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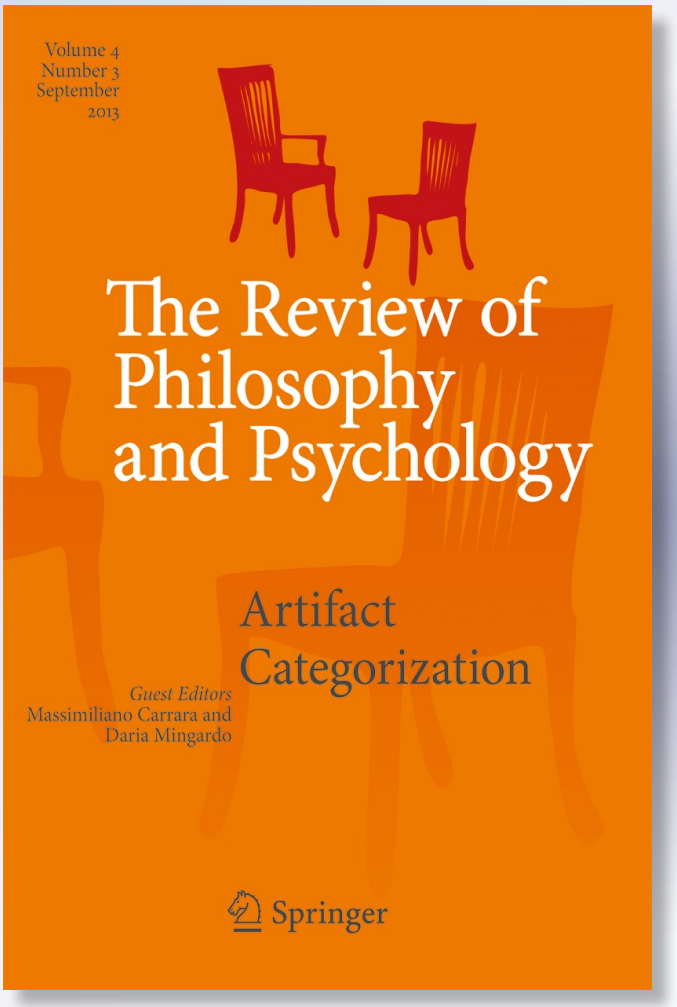

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Abstract This study addresses the issue of artifact kinds from a psychological and cognitive perspective. The primary interest of the investigation lies in understanding how artifacts are categorized and what are the properties people rely on for their identification. According to a classical philosophical definition artifacts form an autonomous class of instances including all and only those objects that do not exist in nature, but are artificial, in the sense that they are made by an *artĭfex*. This definition suggests that artifacts are classified primarily on the basis of the recognition of their artificial nature. Nevertheless, many psychological and cognitive studies maintain that artifacts are categorized mainly on the basis of the recognition of the function they have been made to accomplish. Since tools are also categorized primarily on the basis of their function, this would imply that artifacts and tools are represented in the same way. In the study participants categorized a set of objects (denoted by words) once as tools and once as artifacts. Results show that reaction times (RTs) are faster in the artifact categorization condition than in the tool categorization condition. This pattern indicates that artifacts and tools are not represented in the same way and that the identification of the members of each class is carried out in the basis of different criteria.

1 Introduction

Philosophers and psychologists have both addressed the issue of the artifact kind starting from different perspectives. The philosophical literature has provided a principled definition of artifacts that qualifies them as a specific and individual class of objects including all and only the objects that are made by someone (see e.g. Hilpinen 2011).

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More specifically, according to this definition artifacts are characterized by the fact that they do not exist in nature per se (therefore they are opposed to natural kinds), but are artificial, in the sense that they are made by an *artĭfex* (a maker, an author or a manufacturer). This definition suggests that artifacts are classified primarily on the basis of the recognition of their artificial nature.

For cognitive psychology, the primary interest of the investigation lies rather in understanding how artifacts are categorized and what are the properties people rely on for their identification (see e.g. Mulatti and Coltheart 2012; Mulatti et al. 2008, 2010). Namely, this area of study considers the artifact kind primarily as a psychological kind: i.e. as a class of objects that humans group together (see e.g. Medin and Ortony 1989). The studies on artifacts are part of a research program which aims to describe the overall architecture of human knowledge and its organization according to general categories.

Many of these studies depart from the philosophical analysis of the artificial nature of artifacts, maintaining that artifacts are categorized primarily on the basis of their function (see e.g. Kelemen and Carey 2009; Bloom 1996, 1998, 2000; Keil 1989). The general idea behind this association between artifacts and function is that artifacts are usually created because their makers want them to serve some purpose. The physical features of artifacts will therefore depend on the function they are designed to serve. According to these studies which analyze artifacts starting from their function, recognizing the specific physical features that make an object appropriate for accomplishing some purpose (or more specifically the intended purpose of the maker) is essential to identifying and classifying that object as an artifact.

Therefore, function is considered the critical feature humans use to categorize objects as artifacts. This consideration brings about the theoretical question that this study aims to address. Since function is also the main characteristic we use to categorize tools, should artifacts and tools be considered a single class; i.e. are they represented in substantially the same way? On the one hand the association between artifact and tools also seems to be intuitively justified by the fact that (almost) all tools are artifacts. This is, for example, implicitly assumed by many psychological studies where considerations about the mental representation of artifacts are made starting from arguments and experiments concerning tools (see e.g. Mahon and Caramazza 2009; Kelemen and Carey 2009; Mandler 2002; Greif et al. 2006; Santos et al. 2002). On the other hand, however, artifacts and tools are defined differently and there are many artifacts which are not tools (e.g. works of art or any part of an artificial object which when separated from the whole, cannot accomplish a function).

2 Artifacts and Tools

The class of artifacts is usually considered one of the basic categories human knowledge is organized into. Nevertheless, its investigation turns out to be particularly difficult because the objects that compose it lack homogeneity and because there is wide disagreement about the inclusion or exclusion of specific atypical instances. As pointed out e.g. by Keil, Greif, Kerner in their study on artifacts with the provocative title *A World Apart*: "The literature in cognitive science often contrasts artifacts and natural kinds as though they were compatible levels in a standardized

hierarchy of objects in the world. Although this distinction has featured prominently in many studies of cognition and cognitive development […], it has the potential to mislead. Consider those frequent cases in which non-living and living natural kinds are associated with each other but are contrasted altogether with artifacts. Do the entire class of living kinds and artifacts sit at roughly equivalent levels of generality in this putative hierarchy? It is clear that they do not. The domain of artifacts is much more varied and much less predictable in form and function than the domain of living kinds. […] A closer examination of the nature of artifacts reveals a vast domain with subdomains that may differ at least as dramatically from each other as they do from the entire domain of living kinds. These differences have consequences not only for how adults represent and think about artifacts, but also for how children acquire artifact concepts" (Keil et al. 2009, pp. 231–232).

The variety of the objects that might be included in this class make it difficult—as Keil, Greif and Kerner suggest—to assign artifacts to a specific position in the conceptual hierarchy, determining their degree of generality and their specific contrast with other sets of entities like non-living kinds and living natural kinds.[1] This variety is due, in turn, to the definition of artifacts many researchers rely on. The defining characteristic of artifacts is that they are made by an *artĭfex*: by a maker, an author or a manufacturer.[2] Artifacts do not exist in nature per se. Unlike natural kinds they are not produced by nature or by natural history, and are therefore artificial, i.e. made by someone. An artifact is the result of someone's application of an art—of a technique—to something; it is the product of the mental and physical work of the *artĭfex*.

As e.g. Grandy (2009) points out, when we think of artifacts, what comes to mind is mainly a subclass of familiar objects such as bicycles, cups, clocks, etc. However, following the definition we have just introduced, an extremely wide variety of objects might be included in the class of artifacts. As physical objects produced by an author, works of art are certainly included, but so too are 'anomalous' man-made objects such as cities, roads, and artificial lakes as well as composite or modified substances such as polystyrene, stainless steel and decaffeinated coffee (to be precise, also normal coffee, if we consider that coffee powder does not exist in nature, but only coffee beans do). Social objects created by collective intentionality such as money or marriage (see e.g. Searle 2009) might also be included among artifacts.

Furthermore, even though we commonly think of artifacts in terms of non-biological and non-living objects, this class might actually be extended to the biological world, too. Indeed, some authors maintain that, if we define any kind of object that has been produced through someone's work as an artifact, then we must extend the artifact class to all the animate, living and biological objects obtained by

[1] On the classification of living and non-living things see Dellantonio et al. (2012).

[2] In English the figure of the *artĭfex* is usually described using words like 'creator', 'maker' or 'author'. The term 'creator', however, suggests the wrong notion since a creator is someone who creates from nothing, while the *artĭfex* only modifies something preexistent. 'Maker' renders the idea in a more precise way, even though in philosophy this term has also assumed very abstract meanings (such as e.g. truth-maker) which have distanced it from the practical and manual sense of the word artĭfex. The term 'author' (or 'designer') has an analogous problem since it often refers to the person who conceives and devises something, rather than to the one who practically realizes it. 'Artisan' or 'manufacturer' are more specific, but possibly also more precise in rendering the idea of the concrete acting of the artĭfex.

means of human intervention such as Dobermans, bonsais, and nectarines, which result from human modifications (see e.g. Sperber 2009).

Furthermore, leaving aside genetic intervention, the relationship between biological objects and artifacts remains problematic. One could maintain that there is no difference between carving wood or forging metal to make an object and chopping an animal carcass into pieces to make a steak or kneading and mixing ingredients to make a cake. In addition, even though some authors rely on a definition according to which only *human*-made objects can be considered artifacts (see e.g. Thomasson 2009), others maintain that the class of artifacts is actually wider and includes objects manufactured by animals: according to this view e.g. nests and spider's webs are also artifacts (see e.g. Gould and Gould 1999; Gould 2009).

However, despite the extreme variety of the objects that might be included in the class of artifacts, most studies—in particular, psychological studies—addressing the position of artifacts in the human conceptual architecture focus almost exclusively on a specific type of artifacts, i.e. on tools. A massive number of psychological studies investigate artifacts relying on arguments and experiments regarding tools (see e.g. Mahon and Caramazza 2009; Kelemen and Carey 2009; Greif et al. 2006; Santos et al. 2002). This association between artifacts and tools seems to be supported by commonsense since tools are likely to be the first kind of objects that come to our mind when we think of artifacts (see e.g. Grandy 2009), and (almost) all tools are artifacts. However, this association is grounded on a specific hypothesis about how the artifact kind is categorized and what criteria people use to identify an object as an artifact. Artifacts are primarily objects which have been made by someone. But, when one makes an object, one usually does so because of a specific intention: the intention to satisfy a purpose. In other words, a *maker intentionally produces an object so that it accomplishes a function*. However, if an artifact has been made to satisfy a specific purpose, then its properties will depend directly on that purpose (see e.g. Bloom 1996; Hilpinen 2011; Elder 2009). Thus, artifacts can be identified on the basis of the function that the maker assigned to them (see also Hilpinen 1992, 1993; Bloom 1996; Thomasson 2009). Unless an artifact has been originally designed with the intention to satisfy a certain purpose and afterwards a different function has been assigned to it (like in the case of a teapot used as a flowerpot), original intended function and actual function are one and the same (see e.g. Grandy 2009, 28, Bloom 1996, 10 ff.).

As e.g. Kelemen and Carey stated: "[…] an artifact is intentionally created by a designer to fulfill some function. The intended function is the factor which determines the artifact's surface properties, the actual uses it can serve (the intended function as well as others), and its kind. In that sense, the original intended function is the artifact's essence." (Kelemen and Carey 2009, p. 214; see also Bloom 1996, 1998, 2000; Keil 1989). According to this definition, the recognition of the (intended) function of an object is *essential* with respect to its classification as an artifact. More specifically, in Bloom's words: "[…] our categorization of artifacts is rooted in our intuitions about the creator's intent and how it relates to the physical form of an object" (Bloom 1998, 87; see also Keil 1989; Dennett 1990; Bloom 1996). Artifact kinds are characterized by a wide diversity of appearance and therefore kind membership cannot be based solely on visual features (Lotto et al. 1999). According to this view, what makes us understanding that an object belongs to the class of artifacts is the recognition of the function that object has been made to accomplish: "what an

object looks like and what is done with it are relevant only insofar as appearance and current use are reliable cues to its intended function" (Bloom 1996, 3).

Giving prominence to the function, this definition connects the class of artifacts with that of tools, since tools are also defined primarily by the fact that they are objects which accomplish some function, and it suggests that artifacts and tools are represented in the same way. However, this association between artifacts and tools might be highly problematic.

Firstly, although, on the one hand, we know that already in a very early stage of their development children learn that objects may accomplish some function,[3] on the other hand, we know that objects can accomplish functions regardless of whether they are artifacts or natural kinds. As e.g. Hauser's and Santo's study shows (Hauser and Santos 2009), nonhuman primates are capable of using many instruments to help them reach food. Nevertheless, the fact that they are capable of resorting to tools (such as e.g. long and curved objects to dig up food) and to infer a function starting from the shape of the object does not imply that they can distinguish an artifact as an artificially manufactured object from a natural object (such as a naturally curved stick) which could serve the same purpose. In this sense, it seems possible to categorize tools without considering whether they are also artifacts or not. It seems, therefore, that tools can be identified on the basis of their function, independently from artifacts. This is also an implication of the classical *affordance theory* according to which humans do not perceive only the physical properties of objects, but they also or primarily perceive their affordances; i.e. they see what the objects can be used for (Gibson 1977).

Secondly, the dissociation between artifacts and tools is sustained also by the classical definition of artifacts mentioned before, according to which, differently from the concept of tool, the concept of artifact is not intrinsically linked to the idea of function or defined by it, but the class of artifacts includes all and only the objects made by an *artĭfex*. According to this definition, the class of artifacts is clearly wider than that of tools since it is made of all the objects that have been modified by humans, *including those that do not serve any purpose*.[4] Possible examples of artifacts which don't accomplish any function are not only works of art,[5] but also any *casual or incomplete assembly of parts*. If some of the artifacts do not accomplish

[3] Studies like e.g. Brown 1990; McCarrell and Callanan 1995; Hespos and Baillargeon 2001; Mandler and McDonough 1998 provide evidence that toddlers and even infants are able to recognize the possible function of objects given their structural properties. Furthermore, other research on primates shows that they use tools in an opportunistic manner, choosing whatever object with the suitable shape they find for food retrieval (see e.g. Cummins-Sebree and Fragaszy 2005; Hauser 1997), even though, unlike humans, they don't associate objects with any stable function (see e.g. Vaesen 2012, 4).

[4] Actually, as already suggested before, not all tools are artifacts either. Indeed, there are natural objects that by virtue of their form and properties can be used as tools: a stone can be used to crack nuts or drive a nail; a stick can be used as a harpoon, a protruding root as a stool etc. However, one could answer that objects like these are not tools in a strict sense, but they are natural objects which can be of use for specific purposes. The only connection with tools would be that to understand their possible use, a person must be able to infer the function they might accomplish from their form and from the properties they exhibit.

[5] One could rather maintain that works of art do have a function since they are produced with the aim of communicating something. However, their message—and therefore their function—might be nether immediate nor transparent. If so, it is implausible that the categorization of works of art as artifacts is carried out on the basis of the recognition of this function.

any function, it is possible and maybe even plausible that the recognition of the function of an object *is not essential* for its classification as an artifact.

These observation allow us to put forward two alternative hypotheses on how artifacts are categorized.

(i) From a cognitive point of view the recognition of the intended function is essential for the categorization of artifacts (even though the function of objects doesn't necessarily play a role in the definition of the artifact kind). Since tools are also categorized primarily on the basis of their function, this implies that artifacts and tools are basically represented in the same way.

(ii) Artifacts and tools are two distinct classes of objects, and they are categorized using different criteria. This perspective does not question the fact that tools are also artifacts, i.e. that there is an overlap between these two classes. Rather it denies that the (intended) function of an object determines a decision regarding class membership for artifacts. The suggestion implicit in this hypothesis is that for the classification of an object as an artifact humans rely on the properties revealing its artificial nature, while for its categorization as a tool, humans rely on the properties indicating its functions.

This second hypothesis might actually be split into two different sub-hypotheses. On the one hand, artifacts and tools may be two separate and independent classes, whose members are identified on the basis of their artificial appearance and of their function respectively. On the other hand, tools could be a subclass of artifacts. In this case the identification of artifacts would rely on the recognition of their artificial nature only, while the identification of tools would require both the recognition of their artificiality and of the function of the instances.

Authors who assign an essential role to the identification of the function of an object with respect to its classification as an artifact—and therefore implicitly embrace hypothesis (i)—establish a connection between the judgment of an artifact's kind and the judgment of an artifact's purpose, suggesting that the information we rely on for the judgment of an artifact's purpose is also relevant with respect to the judgment of an artifact's kind (see e.g. Kelemen and Carey 2009, 213–216). However, if hypothesis (ii) is correct and people categorize artifacts and tools in a separate manner, then the judgment of an artifact's kind and that of an artifact's purpose will be two distinct judgments carried out on the basis of different criteria, possibly related to artificiality and function respectively.

Hypotheses (i) and (ii) lend themselves to empirical tests as they make different predictions about how people will perform when asked to categorize objects along the artifact/tool dimension. To test these predictions, we ran an experiment using a Go/NoGo reaction time task. In this task, participants respond when presented with a particular class of stimuli (the so-called *Go* trials) and withhold a response otherwise (these are the so-called *NoGo* trials); the reaction time of the answers to the Go trials is measured.

3 Experiment

The aim of this study was to determine whether artifacts and tools are represented in the same way or not and, more precisely, to determine whether the time needed to

categorize an item (e.g. a hammer) as an exemplar of the category of artifacts or as an exemplar of the category of tools is the same or different. To address this issue we conducted an experiment on adult Italian native speakers using a Go/No-go reaction time (RT) task. Participants were presented with written words that could either be names of living things or names of things that could be classified as both artifacts or tools (e.g. hammer, spoon). There were two blocks of trials in the experiment. In one block, participants were instructed to press a button if the stimulus they were presented with was the name of an artifact and to withhold their response otherwise. In another block, participants were instructed to press a button if the stimulus they were presented with was the name of a tool and to withhold the response otherwise. The order of presentation of the blocks was counterbalanced across participants. Although for a given participant the items in one block were different from the items in the other block, assignment of items to blocks was counterbalanced across participants so that—throughout the experiment—the same item (e.g. key) was classified both as an artifact and as a tool.

In the instructions for the experiment, the Italian words "artefatto" (as a translation of "artifact") and "strumento/utensile" (as a translation of "tool") were used. The noun "artefatto" is somehow problematic since, strictly speaking, in Italian "artefatto" exists only as an adjective or as the past participle of the verb "artefarre". However, "artefatto" is commonly used as a noun both in the spoken and in the written language (including many academic works) with the same meaning as the corresponding English word. The most technically appropriate term we could have used is "manufatto", but this word is somehow misleading since it recalls the idea of "made by hand" and Italian speakers tend (erroneously) to classify as "manufatti" only those specific artifacts that are *not* industrially produced. As far as "tool" is concerned, this was translated using two words instead of one, since in Italian there are many terms referring to tools and—even though they are synonymous as far as their definition is concerned—in everyday usage people tend to apply the one or the other to indicate different kinds of tools. "Strumento" and "utensile" are the most general expressions and, taken together, they cover all the possible tools people can think of.

If—as stated by hypothesis (i) above—the recognition of intended function is essential for the categorization of artifacts, then RTs in the artifact categorization condition should be comparable to RTs in the tool categorization condition, because the criteria for including a given item into one category or the other are the same. Instead, if—as stated by hypothesis (ii)—artifacts and tools are identified by different criteria and these criteria differ in e.g. complexity or availability, then RTs in the artifact categorization condition should differ from RTs in the tool categorization condition: the more complex the criteria, the longer the RTs.

3.1 Method

Participants Twenty students of the Università di Trento took part in the experiment. They were all native Italian speakers and had normal or corrected-to-normal vision.

Materials One hundred names of living things (mean frequency: 8.5 occurrences per million (frequency count were obtained from the CoLFIS database, Laudanna et al.

1995); mean length in letters: 6.6) and 100 names of objects (mean frequency: 10.4; mean length in letters: 7.5) were selected. Objects were selected so that they fit in both the category of artifacts and the category of tools. For counterbalancing purposes, two lists were created, list A and list B, each composed of 50 living things and 50 objects. Objects in list A and list B were balanced in terms of frequency (9.8 (16.4) vs. 11.1 (18.1), $t<|1|$), orthographic neighborhood size (3.4 (4.2) vs. 3 (3.0), $t<|1|$), orthographic neighborhood frequency (7.2 (14.1) vs. 5.9 (9.5), $t<|1|$), letter length (7.44 (2.0) vs. 7.5 (1.8), $t<|1|$), and number of syllables (3 (0.9) vs. 3 (0.8), $t<|1|$).

Apparatus and Procedure Participants were tested individually. Participants sat in a dim light room in front of a computer screen. Stimulus presentation and data recording were controlled by a software developed in E-Prime. Participants performed two blocks of trials: in one block they were required to press a button on the keyboard if the word was the name of an artifact and to withhold the response otherwise; in another block they were required to press a button if the word was the name of a tool and to withhold the response otherwise. Note that the terms 'artifact' and 'tool' were not defined in the instructions given to the participants. The order of presentation of the two blocks as well as the assignment of the lists (i.e. either list A or list B) to the blocks was counterbalanced across participants: thus a full counterbalance of lists and blocks required 4 participants.

Each trial started with a fixation cross (+), centered on the screen, for 500 ms. 100 ms after its offset, a word appeared in the centre of the screen. Participants were required to press the key M on the keyboard as quickly and accurately as possible if the word was—depending on the block—the name of an artifact or of a tool and to withhold the response if the stimulus was the name of a living thing. If no responses were detected within 2 s, the stimulus was removed from the screen and the next trial started. The inter-trial interval lasted 2 s. Each experimental block was preceded by a practice session composed of 22 stimuli.

3.2 Results

Reaction Times Errors in the Go trials (7.8 %) were removed prior to RTs analysis. Correct RTs were submitted to a *t* test with Category (artifacts vs. tools) as a repeated factor in both the by participants (t1) and the by items (t2) analyses. Mean RTs according to condition are reported in Table 1.

Statistical analysis showed that words were categorized significantly faster as members of the category artifacts than as members of the category tools, $t1(19)=2.4$, $p<.05$, $t2(99)=7.6$, $p<.001$.

Errors Mean errors according to condition are reported in Table 1. Errors were submitted to a *t* test with Category (artifacts vs. tools) as a repeated factor in both the by participants (t1) and the by item (t2) analyses.

Participants' accuracy was significantly lower when classifying words as tools than when as artifacts, $t1(19)=2.9$, $p<.01$, $t2(99)=6.8$, $p<.001$.

Table 1 Mean RTs and percentage of error according to condition

Category	RTs		Errors	
	Means (ms)	SD	Means (%)	SD
Artifacts	769	128	3	5,5
Tools	857	163	12	14,5
Diff.	88		9	

SD standard deviations

4 Discussion

To identify a particular object (denoted by a word) as an artifact or as a tool people resort to specific parameters describing the inclusion/exclusion criteria for that class. These criteria need not to be explicit and/or consciously represented and might well be implicit and unconscious. They are, however, strictly dependent on the way individuals learned to use specific words and to classify particular instances.

The idea here is that the time required to classify an item as a member of a given category is a function of the complexity of the criteria against which that item needs to be evaluated: the more complex the set of criteria, the longer it takes to make a decision.

If, as assumed by hypothesis (i), the recognition of the intended function is crucial for the categorization of artifacts, then the classification of an item as an artifact should rely on the same criteria used for its classification as a tool and this would predict the RTs in the artifacts categorization condition to be similar to those for the tools categorization condition.

The experimental data show that this is not the case, as RTs are faster in the artifact categorization condition than in the tool categorization condition. Since the proposed stimuli were the same for both tasks, the difference in the reaction times cannot be ascribed to stimulus differences, but must be explained on the basis of the different degree of complexity of the parameters used for categorization in each case. This pattern is consistent with hypothesis (ii) according to which artifacts and tools are two different classes of objects. Thus, the pattern of results shows that artifacts and tools are not represented in the same manner. Rather, *the identification of the members of each class is carried out on the basis of different criteria*, and *the criteria people apply to identify tools are more complex that the ones we use to categorize artifacts*.

This claim receives indirect support also from the observation that the size of the effect is quite similar when participants are required to perform the tools decision on the first block and when they are required to perform the tools decision on the second block (82 vs. 94 ms, $F(1, 40)<1$). This suggests that the decision that an object is a tool is not slowed down as a result of an implicit comparison with the artifacts decision.

Previously, hypothesis (ii) was split into two sub-hypotheses and we suggested that artifacts and tools can *either* be two separate and independent classes, whose members are identified on the basis of different criteria (presumably artificiality and functionality respectively) *or* tools can be a subclass of artifacts. In this later case tools identification

would be a two-step process: the object is firstly identified at the level of artifacts and then at the level of tools using two sets of criteria (presumably artificiality and functionality). Our results are compatible with both possibilities. In fact, if artifacts and tools constitute two separate classes, then the RTs difference in the two conditions must be due to the fact that the criteria used to identify tools are per se more complex than those used to identify artifacts. On the other hand, if tools are a subclass of artifacts, then the RTs difference in the two conditions must be due to the fact that the identification of tools is a two-step process, while the identification of artifacts requires one step only.

Although our data do not allow us to distinguish between these possibilities, the pattern of errors might be diagnostic that the sub-class hypothesis is less tenable. In fact, the number of errors is much higher in the tools than in the artifact decision. In addition, these errors are distributed over many of the items with at most three participants failing to categorize any specific item as a tool. The errors in the tool condition are evenly distributed across all the items, i.e. there are no items with a particularly high number of errors: the maximum number of errors for any given item is three. This suggests that the identification of an item as a tool does not only take longer than its identification as an artifact, but is also in general less univocal, i.e. more complex and error prone.

While the idea that the identification of the members of each class is carried out on the basis of different criteria was quite predictable given the difference between the definition of artifacts and tools, it is quite surprising that tool categorization is slower than artifact categorization. Indeed, the artifact class has been shown to include an extremely wide variety of objects, while tools are a relatively more homogeneous class and, in general, categorization is expected to be easier (i.e. faster) when the class members are internally more homogeneous (Forster 2004). In fact, some authors have suggested that intended function is critical for categorizing artifacts exactly because it is difficult to think of some *other common* and *identifiable* characteristics people could rely on to group artifacts together as they are physically so different from each other (see e.g. Bloom 1996).

To sum up, the criteria humans use to identify an item as an artifact and or a tool must be different. We have suggested that artificiality could be the signature of artifacts, while function could be the defining characteristic of tools. Our data suggest that the latter is harder to detect than the former.

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