the literature. Nevertheless, the idea seems to be commonly understood in the sense that researchers questioning the cognitive bases of human tool use never integrate construction behavior into the analysis, again because of the manipulation criterion that excludes it.

However, if we look at non-human animals, this bijection is hardly tenable. For example, the proto-use of tools in ants (see Table 1.2) consists of the projection of a grain of sand using the head. This behavior is highly stereotypical and does not result from lifelong learning to improve this technique. Similarly, the nest building of the *Paralastor* wasp is so stereotypical that if a hole is made in the nest, the wasp does not try to plug it, but reconstructs a nest around this hole to plug the hole. Conversely, web construction in spiders follows a non-stereotypical sequence of adding or removing certain wires (Hansell and Ruxton 2008). This flexibility is also found in nest building in birds (Crook 1963). Similarly, tool use in non-human primates may involve changing twigs if the one used is not appropriate for the behavior achieved (Shumaker *et al.* 2011).

In short, both tool use and construction can be achieved on the basis of stereotypical or flexible behaviors, suggesting that distinct cognitive levels could be used regardless of the behavior. There is therefore no cognitive bijection between these two behaviors. The corollary is that there is no reason to consider tool use as a more complex phenomenon at the cognitive level. This conclusion has two main implications. The first is that any tool use, tool making or construction behavior can be based on distinct cognitive processes between species, whether between non-human species themselves or between non-human species and humans. The behaviors of construction of a web by a spider, a nest by a bird or a wardrobe by a human have in common only the objective description of the behavior, the construction. However, this does not imply that similar cognitive bases are necessarily at stake under the pretext that it is a behavior categorized as a construction. The same reasoning must be applied to the use and making of tools. Just because different species use and make tools does not necessarily mean that the same cognitive processes are engaged. In other words, this principle calls into question the principle of argument by analogy supported by Darwin. The second conclusion is that, conversely, the same cognitive abilities can be involved in tool use, tool making and construction behaviors, with the

objective breakdown of the behavior again being arbitrary and not reflecting a common ability. For me, this second conclusion is a strong premise of the thesis defended in this book, namely that in human tool use, tool making and construction are possible through a common cognitive mechanism: the ability to solve physical problems by using objects external to the body.

1.5. In-defining the Tool: cognitive reality

Defining concepts or behaviors is an essential step in knowing what you are talking about. However, what is important to understand is that no definition is epistemologically neutral, in the sense that defining already corresponds to delimiting the question or rather the problem at hand. In other words, if the criterion of manipulation is central to the definition of tool use, then this irremediably leads researchers to propose theoretical models to explain how this manipulation takes place at a cognitive level. It is precisely this trend that we observe in psychology and neuroscience, where a massive consensus is emerging around the existence of manipulation-specific motor programs. Once again, I will come back to this proposal critically in Chapter 3. For the time being, the question is whether this manipulation-centered definition is effective in understanding human tool use and, more generally, human materiality.

1.5.1. *The absence of boundaries between tool use, tool making and construction*

If there is no cognitive boundary between tool use and construction, it is also because it is obvious that the referencing of behaviors often leads to an increase in the trait, as if the individual's behavior could be perfectly dissected into sequences of sub-behaviors, one being attributed to use, another to construction, etc. However, it is very likely that in the continuum of behaviors performed, this division is really difficult to make, so that tool use becomes tool making or construction, and vice versa.

To illustrate this aspect, let us consider a human individual who notices that water is flowing from the ceiling. A first solution may be to grab a cup and hold it to collect water. In this case, it is a matter of tool use, since there is manipulation. The cup is then the tool. Imagine that this individual decides to put the cup down, then it becomes a construction behavior in the sense

that she/he no longer needs to hold what was just before a tool, the cup also constituting a semi-permanent entity, an essential criterion for construction. However, if the individual has no predefined object at hand to solve this problem, and a plastic bottle is within reach, she/he can cut it into a container with a fairly wide opening and hold it. This is an instance of tool making since the object is modified just before its manipulation, but nevertheless manipulated during use. If she/he decides to put this bottle cut in half on the ground again this behavior becomes a construction behavior once more.

Reasonably, it seems difficult to consider that each of these scenarios refers to distinct cognitive processes, as if the individual were to move from a useful cognitive process to tool use, then tool making, or construction[6]. It is most likely that what matters here is the individual's ability to produce a solution that solves the physical problem of water dripping. For this reason, I will now use, as explained at the beginning of this chapter, the term Tool to refer to any behavior aimed at modifying one's environment to solve a physical problem using objects external to the individual's body, regardless of whether the behavior can be classified as tool use, tool making or construction.

1.5.2. *Tool use: a fragile definition*

In reality, there is a fragility in the very definition of the tool, which consists of seeing the tool as what is being manipulated. One way to illustrate this fragility is to turn to the attempt to define the tool proposed by St Amant and Horton (2008). These authors proposed that when a chimpanzee wedges a stone under another stone to use it as an anvil, then places the nut on the anvil and hits the nut with a hammer stone, the only tool is the hammer. Similarly, when a carpenter attaches a piece of wood

6 The example of flowing water illustrates the idea that the division of these behaviors remains purely arbitrary and dependent on the observer's eye. Unfortunately, it is possible that a certain reluctance to accept the idea that there are no cognitive boundaries between these behaviors sometimes appears among researchers, as this would be tantamount to accepting the idea that the criterion of manipulation is clearly secondary in the question of tool use. More precisely, it would be tantamount to these researchers sawing off the branch on which they are sitting, especially when the major idea of their cognitive theory lies in the assumption that tool use requires specific motor memories for manipulation. I will come back to this aspect in more detail in Chapter 3.

between two other pieces of wood, wraps the piece with sandpaper, and starts sanding, the only tool is sandpaper. Now imagine that the carpenter fixes the sandpaper to a table, grabs the piece of wood with both hands and starts sanding. In this case, what is being manipulated is the piece of wood. However, it would be surprising to consider it as the tool. The problem also arises if the carpenter holds the piece of wood in one hand and the sandpaper in the other, alternating movements with one while stabilizing the other and vice versa. In this case, both objects are manipulated, so what is the tool? This ambiguity also exists among animals. Egyptian vultures can use a stone held in the beak to hammer or drop it on an egg. However, they can also hold the egg and drop it on stones on the ground to break it (van Lawick-Goodall 1970). In the same way, distinguishing what is the tool in this example is tricky. One way to do this could be to remove the manipulation criterion, focusing on the idea that what ultimately matters is the production of mechanical action to solve a physical problem, regardless of the need to identify what is being manipulated. To accept such a proposal, however, is to exclude the main criterion for tool use, namely an object that is manipulated. Moreover, if the focus is placed on carrying out a mechanical action, this would gradually mean integrating construction into tool behaviors.

1.6. Conclusion

In this chapter, I have discussed the idea that, if we wish to understand the cognitive origins of human materiality, we must stop the fascination that scientists have with tool use, leading them indirectly to assume that this behavior is based on specific cognitive processes that are distinct from construction. Once again, I do not condemn the approach of studying tool use to understand human materiality more generally. Rather, I criticize the idea that human materiality could be summed up in this form of behavior. In other words, I postulate that tool use, tool making and construction behavior are manifestations of the same cognitive capacity in Man, thereby calling into question the emphasis unfairly placed on manipulation: Man does not manipulate tools, he solves physical problems in his environment leading him, among other things, to manipulate tools, but also making them or building constructions. In the same vein, I propose that there is no reason to consider animal tool use as part of cognitive processes at a higher level than construction. Some animals may perform stereotypical behaviors to use tools or build nests and other more flexible procedures to perform both forms of behavior. There is no cognitive bijection for tool use or construction.

Simply, for humans, cognitive processes other than those operating in animals could come into play to explain our ability to either use, make or build. This is what I call the Tool. The rest of this book will aim to explain the cognitive bases of this ability, no longer seeking to distinguish between tool use, tool making and construction. It will also lead me to discuss the theoretical conceptions that have not taken this position and for which the place of use – and therefore of manipulation – is central.