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Substitutive, Complementary and Constitutive Cognitive Artifacts: Developing an Interaction-Centered Approach

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Abtract Technologies both new and old provide us with a wide range of cognitive artifacts that change the structure of our cognitive tasks. After a brief analysis of past classifications of these artifacts, I shall elaborate a new way of classifying them developed by focusing on an aspect that has been previously overlooked, namely the possible relationships between these objects and the cognitive processes they involve. Cognitive artifacts are often considered as objects that simply complement our cognitive capabilities, but this "complementary view" seems to be an oversimplification. Assuming an "interaction-centered approach", this article identifies three essential ways in which cognitive artifacts carry out their function: complementing, constituting and substituting our cognitive processes, and builds a taxonomy of these objects that is grounded on these relations. In so doing, it also addresses the chaotic set of different micro-functions carried out by cognitive artifacts, which have not thus far been dealt with, sorting these functions into three corresponding categories. The second part of the article analyzes in greater detail how cognitive artifacts work in our cognitive life, identifying a new kind of functions, called semi-proper functions, and providing a new definition of cognitive artifact based on the previous analysis of these objects.

1 Introduction

Every day our cognitive system automatically categorizes both natural and artificial objects. For example, we recognize the differences between various fur-bearing animals, correctly distinguishing dogs from cats, and recognize objects with different shapes as exemplars, for instance, of chairs or of tables (Carrara and Mingardo 2013). Sometimes we categorize certain objects in a way that could be in contrast with their

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scientific classifications (Dupré 1993; Bird et al. 2016). Take the whale, for example. There is an inclination to consider it as a kind of fish, inasmuch as it exhibits certain morphological traits similar to fish, and, above all, as it shares a peculiar habitat with these animals, namely the sea. Nevertheless, through a biological approach we recognize the whale as an animal with certain morphological and reproductive traits different from those in fish. We can thus conclude that the whale is a creature belonging to a different family, namely that of mammals.

Natural classifications and taxonomies are based on biological assumptions. Clearly, such a criterion is not available for the artificial objects that populate our modern life, but we do have intuitions of a different nature regarding how these objects should be grouped together, and we tend to categorize them automatically (Bloom 1998; Gelman and Bloom 2000; Malt and Sloman 2007a, 2007b). We consider chairs, sofas and couches as similar artifacts in comparison with tables, airplanes and scales. Chairs, sofas and couches are regarded as 'kin' in virtue of the similar function we assign to them, as happens in many cases (Kornblith 1980; Baker 2007). Furthermore, although biological criteria cannot be applied in the classification of cognitive artifacts, we can try to build a taxonomy based on their properties. Consequently, if we have intuitions about the similarities between different artifacts, and if we can classify them according to certain theoretical criteria, it turns out that our intuitions may at times be in contrast with one (or more) of these classifications. For instance, we can intuitively consider GPS navigation systems and maps as objects of the same kind. We may consider them as similar insofar as we use both to orient ourselves in space and – at least at a certain level of abstraction – they seem to have the same function. In any case, if by developing a taxonomy it turned out that the two objects were – contrary to what our intuition might tell us – of two different species, we would be forced to question the accuracy of our insight. As in the case of whales, we would be pushed to revise our intuitions and to consider the GPS navigation system and the map as two different kinds of objects.

GPS devices and maps are particular kinds of artifacts, namely cognitive artifacts. Cognitive artifacts can be tentatively defined as physical objects that have been created or modified in order to functionally contribute to a cognitive task (see Norman 1991; Hutchins 1999; Brey 2005; Heersmink 2013). In the case of GPS devices and maps the cognitive task involved is – obviously – navigating.

In recent years, cognitive artifacts have been dealt with by both cognitive scientist and philosophers. In particular, some philosophers of cognitive science (Brey 2005; Heersmink 2013; Casati 2017) have elaborated taxonomies to classify them and have focused on the metaphysical issues surrounding these objects (Heersmink 2014; Vaccari 2016). On the other hand, the cognitive scientist Donald A. Norman (1993) developed an approach oriented towards the design of smart cognitive artifacts. Norman aims to show how different cognitive artifacts can make a cognitive task easier or more difficult, depending on the kind of representations they provide. More broadly, he aims at increasing «the general understanding of how these technologies of cognition interact with the human mind» (Norman 1993, p.8). In this paper, I conduct a philosophical analysis of cognitive artifacts oriented towards their cognitive dimension, namely an analysis focused on how our mind deals with these objects. I try to do this by elaborating a new theoretical taxonomy of cognitive artifacts that is based on the different kinds of interactions we have with them. In this way, I embrace an "interaction-centered approach" that draws on Norman's work, but it is applied on the philosophical level. This paper has three aims: to build up a new

taxonomy of cognitive artifacts grounded on their relationship with our mind, to shed some light on how these objects exploit their function, and to foster the development of a new theoretical framework to be employed in the analysis of the moral aspects they involve (Heersmink 2015; Fasoli 2016).

Unfortunately, in the past philosophers and cognitive scientists did not make a great effort in classifying cognitive artifacts, and today we have few theoretical classifications at our disposal (Norman 1993; Brey 2005; Heersmink 2013). Considering the increasing diffusion of these objects in our modern life and the moral issues which surround them, this lack of attention seems surprising. Beyond pushing us to revise our intentions about artifacts, having a smart taxonomy of these objects could provide us with several theoretical advantages (Heersmink 2013, p. 469–470). The aim of this paper is to improve our understanding of cognitive artifacts by developing both a new way of classifying such objects and a deeper investigation of the various functions they carry out.

The structure of the paper is as follows. In the first part I will discuss two recent classifications of cognitive artifacts, and underline some deficiencies of these proposals that could be overcome by a different approach. The broad lines of this different approach to cognitive artifacts are outlined in the following section, where an alternative taxonomy of cognitive artifacts is expounded. Finally, in the second part of the article I will stress some metaphysical and moral consequences of the conceptual work undertaken, pinpointing a particular, hitherto unrecognized kind of function of cognitive artifacts.

2 Existing Classifications of Cognitive Artifacts

Cognitive artifacts distinguish themselves from other artifacts insofar as their specific function is to represent, store or retrieve and manipulate information (Brey 2005, p. 384), contributing to the solving of a cognitive task (Norman 1991; Heersmink 2013; Casati 2017). While artifacts such as chairs, knives and cars have been built to serve a non-cognitive function, objects that are used to perform cognitive tasks give us "clear epistemic benefits, as they make such tasks easier, faster, more reliable, or possible in the first place" (Heersmink 2014, p. 1, see also Kirsh and Maglio 1994). Maps, check-lists, calculators and compasses are all examples of cognitive artifacts.

According to Heersmink (2013), two main kinds of approach in the classification of cognitive artifacts have been developed in recent years. These approaches have been defined as "cognitive-centered" and "artifact-centered" (Heersmink 2013, p. 472). The first approach focused on the cognitive capacities associated with cognitive artifacts and led to a quite intuitive way of classifying these objects. Brey (2005), for instance, maintains that "various classes of cognitive artifacts may be distinguished, based on primary cognitive capacity or capacities they extend or aid" (Brey 2005, p. 385). He lists several basic cognitive abilities, such as memory, interpretation, search and conceptual thought (Brey 2005, p. 385–386), pinpointing, for every ability, some devices that extend them. He mentions memory devices (like notepads), interpretation devices (for example all the measuring devices), search devices (like labels) and devices capable of aiding conceptual thought (for example computers).

Therefore, according to Brey some devices, such as notepads, extend memory functions, while others, such as thermometers, are employed for measuring and, by permitting the "assignment of a numerical value to a perceived quality" (Brey 2005, p.

385), change our interpretation of the world. In the third class of artifacts identified by Brey we find labels, filling systems, and, in general, objects that enhance our ability to search for and recognize things (Brey 2005, p. 386). Lastly, the class of artifacts capable of helping conceptual thought include more complex devices like computers. These artifacts can help us specifically in problem solving (e.g. finding the solution to mathematical problems), an ability often involved in conceptual thought.

This way of classifying cognitive artifacts is quite intuitive and straightforward. Nonetheless, this general approach was rejected by Heersmink (2013). According to Heermink, Brey's taxonomy, being completely focused on the cognitive processes, risks excluding the intrinsic features of the artifacts:

> Current categorizations are, moreover, anthropocentric, i.e., they start with human cognition and then categorize artifacts in terms of the cognitive process to which they contribute to (Heersmink 2013, p. 468).

In Heermink's view it is both possible and necessary to avoid the anthropocentrism entailed by previous taxonomies by assuming a different – "artifact-centered" – approach, that is, focused on artifacts rather than on cognitive processes. This novel theoretical perspective, in Heersmink's view, would guarantee a more neutral epistemic analysis of cognitive artifacts (Heersmink 2013, p. 472). First, according to Heersmink, we should distinguish

> two kinds of information-structure: representational and not representational information-structures. Representational artifacts contain information-structures *about* the world (i.e. representational information), whereas non-representational artifacts contain information-structures *as* the world (i.e. ecological information) (Heersmink 2013, p. 472).

The resulting taxonomy is hierarchical, and can be described as follows. Cognitive artifacts are considered as a family, inside which it is possible to discriminate two genera of artifacts (representational and ecological), and several species (see Fig. 1). Representational species are identified on the basis of Peirce's work on representational systems (Peirce 1935), and are of three kinds: iconic, indexical and symbolic. An iconic representational artifact is "relevantly similar or isomorphic to what it represents" (Heersmink 2013, p. 472). Maps are typical examples of iconic artifacts. Indexical artifacts have a "direct causal connection between the index and its subject" (Heersmink 2013, p. 474), as in the case of a compass. Finally, symbolic artifacts "acquire their meaning and content through shared use" (Heersmink 2013, p. 472), and exhibit a strong strand of arbitrariness.

Ecological artifacts, on the other hand, are characterized by exhibiting non-representational information.

> The artificial rotation of a zoid in playing Tetris clearly has a functional role in performing a cognitive task… rather than triadic situated cognitive systems

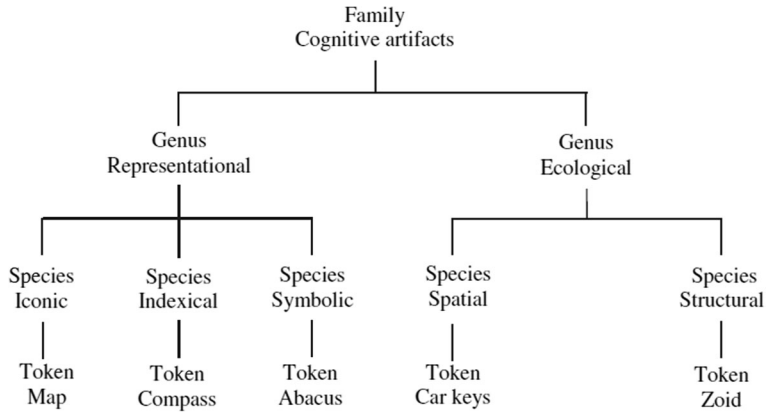

Fig. 1 The taxonomy of cognitive artifacts elaborated by Heersmink (2013) (Taken from Heersmink 2013, p. 473)

(agent-representational artifact-world), ecological artifacts concern dyadic situated cognitive systems (agent-artifact) (Heersmink 2013, p. 476).

Heersmink distinguishes between two species of ecological artifacts. The first is the spatial species, in which he includes artifacts that encode information through the spatial dimension: "By putting artifacts in certain locations that are either deliberately usual or deliberately unusual, we intentionally encode information into the artifact and its location" (Heersmink 2013, p. 477). For instance, a spatial ecological cognitive artifact is created when I leave "a rented DVD on my desk to remind myself to bring it back to the video store" (Heersmink 2013, p.471). A different species of ecological cognitive function arises "in virtue of their manipulable physical or virtual structure" (Heersmink 2013, p. 478). The Tetris zoid and its rotation or the rearrangement of the letter tiles in Scrabble are typical examples of this species of artifacts identified by Heersmink.

The reason we should consider both these approaches unsatisfactory for our purposes, and look for a different way of classifying cognitive artifacts, will be clearer after a brief discussion of some of the shortcomings they involve.

2.1 Examining Existing Classifications: Cognitive Artifacts Are (Always) Representational

While the main strength of the "cognitive-centered" taxonomy developed by Brey lies in the fact that it is intuitive and easy to employ – being grounded on an analysis of representational and non-representational systems – Heersmink's "artifact-centered" proposal constitutes a step towards a deeper theoretical understanding of this class of objects and of their properties. However, it is legitimate to ask whether Heersmink's approach permits us to distinguish between the most significant aspects of the cognitive artifacts.

Let us start by taking into consideration the distinction between representational and ecological artifacts, which are considered as two different genera of objects. According to Heersmink, while representational artifacts "stands for something else" and involve a triadic relation between an interpretant, a sign and an object (Heersmink 2013, p. 473, see also Haugeland 1991, p. 62), ecological artifacts exhibit non-representational information

(Heersmink 2013, p. 476), and can be spatial or structural. In the first case, as already noted, "the intelligent use of space enables us to encode important information into artifacts that are typically neither designed nor made for cognitive purposes" (Heersmink 2013, p. 477). On the other hand, structural cognitive artifacts "obtain their cognitive function in virtue of their manipulable physical or virtual structure" (Heersmink 2013, p. 478).

Examining the function carried out by *spatial* ecological artifacts in greater detail, the differentiation between them and representational cognitive artifacts seems questionable. Consider the example of the DVD intentionally left in an unusual location as a reminder. In this case, the position in space encodes some kind of mnemonic information and the triadic relation between an interpretant, a sign and an object is apparently missing. However, although these elements are not immediately recognizable, it is easy to realize that it is the particular position of the object that helps us remember to return the DVD to the video store. And that particular position seems to constitute a kind of sign, or at least a proto-sign, whereas the state of things – "bringing it back to the video store" – is the object. Obviously, in this situation the person who leaves the DVD in the unusual position is the interpretant. In other words, examining the function of the artifact more accurately it seems difficult to deny that its unusual position, in one way or another, *represents* – at least in a weak sense – the mnemonic information, insofar as it apparently "stands for something else". In a similar way, just as a mechanic, while disassembling a bike, can put every piece down following a logical order, so he can reassemble the bike by following that order (see Kirsh 1995). Again, even in this case there seems to be a sort of codification of a logical order *in* space, which is employed as a dimension for *representing* some kind of information. The position of a piece (before or after another) during the disassembly process constitutes a sign of the correct positioning for that piece during the reassembly process.

A different flaw seems to affect Heersmink's investigation of structural cognitive artifacts, which "obtain their cognitive function in virtue of their manipulable physical or virtual structure" (Heersmink 2013, p. 478). In fact, considering the Tetris zoid or the Scrabble letters, it is difficult to discern any representational elements, and these objects thus appear to be good candidates for being non-representational artifacts. The real question about this kind of objects regards, rather, their ontological nature: are they really cognitive artifacts? The cognitive task involved in the Tetris case is the recognition of the best position of the zoid inside the pattern below, which is simplified by the manipulation of the zoid. This function, however, does not arise from the zoid *itself* (in relation to the task considered), but in virtue of something else. It is the *movement* of the object that simplifies the mental process of individuation of the correct insertion. This movement constitutes an "epistemic action", as Kirsh and Maglio (1994) point out (see also Brey 2005, p. 388), which in turn constitutes a method, or procedure, that we apply to the object to facilitate our cognitive task. Nonetheless, according to a distinction introduced by Heersmink himself, we should consider only physical objects as artifacts, while procedures or methods should be considered as kinds of techniques (Heersmink 2013, p. 468). Heersmink introduces the concept of "technique" in order to distinguish cognitive artifacts from mental procedures, such as the method of loci (Heersmink 2013, p. 468) or in general all mnemotechnics. He does not consider "perceptual-cognitive" techniques, but this is exactly the kind of entity entailed by the Tetris and Scrabble examples. Cognitive artifacts never require any such physical manipulation in order to exploit their cognitive function and thus *to be* artifacts.

Ultimately, if spatial cognitive artifacts can be actually considered as (weak) representational artifacts and if cognitive functions of structural artifacts arise from some particular kinds of technique, it seems hard to find other good candidates for non-representational artifacts. For this reason, it seems reasonable to abandon the distinction between the representational genus and the ecological genus, acknowledging that all cognitive artifacts are, in different ways, representational.

2.2 Examining the Existing Classifications: What they Leave Out

This issue concerning non-representational artifacts could potentially be solved by the inclusion of spatial cognitive artifacts within the representational genus, and eliminating the distinction between ecological and representational cognitive artifacts (namely, recognizing that all the cognitive artifacts are, to different degrees, representational). However, beyond this specific problem, two other questions relating to this "artifact-centered" approach need to be addressed. First and foremost, building a taxonomy while completely excluding the "cognitive side" seems in contrast with the functionalist assumption, endorsed even by Heersmink, which considers cognitive artifacts as physical objects that play a functional role in the solving of a cognitive task. If functions do not exist autonomously in the world, but are, rather, entities that arise in virtue of the relationships between the information structure and our cognitive system, as Heersmink himself recognizes (Heersmink 2014), excluding the cognitive system while building a taxonomy means excluding a key element of the subject of investigation.

The second issue affects both classifications taken into consideration, and regards a particular aspect of cognitive artifacts that seems to be neglected by them entirely. Consider maps, GPS navigation systems and compasses. Assuming Brey's "cognitive-centered" approach, these objects should be all included in the same class, namely that of orienteering artifacts, while, when employing the taxonomy developed by Heersmink, they would be analyzed with respect to their representational properties. In particular, in Heersmink's taxonomy maps and GPS navigation systems would be classified as the same kind of artifact, inasmuch as they share almost all the representational elements and exploit the same function. However, if we look more closely at how these objects work, we notice that they carry out that function very differently. When using a map, the involvement of our sense of orientation is absolutely necessary, because this kind of artifact, in order to function properly, must be correctly matched to the environment by users, recognizing, for instance, the correspondence between the items represented by the map and objects in the physical world. On the other hand, the GPS navigation device requires only to be correctly set and to be understood when receiving its instructions, for instance distinguishing right from left. In this case, the employment of the sense of orientation is not necessarily involved, because it is not essential for completing the task. According to Heersmink, the two objects "on a course-grained (or macro-) functional level of abstraction […] have the same function" (Heersmink 2014, p.7), since in both the situations the task is ultimately accomplished by the agent. Both an agent employing a map and one employing a GPS navigation device behave in a very similar way. They sometimes consult the artifact and choose the direction to follow. It seems reasonable to wonder whether it is not possible to go further in this analysis of the objects, trying to grasp the difference between their

cognitive functioning at a "micro-functional" level. As underlined before, beyond the just mentioned similarities, the two artifacts carry out very different cognitive functions and involve very different cognitive processes. But how? Could a taxonomy of cognitive artifacts really be blind to such differences? This point will made be clearer by adopting a different point of view.

3 Assuming an "Interaction-Centered Approach": A New Taxonomy

According to Norman (1993), cognitive artifacts carry out their function by modifying our tasks (see also Casati 2017). When we employ a checklist, for instance, we no longer need to memorize the items of a list but simply have to write them on a sheet (or on a different support), remember to have a look at that list when needed (and, of course, remember to take it with us) and to read its items (Gawande 2009). Cognitive artifacts can modify our tasks in very different ways, but – as noted in the previous paragraph – current classifications seem blind to this aspect. This fact emerges also when observing how cognitive artifacts have been characterized by scholars. In most cases, they are considered as objects that simply *extend* or *complement* our cognitive capacities (Brey 2005, p. 384, Sutton 2010), but, sporadically, a different view of these objects seems to emerge. Consider, for example, how cognitive artifacts are described in the oft-cited paper by Heersmink (2013)). In its abstract – and in line with the "complementing conception" just mentioned – Heersmink defines cognitive artifacts as "human-made, physical objects that functionally contribute to performing a cognitive task" (Heersmink 2013, p. 465). Nonetheless, a few lines later they are described as "instruments that allow us to perform cognitive tasks we would *otherwise not be able to perform*" (Heersmink 2013, p. 465–466, emphasis added).

The difference at stake here regards the kind of general relationship between artifacts and the cognitive system (see also Brey 2005, p. 387–388). Once our attention is focused on this aspect, these definitions immediately appear to refer to two different kinds of artifacts. The first kind of object *contributes* to the task being performed, which could consequently be completed on its own, without any artifact. Consider, again, the DVD intentionally left on the desk. If you cannot remember anything, you would also forget the meaning of its particular position. You must necessarily remember why the DVD is there. For this reason, we can say that it *complements* your memory. On the other hand, the second kind of artifact is strictly necessary for the accomplishment of the cognitive task, because it constitutes a necessary condition for the realization of the task itself. Written texts, for instance, are necessary for the accomplishment of reading, a cognitive task that cannot be carried out without any artifact. Texts can be written on sheets of paper as well as in the sand or in other supports but they must exist somewhere in order to be read.

If the "cognitive-centered" classification elaborated by Brey and the "artifact-centered" one created by Heersmink both seem blind with respect to the differences in the ways these objects change our tasks, we should look for a third way of taxonomizing them. This can be done by adopting a point of view situated between the artifacts and the mind, and by focusing on those relationships between cognitive artifacts and cognitive processes that are overlooked by the before-mentioned taxonomies. As Hutchins has recently noted, «the interesting questions concern the elements of the

cognitive systems, the *relation among the elements*, and how cognitive processes arise from interactions among these elements» (Hutchins 2014, emphasis added, see also Davies and Michaelian 2016, p. 312).

Once we have decided to assume an "interaction-centered approach", it is quite a straightforward move to distinguish between the two kinds artifacts by focusing on the different relationships just underlined. The first kind of relationship is *complementarity* (Fasoli and Carrara 2016; Fasoli 2016) and occurs whenever the artifact complements a cognitive process that can exist independently. The second kind of relationship is realized when an artifact constitutes a *necessary* condition for the completion of a task that could not otherwise occur. I will gather all the artifacts that complement cognitive processes into the class of "complementary cognitive artifacts", and will call the second kind of artifacts – which are essential for the realization of the task – "constitutive cognitive artifacts". This label intentionally underlines that these objects are strictly necessary for the realization of a new task, which could not otherwise be achieved. Of course, the text does not need to be written on a sheet; it could be written in the sand or be projected on a screen. However, it is not possible to realize a form of reading without a text, regardless of the kind of physical support. Conversely, with some added effort we can remember to bring our DVD back to the store even without any memory-aid.

Complementarity and constitution do not exhaust all the possible relationships between artifacts and the mind. A cognitive artifact can also *substitute* a cognitive process, which may exist independently. Take a GPS navigation system. When using a map, we have to employ our sense of orientation, whereas when employing a navigation system this does not seem necessary (Casati 2017). We do not need to know where we are; we do not need to recognize any correspondences between the map and the environment, or to identify the best route among many possibilities (Javadi et al. 2017). The only thing required in order to use the device efficiently is to enter the data correctly and to follow the instructions of the instrument, distinguishing between right and left, and turning at the right moment. In this case, the substitutive cognitive artifact carries out all, or at least most, of the cognitive work necessary for the task to be completed (Fasoli 2016).

Complementarity, constitution and substitution are thus recognized as the three possible fundamental relationships between cognitive artifacts and our cognitive processes. Nevertheless, cognitive artifacts often not only interact with one of our cognitive abilities at a time, but may engage our cognitive system in many ways simultaneously. A recipe, for instance, needs to be read, but above all it replaces our memory in the memorization of the ingredients. We can thus distinguish between simple cognitive artifacts that interact with only one of our abilities, and complex cognitive artifacts that interact with many (see also Fasoli and Carrara 2016). For instance, the DVD on the table is a simple artifact that interacts with only a single capability, namely our memory, while a recipe is a complex cognitive artifact that is simultaneously constitutive, because it is read, and substitutive, because it replaces our need to remember how to prepare the dish.

Quite often it is possible to identify a primary feature of a complex cognitive artifact. Consider again the GPS navigator. Insofar as it can offer us various texts, for example the name of a street, it represents not only a substitutive but also a constitutive artifact. However, the constitutive component is clearly quite insignificant, because its main feature is the capacity of guiding us towards a particular position in space, and reading

plays a secondary role in the functioning of the tool. In other cases, it does not seem possible to consider one of the features of the cognitive artifact as more prominent than another. As I have just emphasised, the class of cognitive artifacts is very heterogeneous, and the issue is complicated by the possibility of using the same artifact in different ways. This aspect will be addressed more in detail in the next section.

Moreover, although texts are the only artifacts that can be considered as properly constitutive, other artifacts, while theoretically not necessary for the task, are practically mandatory. Consider logic derivations. While simple logic derivations can easily be worked out mentally, it is impractical to approach complex ones in this way, even if the task is theoretically possible. Keeping all the symbols and the calculations in one's head would require an enormous effort – one that would be impossible for most people. Something similar also seems to occur in the case of the aforementioned tetris zoid and the task of finding its best arrangement in the underlying pattern. Mentally reconstructing the zoid and the pattern, and solving the task by simply imagining the best position of the zoid is, in principle, possible. However, such a feat would be extremely difficult to perform because the complexity of the pattern would requires a kind of computational capability that our brains do not normally possess. We can consider these artifacts as "quasi-constitutive" for the task at hand.

To sum up, classifications that have been heretofore taken into consideration seem to neglect how these objects change our tasks. While some artifacts integrate our cognitive capabilities, others substitute such abilities or represent a necessary condition for the execution of some cognitive task. Assuming an "interaction-centered approach", I propose to build a classification of cognitive artifacts that is grounded on this difference and sensitive to the distinct relationships between cognitive processes and artifacts. Hence, I distinguish between substitutive, complementary and constitutive cognitive artifacts (Fig. 2).

4 Metaphysical Foundations of the New Taxonomy and Its Moral Implications

The new classification just elaborated is an attempt to individuate some significant structural properties of cognitive artifacts. If it actually does so, these aspects should be in some way grounded in the metaphysical structure of these objects. This is because "correct classifications must, in some sense, be discovered rather than merely invented" (Dupré 1993, p. 17). I will now try to show how the new classification can contribute to

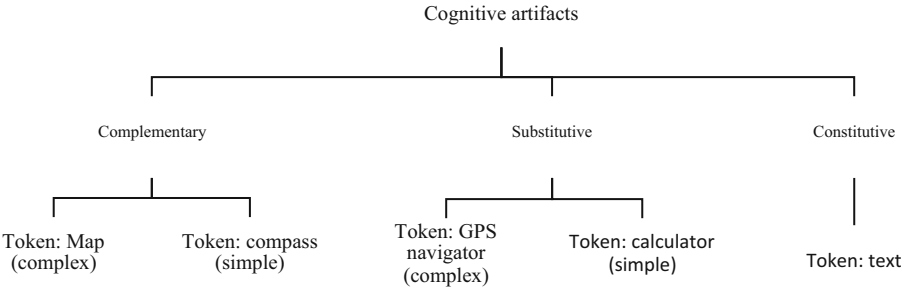

Fig. 2 The new taxonomy

the development of a metaphysically coherent notion of cognitive artifacts. The consequences of the new taxonomy for the moral issues surrounding cognitive artifacts are also worth considering.

4.1 A New Definition of Cognitive Artifacts

It has been recently argued that a functional view of cognitive artifacts (namely a view that considers the functional contribution to the solving of a cognitive problem as their essence) such as the one adopted in this paper, entails significant metaphysical problems (Vaccari 2016). According to Vaccari «the question of artifacts runs into more general and well-known problems with functionalism» (Vaccari 2016, p. 4) and in particular into the so-called boundary problem (see also Shapiro 2008): «there is no principled way to distinguish a realizer of a function from a causal inference on the realizer» (Vaccari 2016, p. 4). In other words, conceiving cognitive artifacts as those objects that *functionally contribute* to the completion of a cognitive task, we encounter the problem of distinguishing between what is functionally significant and what is not, and this is not as simple as it may seem. When a map is used, for instance, it seems quite difficult to discriminate whether the real functional contribution is being carried out by the physical object, by the representation or by the patterns of activation induced by the map in the brain (Shapiro 2008; Vaccari 2016). Firstly, in striving for a better definition of cognitive artifacts we can focus on the specific contribution provided by what we consider to be a cognitive artifact, that is – as Norman claims (1993) and as I have stated before – the modification it brings to a cognitive task. A shopping list permits us to change the original task "memorize a list of items" to the task "write the list of items on a sheet and bring it with you". A calculator transforms the task "mentally calculate" into the task "enter the numbers into the calculator and read the result". And so on. By providing us with representations, cognitive artifacts change our cognitive tasks.

Secondly, it is possible to interpret the meaning of "functionally contributing to the completion of a cognitive task" in terms of the relationships just identified, namely substituting, complementing or constituting our cognitive processes. Drawing from the previous analysis, I propose the following new definition of cognitive artifacts: those physical objects that have been created or modified to contribute to the completion of a cognitive task, providing us with representations that we employ for substituting, constituting or complementing our cognitive processes, thus modifying the original cognitive task or creating a new one.

Thus, by means of the new taxonomy, a definition of cognitive artifacts that avoids the most pressing metaphysical conundrums entailed by the functionalist approach has been elaborated. Specifying that these objects have a representational nature, and that they permit us to modify the original cognitive task, the new taxonomy also provides us with a more precise notion of cognitive artifacts.

4.2 Nonmaximal and Minimal Semi-Proper Functions

Specifying the meaning of "functionally contributing" in terms of the relationships just individuated seems to be a step forward in the working out of a coherent notion of cognitive artifacts. Nonetheless, cognitive artifacts, and artifacts more in general,

sometimes play different functions depending on the users' purposes and on the context in which they are used.

Investigating the metaphysical structure of cognitive artifacts, Heersmink (2014) develops a pluralistic notion of functions, grounded in the previous analysis by Preston (1998, 2013), in which a distinction is made between the proper function and the system function. The proper functions of cognitive artifacts are the functions that have been historically assigned, while the system functions «are either improvised uses of artifacts or the function of novel prototypes» (Heersmink 2014, p. 4). The proper function of an abacus is to calculate, but if we use it during a race to keep track of the number of laps completed by a runner, it assumes a different (system) function, becoming a mnemonic aid. When we ascribe a temporary (system) function to a cognitive artifact in different contexts, the relationship with our cognitive processes may change radically, and may sometimes even disappear. If we use a GPS navigator as a paperweight, for instance, it obviously performs no cognitive functions and consequently has no relationships with our cognitive processes. Therefore, it is necessary to specify that the new taxonomy classifies cognitive artifacts with respect to their proper function.

When discussing different functions performed by the same artifact, an issue seems to arise. Consider the case of a traveller who has checked his route on a map and memorized the way before starting his journey. Once he has arrived in loco, he finds his way correctly, using his memory and his sense of orientation, but he also refers to a GPS navigation system once or twice to check that the direction he has taken is right. In this case, the relationship between the tool and the cognitive processes – contrary to that said before – appears to be complementary and not substitutive. In fact, the information provided by the GPS navigators integrates his cognitive processes that work on the identification of the memorized path and of some reference point, but does not substitute them. Obviously, this cannot be considered as a system function of the GPS navigator. Insofar as, in this context, the artifact does not substitute the cognitive processes but rather complements them, should we conclude that there is a flaw in the new taxonomy? In this example the traveller exploits a function of the GPS navigator that is neither proper nor improvised. In fact, its proper function is to get us to a destination, and in this case it does not do that. It does, however, contribute to the carrying out of our task of orientation. I propose to call this kind of function "semi-proper". Semi-proper functions are realized when users exploit the proper function of a complex cognitive artifact only partially. It occurs when users employ only a part of the information a cognitive artifact may provide. If we write a shopping list but we leave the list at home, we cannot exploit its proper function – namely the substitution of our memory – when we are at the supermarket. Nonetheless, having written the list will probably make it easier to remember what to buy (although we will probably forget some items). In this way, the list carries out a semi-proper function by improving our memorization of some items, which was the original task it was supposed to contribute to. This is not an extemporary function, inasmuch as we are not employing our shopping list for a different purpose. It can also be reasonably argued that this is the most basic function a shopping list can provide. Thus, another distinction can be introduced at a lower level, discriminating between the nonmaximal and the minimal semi-proper functions of the cognitive artifacts (Table 1). While the GPS navigator of the traveller just mentioned plays a nonmaximal semi-proper function, the forgotten shopping list plays a minimal semi-proper function. The minimal semi-proper function is the most basic semi-proper

Table 1 Proper functions, semi-proper functions, and system functions

Proper functions (maximal)	Semi-proper functions	System functions
	Nonmaximal function	
	Minimal function	

function an artifact can perform. When a traveller looks at a map only once and memorizes a long route instead of employing that artifact to orient himself during his journey, he is employing the minimal semi-proper function of the map. In fact, maps have long been printed on paper rather than other supports as their proper function is to be checked repeatedly 'on the spot', throughout an orienting task. Paper is light, occupies little space and it is easy to carry. When employing the proper function of a map during a navigational task a person need not memorize a route completely.

Given the complexity of many modern cognitive artifacts and the wide variety of usages we can make of these objects, it is not always possible to identify either the minimal semi-proper cognitive function of a cognitive artifact or, at times, its semi-proper function. This is because some cognitive artifacts provide us with 'all-or-none' information, and semi-proper functions arise only when the proper function is only partially exploited. For instance, it seems impossible to identify a semi-proper function of the aforementioned DVD, insofar as its results cannot be employed only partially: we either use them or we do not.

Nonetheless, to properly understand how cognitive artifacts work, it is important at least to recognize that the degree of interaction between cognitive artifacts and our mind may vary depending on the kind of function we ascribe to them. And such variability moves mainly along these two dimensions, the minimal and the maximal, depending on the informational complexity of the object. In this view, the proper function of a cognitive artifact can be considered as its "maximal" function, because it involves the minimum contribution in terms of cognitive processes of the user in the solution of a cognitive problem compared to the minimal semi-proper function that, in turn, involves the maximum in terms of cognitive effort.

As has been stressed many times by cognitive sciences, we human beings have strong limitations in our information processing and storage capabilities. We create artifacts and offload information into the world to augment human capacities (Kirsh 1995; Hutchins 1999; Brey 2000; Clark 2004), and our brains often tend to avoid the most demanding cognitive tasks (Kahneman 2011). For this reason, we are usually inclined to use these objects by exploiting their maximal cognitive abilities. In fact, using a GPS navigator only to complement our orientation seems quite unusual, inasmuch as we usually employ it to substitute our sense of direction.

That being so, classifying cognitive artifacts by focusing on their proper functions is a theoretical choice that seems justified and consistent with our intuitions about these objects. Consider once again the GPS navigator. The fact that it is such a kind of tool is not related to its ability to provide us with maps, or to help us remember our way, but rather to its capability of getting us to a destination, calculating a path and providing us with instructions at every intersection. The complementary use of the GPS navigation is not the proper use of that tool. In this and similar cases, it seems appropriate to say that

a substitutive cognitive artifact is being employed in a complementary way. Analogously, if we use the abacus as a device for counting, and not for calculating, we are likely to consider it as an abacus that is being employed by exploiting a semi-proper function of that object instead of considering it as a true counter, at least if we do not do it regularly (Heersmink 2014, p. 3–4).

5 Moral Aspects of Cognitive Artifacts

There are several questions arising from this new approach to cognitive artifacts. Looking at the neural side of the problem of artifacts, for instance, we may ask if are there any similarities between cognitive processes and the circuits underlying the employment of similar cognitive artifacts. Furthermore, the new taxonomy represents a challenge for advocates of extended cognition theories in general, who should specify which kinds of artifacts represent genuine cases of mind – or cognition – extensions and which do not (Clark 2004, p. 32–33, see also Heersmink 2013, p. 466).

Many other questions regard the moral aspects of these objects and the possibility that different relationships between the mind and artifacts could reflect different potential effects – positive or negative – for our brain, at least under specific circumstances. First and foremost, should we consider substitutive cognitive artifacts as potentially dangerous insofar as, in employing them, we run the risk of compromising some cognitive capabilities (Carr 2011; Heersmink 2015; Fasoli 2016) – or should we consider them as positive insofar as they permit us to improve other more important cognitive capacities? This question does not appear to have a unique answer, inasmuch as these artifacts may be either deleterious or enhancing, depending on many variables. Broadly speaking, the risk of losing a cognitive ability due to the use of an artifact arises when we cease to use an ability that requires constant practice in order to function properly. Certain abilities, depending on their kind, may be retained even without being practiced for an extended time, while others may be lost over a much briefer period. Considering the complexity of our brain and the number of elements to be kept in consideration, such an assessment seems a challenging goal, and will have to be carried out on a case by case basis.

Even when we are not able to reliably assess this risk, it is possible to make a different kind of evaluation by focusing on the specific ways in which a cognitive artifact is supposed to improve our cognitive capacities. Obviously, saving time and cognitive effort thanks to cognitive artifacts does not automatically represent a guarantee of improvement of any other cognitive capability. Rather, substitutive artifacts enhance our capacities when they are embedded in more complex cognitive tasks – for instance when calculators are employed to solve difficult mathematical problems rather than simple calculations. In these cases, the cognitive agent solves a complex cognitive task with greater ease thanks to the substitution of certain cognitive processes.

Paradoxically, substitutive cognitive artifacts support the improvement of certain cognitive capabilities even when we employ only part of the information they provide, namely when we exploit their semi-proper function. We may argue that exploiting the semi-proper function of the aforementioned GPS navigator may not only help maintain one's sense of direction, but may sometimes even improve it. Consequently, we may speculate about the possible advantages of not always exploiting their proper (maximal)

cognitive function, in order to preserve certain cognitive capabilities or to support certain learning processes. Nonetheless – as argued in the previous paragraph – given the various factors that push us to exploit the maximal function of these objects, we may reasonably ask if recommendations to artifact users would be sufficiently convincing. In turn, this would require a discussion about the power of cognitive artifacts to steer us towards specific behaviours. While the fact that artifacts (and more generally, technology) can, in some way, elicit certain specific behaviours has rarely been definitively denied (Pitt 2014), it is still not clear how, and to what degree, they do so (an important contribution to the understanding of this point has been made by Latour 1994, see also Heersmink 2015, p. 9).

Finally, when the risk of losing some cognitive capability seems real, we should individuate the most important capacities to be preserved, and those which can be given up without regret (Heersmink 2015). This would seem to require a kind of cognitive cost-benefit analysis which has not yet been performed. If the ability to memorize several phone numbers seems to be something we would not regret losing in the future, and in this case phonebooks can unproblematically substitute our brain, things become more complicated when we consider other technologies. For instance, the possibility that the habit of using search engines may interfere with our ability to memorize and access different kinds of information is more worrisome. In turn, the disparity between these two conditions in which substitution is realized raises a different, and fundamental, question: which kinds of dependency from technology are we willing to accept and which not? Clearly, much depends on the reversibility or irreversibility of the processes, and on how we conceive the relationship between ourselves and technology.

To sum up, we have tentatively identified two conditions under which substitutive cognitive artifacts profitably support our cognitive processes, and one condition in which they are not detrimental. Such artifacts seem to play a positive role in learning processes when we exploit their semi-proper functions, and when they are embedded in more complex tasks. Instead, they appear to be "neutral" when they substitute cognitive capabilities that we either do not really risk losing (because they are so deeply rooted in our brain that they cannot be lost), or can lose without regret, because we do not consider them highly significant.

The complexity of these issues reveals that the elaboration of a taxonomy constitutes only the starting point of a comprehensive theory of cognitive artifacts. In terms of its future development, a theory of this kind should examine these objects both individually, from a taxonomic point of view, and in connection with the various cognitive capabilities they involve. In particular, what we seem to be lacking is a theory of how a specific design of a cognitive artifact produces specific affordances, and how these affordances induce us to initiate one cognitive process rather than another. From this perspective, it is worth noting that assuming a determinist (at least to some degree) view of technology does not entail renouncing the possibility of limiting the substitutive usage of artifacts. In other words, we may hypothesize that substitutive artifacts will guide us to employ them in a substitutive way (namely exploiting their proper function) but we can still evaluate the possibility of introducing some sort of "auto-limitations". Once we discover that a cognitive process is in some way dangerous or deleterious, we may nudge ourselves towards specific cognitive processes. We can imagine smart GPS navigators sometimes turning themselves off and providing us only with maps, thus forcing us to employ their semi-proper function in order to keep our

sense of direction in good working condition (Fasoli 2016). Intentionally restricting the functioning of artifacts can be viewed as a radical choice, but may be necessary to avoid the loss of specific abilities.

6 Conclusion

"At least for the most part, it seems that what makes two artifacts members of the same kind is that they perform the same function" (Kornblith 1980, p. 112). According to the taxonomy just elaborated, we should seriously reconsider this statement and our intuition about the similarities between cognitive artifacts. Maps and GPS navigators, for instance, apparently have the same function, but are different kinds of artifacts because they change our cognitive tasks in a different manner, by maintaining a different relationship with our cognitive processes. These different relationships between artifacts and minds are the true specific characteristics of cognitive artifacts, and should not be buried beneath a theoretical classification.

At the beginning of this paper I showed that our intuitions about natural objects can be misleading. Sometimes we tend to consider objects as similar in virtue of similarities between certain non-crucial features, without considering other attributes that are less explicit, but essential. The same may also be true of artificial objects – in the case of cognitive artifacts – when we focus only on their function considered on a macro-level. However, the present taxonomy will assist us in revising these misleading intuitions.

My hope is that this new taxonomy may also be helpful in addressing new moral issues connected to technology. Cognitive artifacts constitute some of the most ubiquitous ingredients of our mental life, and recognizing the hidden structure of their functioning is one of the most important goals to achieve in order to develop more effective tools without running the risk of losing important cognitive abilities.

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