A Dual-Aspect Theory of Artifact Function

Marc Artiga[1] ⬤

Abstract

The goal of this essay is to put forward an original theory of artifact function, which takes on board the results of the debate on the notion of biological function and also accommodates the distinctive aspects of artifacts. More precisely, the paper develops and defends the Dual-Aspect Theory, which is a monist account according to which an artifact's function depends on intentional and reproductive aspects. It is argued that this approach meets a set of theoretical and meta-theoretical desiderata and is superior to alternative views.

1 Introduction

Objects as diverse as hammers, soccer balls, amulets, times machines, laptop fans, seashell horns and totem poles have a striking commonality: they possess functions. But what property are we attributing when we ascribe functions to them? What determines an artifact's function? The goal of this paper is to provide an original answer to these questions.

More precisely, in this essay I would like to put forward a theory of artifact function, which partly derives from progress made in the biological case, but which also takes seriously the distinctive features of artifacts. In particular, I will defend the Dual-Aspect Theory, which is a monist account according to which an artifact's function depends on intentional and reproductive aspects. This approach should be understood as a theoretical definition of the notion of *artifact function*: it primarily aims to describe the property that is ascribed in functional attributions, rather than investigating the conception that scientists, laymen, engineers or designers have of functions, or stipulating a new meaning for other purposes. The Dual-Aspect Theory is supposed to clarify the nature of artifact functions.

The paper is structured as follows. Section 2 puts forward the most important desiderata for a theory of artifact function and shows that extant theories fail to satisfy some of them. In Sect. 3 I develop the Dual-Aspect Theory (DAT) and in Sect. 4

✉ Marc Artiga
  marc.artiga@uv.es

[1] Departament de Filosofia, Universitat de València, Valencia, Spain

I argue that DAT meets the previous desiderata, is extensionally adequate and is superior to alternative hybrid views. Finally, Sect. 5 addresses some objections.

2 Desiderata

The goal of this first section is to provide a set of desiderata that a satisfactory theory of artifact function should accommodate. Although no desideratum is fully uncontroversial, this list includes a set of widely accepted features, either because of the explanatory roles that functions are supposed to play or because they are intuitively compelling.

First of all, some desiderata are shared by theories of biological and artifact functions:

ESSENTIAL/ACCIDENTAL: Functions are appropriately distinguished from non-functional effects.

NORMATIVITY: An item's function sets a normative standard.

EXPLANATION: An item's function has an important explanatory value.

The first desideratum suggests that not any effect should qualify as a function (Wright, 1973; Wouters, 2005: 134; Houkes & Vermaas, 2010: 5). The regular noises produced by my heart or by my laptop fan count as one of their effects, but surely not as one of their functions.[1] Secondly, functions set a normative standard: hearts are *supposed to* pump blood and computer fans are *supposed to* cool computers; if they don't have this effect, they malfunction, or fail to function correctly (Millikan, 1989; Neander, 1991: 454; Price, 1995: 143; Wouters, 2005: 133–134; Krohs & Kroes, 2009: 3; Houkes & Vermaas, 2010: 5; Preston, 2018). In many artifacts this aspect is even legally recognized, as many warranties only cover damages produced in proper use (Preston, 2013: 151). The third desideratum suggests that functions have some explanatory value (Nagel, 1977: 291; Price, 1995; McLaughlin, 2001: 168; Mossio et al., 2009). In the context of biological traits, for instance, it is usually assumed that a trait's function contributes to explaining the trait's existence: present-day hearts exist and have a particular structure partly because their function is to pump blood. A parallel reasoning seems to hold in the case of artifacts: we can partly explain the existence and structure of my computer's fan by appealing to its function as a cooling device. An adequate theory of biological or artifact functions must account for these phenomena.

In addition, artifacts have certain distinctive aspects that also need to be accommodated. First of all, whereas it is unclear that the first token of a new biological trait has functions, most philosophers think it is extremely plausible that

---

[1] The ESSENTIAL/ACCIDENTAL desideratum is sometimes understood as suggesting that a theory of function should not only distinguish functional from non-functional effects, but also differentiate central from peripheral functions (e.g. Houkes & Vermaas, 2010: 5). In Sect. 5 I will argue the Dual-Aspect Theory also accommodates this feature.

first token of an original artifact can possess them (Millikan, 1989: 294; Griffiths, 1993: 420–421; Allen & Bekoff, 1995: 614; Vermaas & Houkes, 2003; Longy, 2013; Preston, 2018):

INNOVATION: The first exemplar of a new kind of object can have a function.

Think about the inventor of the zipper, Otto Gideon Sundback. His first token of a zipper already had the function of binding the edges of two pieces of clothing. Similarly, when Edison created the first prototype of light bulb, it already had the function of producing light.

This point leads to a second distinctive desideratum of artifacts, what Preston (1998, 2009) calls 'phantom functions' (see also Allen & Bekoff, 1995: 614; Baker, 2007: 56; Holm, 2017):

PHANTOM: An item can have a function even if it (or any other item of the same kind) has never been able to fulfill it.

An example of phantom function is provided by amulets. The nazar is an eye-shaped amulet used worldwide to protect people from evil's eye, but this function is impossible to carry out (assuming that there is no evil's eye, of course). Consider also Ali Razeghi's claim that he had invented a time machine in 2013. Generally, newspapers reporting this story didn't question the idea that he built a machine with the function of bringing the future to the present (although they obviously questioned whether this function could be carried out). Likewise, Preston (2013: 138) suggests that although bug zappers are supposed to reduce the number of mosquitoes around by killing them, some evidence indicates that they are not very efficient at it; indeed, they might actually increase the population of mosquitoes nearby.

Interestingly, the combination of INNOVATION and PHANTOM suggests a striking category: a new kind of object can have a function, even if it is unable to perform it (Preston, 2018). This looks like a plausible result: we can imagine Sundback with an early prototype of zipper thinking that its function is to bind edges, but that it still does not work.

Finally, I would like to add two meta-theoretical desiderata, which do not derive from any particular feature of artifact functions, but from general theoretical virtues that any desirable account should possess:

UNIFICATION: The analysis does not multiply the senses of *artifact function*.

All things being equal, a theory that accounts for all features of artifact functions by assuming that it refers to a single property should be preferable to a theory that claims it refers to multiple properties (Houkes & Vermaas, 2010: 8). An obvious motivation for this desideratum is Occam's razor: we should not multiply the senses of *artifact function* beyond necessity. Theoretical simplicity is a general virtue of any explanation and our account will be simpler if we can

accommodate all cases by attributing a single property. Of course, one might have strong reasons for going pluralist or contextualist, but everything else being equal a monist approach should be favored.

Now, I formulated UNIFICATION in terms of artifact functions, yet many philosophers probably embrace a more stringent desideratum, namely that, all things being equal, we should prefer an account that does not multiply the senses of *function*, so that a single analysis applies to artifacts, biological entities, social facts, etc... (e.g. Boorse, 2002: 67; Perlman, 2009). I agree that this is a compelling desideratum as well. Nonetheless, I will not discuss it here for two main reasons. On the one hand, addressing this desideratum would require analysing in detail how the notion of function is used in these other domains, and this is a project that lies beyond the scope of this paper. But, more importantly, it is unclear that this kind of unification can be achieved: note, for instance, that biological and artifact functions have different properties (e.g. PHANTOM and INNOVATION apply to artifacts, but not to biological functions), so it is hard to see how an overarching definition could satisfactorily apply to all of them.[2] In any case, in this paper I will leave aside the question of whether such an analysis can be developed.

Nevertheless, I think there is a weaker desideratum with respect to the relationship between biological and artifactual functions that is safer and that most people should be happy to accept:

RELATION: There is no hard line between biological and artifact functions.

All things being equal, we should prefer a theory that accounts for the close connections between the functions of biological entities and artifacts (Krohs & Kroes, 2009; Perlman, 2009: 19; Longy, 2013). As we saw above, given the desiderata shared by functional entities in biology and technology, it is reasonable to expect that the process giving rise to functions should be partly similar in the two cases.[3] A second important motivation for taking this desideratum seriously is that many functions lie between the biological and the artifactual realm (Longy, 2009). For example, to what extent the function of roses is biological or artifactual, given that their evolution has been intentionally directed for centuries? (Perlman, 2009) The same seems to be true of most domesticated plants and animals, as well as organisms designed in synthetic biology (Sperber, 2007; Holm, 2013). Drawing a clear-cut line between biological and artifact functions would leave many difficult cases in-between. Finally, an approach that satisfies RELATION can more easily explain the fruitful exchange of theoretical models from biology to technology and vice versa (Lewens, 2004a, 2009; Houkes, 2009).

---

[2] Of course, it might be possible to accommodate all kinds of functions within a single comprehensive theory of mind and world. My point is simply that the four-line theories that are typically provided in the context of artifact functions are unlikely to account for all functional discourse.

[3] Indeed, note that RELATION is compatible with the same theory of function applying to both domains. Thus, one way of satisfying RELATION is to provide a single account for biological and artifactual functions.

This is the list of desiderata we will assume in the rest of the paper. Although none of them has escaped criticism, they exhibit wide support and I think they are intuitively compelling. Furthermore, my arguments will often appeal to different desiderata, so I think the main claims and arguments of the paper would resist the rejection of some of them. We should start somewhere, and I think these desiderata offer a clear and well-motivated starting point.

There is a final question that needs to be addressed before moving on. Since satisfying some of these desiderata might be in tension with fulfilling others, the question of trade-off inevitably arises. Do all desiderata possess the same rank? Or is it more important to meet some of them than others? My tentative answer is that UNIFICATION should be ranked lower than the rest: it seems that a theory that fails to account for normativity or that fails to distinguish functions from non-functional effects has a serious problem, whereas a theory that accommodates all desiderata but UNIFICATION does not have a problem—it is just not as ideal as we would like it to be. This might be rooted in the fact that UNIFICATION describes a goal we strive to achieve, but which might be impossible to get, while the other desiderata are supposed to capture properties that functions actually possess and which are explanatorily relevant. We could express the same idea in moral terms by saying that satisfying UNIFICATION is supererogatory, while fulfilling the other desiderata is required. Although providing a unificatory theory is a worthwhile goal, this aim should not be pursued the cost of failing to accommodate any other desideratum.

2.1 Previous Approaches

Having settled the desiderata, let us address the main question of the paper: What theory can account for the function of hammers, amulets, seashell horns and totem poles? What determines an artifact's function? Since artifacts are objects produced, used or designed by intentional agents, probably the first suggestion that comes to mind is that functions must derive from the intentions of the designer, producer or user (Evnine, 2016: 120). This is the key intuition of intentionalist theories according to which an item x has a function F iff an agent designs, produces or uses an object x with the intention to F (Neander, 1991; Searle, 1995; Baker, 2007: 51). This account has the obvious appeal that many of the functions of daily objects are effects that designers, producers and users intend them to have. Furthermore, it has the advantage of being extremely simple (e.g. it clearly satisfies UNIFICATION). Nonetheless, it also faces serious problems.

First, it fails to account for unintended functions of objects. Think, for example, about so called 'latent functions', which Merton (1968: 105) defined as objective consequences contributing to the adjustment or adaptation of a system which are neither intended nor recognized by agents. A totem pole has the latent function of reinforcing group identity, even if this effect is not consciously intended by anyone in the tribe. Recognizing latent functions is fundamental for anthropology and sociology, since finding out that an object or behavior lacks a manifest function should not stop research. Note, however, that the existence of latent functions implies that an object can possess the function F even if nobody actually intended it to F

(Perlman, 2009: 28; Preston, 2013; Longy, 2013; cf. Thomasson, 2007: 57). Moreover, on a purely intentionalist theory the process endowing artifacts with functions and the conditions for ascribing biological functions are completely different (unless we are also prepared to endorse some form of creationism with respect to biological entities). Thus, intentionalist theories also fail to satisfy RELATION.[4]

An alternative proposal is to use the approach that works for biological entities and apply it to artifacts. According to the most popular theory of biological functions, the (selectionist) etiological theory, a trait's function is to F iff it has been selected for F (Millikan, 1984, 1989; Neander, 1991; Griffiths, 1993; Godfrey-Smith, 1994). For example, the function of pancreatic islets is to produce certain hormones because this is the effect that explains their selection. Similarly, one might argue that an artifact has a function if it has been selected for F in a process that mimics natural selection (i.e involving variation, heredity and differential reproduction—Preston, 1998, 2013). To illustrate this suggestion, consider the function of projectile points, which were hafted to ranged weapons. Their function probably was to kill animals, and they actually seem to have been historically reproduced because of this effect. Indeed, it has recently been argued that the evolution of projectile points can actually be modeled using the tools of evolutionary theory (Mesoudi, 2011, 91; O'Brien et al., 2001). Other examples that have been suggested to fit this pattern are the evolution of writing tools (Preston, 2009), pottery in the lower Mississippi Valley (Lyman & O'Brien, 2000) or recent evolutionary design in electronics (Houkes, 2009).

Unfortunately, this proposal is not devoid of problems. For one thing, it does not satisfy INNOVATION and has difficulties with PHANTOM: If an item has a function in virtue of belonging to a kind that has been selected for, new artifacts or objects that belong to kinds that have never been able to perform F cannot have functions (Preston, 2009; Longy, 2013; Holm, 2017). More generally, it seems that artifacts can have many other functions that those deriving from a history of selection through a process analogous to natural selection.

A third proposal defines the functions of tokens in terms of the contribution that they actually make to the attainment of a goal of a larger system. Roughly, the idea is that an entity has function F iff it contributes to a capacity of a larger system by F-ing (Cummins, 1975). For example, the heart's function is to pump blood because this is its contribution to the circulatory system. As many people have pointed out, however, this analysis of function probably fails to account for ESSENTIAL/ACCIDENTAL, NORMATIVITY, EXPLANATION in the context of biology, so this approach is likely the inherit the same difficulties in the context of artifacts (Houkes & Vermaas, 2003: 283). On the one hand, any contribution to a capacity of a larger system might qualify as a function, so it is probably unable to draw a distinction between essential and accidental effects (Millikan, 1989: 294). Secondly, it fails to accommodate

---

[4] It could be replied that intentionalism and the standard etiological theory of biological functions have some important element in common, namely that both of them define functions as reasons for existence (Neander, 1991). Unfortunately, this analysis would render the theory too narrow and too broad at the same time, as I will argue in Sect. 4.3.

malfunction: if an item fails to contribute to a system's capacity, it lacks a function and only items that posses a function can malfunction. Likewise, on this approach functions are not supposed to contribute to explaining the existence of the functional item. Finally, since this notion requires an item to actually perform F in order to have a function, it probably fails to fulfill PHANTOM as well.

These and similar difficulties with monist accounts have led some philosophers to embrace some sort of pluralism. Preston (1998,, 2003, 2009),[5] for instance, holds a disjunctive theory according to which artifacts can have two different kinds of functions: etiological and Cummins-functions. One difficulty of this particular view, however, is that it fails to account for some cases that neither the etiological nor Cummins' approach are able to accommodate: functions that artifacts have never been able to perform, i.e. phantom functions (Houkes & Vermaas, 200: 285).[6] Furthermore, pluralist approaches fail to satisfy UNIFICATION, because they tend to multiply the senses of *artifact function*. As a consequence, functions proliferate: on Preston's account a hammer would have two functions with exactly the same content (driving nails), one deriving from etiology and the other from its actual contribution to a capacity of a system.[7]

Interestingly, note that those cases that seem problematic for intentionalist theories (latent functions) might be readily accommodated by etiological perspectives, since these artifacts often have a history of reproduction, whereas counterexamples to selectionist approaches (innovative and phantom functions) are easily accommodated by intentionalist approaches, given that they are intended effects. This result suggests the following challenge: Is is possible to include the key insights of intentionalist and etiological approaches in a single account without adopting a straightforwardly pluralist view, which would proliferate the senses of function and fail to comply with UNIFICATION and (possibly) RELATION?

Meeting this challenge is one of the key motivations for the Dual-Aspect Theory (DAT), which I will present and defend in the remainder.

---

[5] Let me stress that a fair assessment of Preston's account as well as other approaches would require more space than the one I can offer here (some of these alternative views will be discussed in Sect. 4.3). In any case, please keep in mind that the main goal of the paper is to put forward an original theory of artifact function rather than providing a complete survey and exhaustive analysis of extant approaches.

[6] Indeed, Preston (2003) agrees: she recognizes the intuitive force of PHANTOM, but since she thinks no account can accommodate all desiderata, she gives this one up.

[7] Interestingly, a virtue of Preston's account (shared with other pluralist views) is that, although she presents a disjunctive theory, it applies to both biological and artifactual functions, so although it fails to satisfy UNIFICATION as I formulated it (because it multiplies the senses of *artifactual function*) it achieves some sort of unification across domains. In any case, as I argued in Sect. 2, I think this meta-theoretical desideratum is less important than the others, which her account fails to meet (e.g. PHANTOM), so even if some pluralist accounts provide some sort of unification, I their difficulties with the other desiderata of higher rank suggest that the Dual-Aspect Theory that I will present should be preferred to them.

3 The Dual-Aspect Theory

The Dual-Aspect Theory[8] is my proposal for accommodating the previous desiderata by means of a non-pluralist account that includes intentional and non-intentional aspects. In a nutshell, the account can be spelled out as follows:

(DAT) x's effect F is a paradigm case of artifact function iff

1. x belongs to a type X and entities of type X have been reproduced (partly) because they performed F.
2. Some agent with control designs/produces/intends to use x for F-ing

A first important remark on this definition is that it primarily defines what is required for an effect to qualify as a *paradigm* case of artifact function. My use of the notions 'paradigm' and 'marginal' derives from Godfrey-Smith (2009) (although, of course, similar concepts have been employed by other philosophers before him). Godfrey-Smith develops the concept of paradigm in the context of analyzing what he calls 'Darwinian populations', which are populations that have the capacity to undergo evolution by natural selection. Paradigm instances of a category are those that have greater scientific importance and a more significant explanatory role. For instance, paradigmatic Darwinian populations possess reliable mechanisms of inheritance, contain some variation, are highly integrated collectives, have a high degree of reproductive specialization (germ/soma distinction), etc. A population that fails to possess some of these features will count as a marginal instance of Darwinian population (or, at some point, as not an instance of Darwinian population at all). For example, honeybees probably are a paradigm case of Darwinian population because they score relatively high on all dimensions: they form an integrated collective, possess mechanisms of inheritance, reproductive specialization, etc. In contrast, sponges have some level of integration and a reliable mechanism of inheritance, for instance, but lack reproductive specialization (they do not possess anything like a germ/soma distinction). Consequently, unlike honeybees, sponges are a marginal case of Darwinian population because they score low on some dimensions.[9]

---

[8] The expression 'dual-aspect' is reminiscent of the research program 'the dual-nature of technical artifacts' (Krohs, 2009; Houkes & Vermaas, 2010; Kroes, 2012). Nonetheless, the goals of both projects differ significantly: whereas 'dual-nature' refers to physical and intentional features, the dual-aspect approach seeks to exclusively analyze functions in terms of intentional and reproductive aspects (for reasons that will be provided below). No relation with the homonymous theory in philosophy of mind is intended.

[9] Crucially, note that the suggestion is not that there are multiple concepts of 'Darwinian population'. The idea is that different *aspects* are relevant for establishing whether an entity qualifies as a central or peripheral instance of a Darwinian population. Similarly, my proposal is that the intentional and non-intentional aspects define two dimensions of artifactual functions, but that does not mean that we are defining multiple concepts of function.

In general, I think the focus on the paradigm-marginal distinction is a useful strategy for addressing questions in biology, technology and sociology. As I will argue below, this perspective provides some conceptual tools that are useful for illuminating certain issues. Furthermore, it allows us to shift the focus from the counterexample game (Perlman, 2009) to more interesting questions about central and peripheral cases. However, I don't think adopting this perspective entails that one can entirely avoid the question of specifying necessary and sufficient conditions for having an artifact function. With respect to that concern, my suggestion is that, in the same way that partly satisfying some of the aspects mentioned above suffices for qualifying as a (marginal instance of) Darwinian population, scoring high on one of the two dimensions of DAT suffices for being a (marginal instance of) artifact function. That is, either fulfilling the intentionalist or the reproductive aspects probably suffices for having an artifact function, whereas satisfying at least one of them is necessary for having an artifact function. Nevertheless, both are necessary for a function to be paradigmatic. Notice that, in principle, DAT could be understood differently: one could, for instance, accept DAT and hold that both conditions are necessary for an effect to qualify as an artifact function, that the two conditions are jointly (rather than independently) sufficient or that DAT fails to provide necessary and sufficient conditions.[10] The main reason for adopting the particular interpretation I favor is that on this view DAT can satisfy all desiderata presented in Sect. 2, as I will argue in Sects. 4 and 5. Thus, these two sections provide an extended argument for my particular interpretation of DAT.

Now, let me explain the two claims of DAT in some detail. According to the first aspect, a paradigm artifact function F belongs to a type of entity that has been reproduced because it performs F. Boilers and umbrellas are reproduced partly because often enough they successfully heat water and protect their bearers from rain, respectively. This process might be similar in some respects to the process of selection involved in natural selection, but some important differences remain. As some people have pointed out (Vermaas & Houkes, 2003; Preston, 2013: 159; Sperber, 2007: 128) in the case of artifacts, reproduction (rather than selection among variants) is much more important. Although sometimes selection among objects having slightly different effects takes place, very often artifacts get copied because of their benefits, irrespective of whether any other entity of the same type is more or less successful. I think my umbrella would possess exactly the same function even if it was the only model in the market and no alternative type of umbrella had existed

---

[10] One way of capturing the relationship between biological and artifactual functions is to consider 'function' a family-resemblance concept, as suggested by Carrara et al. (2011) and Vermaas (2013). Yet, I think that analysing 'function' along the paradigm-marginal axis is compatible with different views on the question of providing necessary and sufficient conditions (including certain views according to which the quest for necessary and sufficient conditions is pointless). My take on this issue is that this question remains a meaningful and important one, so my suggestion is that the two conditions of DAT are independently sufficient and satisfying one of them is necessary for artifactual functions. As a result, it probably does not fit the idea of 'family resemblance', as it is usually understood.

before.[11] Similarly, artifact reproduction is often formal rather than material (Godfrey-Smith, 2009: 155) and, in contrast to biological entities, artifacts do not usually produce copies of themselves: reproduction requires an external agent (Millikan, 1984: 23-25; Lewens, 2004b: 142-3). One way of developing this idea is in terms of an agent's *control* (see below). There is a complex debate on the process of reproduction of material culture and I cannot delve into this issue here. For our purposes, let me just say that some broad process of reproduction, which in certain respects is analogous to the process of heredity involved in natural selection, is a defining aspect of artifact functionality.

The second claim of DAT asserts that in paradigm cases someone intends the artifact to be used for F-ing. This aspect is supposed to be broad enough to encompass the intentions of designers, producers and users. Again, boilers and umbrellas have been intentionally designed, produced and used for their functions. I think this is a virtue of the account, not only because often distinguishing these three roles in practice is far from easy (Preston, 2003, 2013: 170–175), but also because one can easily find examples of function in which one of these elements is missing. The current function of Post-It notes, for instance, was not intended by his inventor, Spencer Silver, who was attempting to develop a super-strong adhesive. In this example, the intentions of users as well as the effects that account for their reproduction are much more important than its original design. In paradigm instances, all of them (designers, producers and users) intend the object to be used in (roughly) the same way, but in less central cases intentions might differ.

A further important qualification needs to be added to this second aspect. Suppose that I'm sitting in my living room and decide that the Eiffel Tower actually has the function of being a huge bird nest. It is hard to accept that this distant thought can actually warrant a new function to the Eiffel Tower (even a marginal one). For my intention to endow an artifact with a function I should have some *control* over the object. In other words, the agent's intentions can only determine functionality when she can manipulate or intervene on the object in certain respects. Central examples of agents that are in this position are designers, producers and users. Accordingly, 'control' should be understood in a very broad way: it surely includes creating an object, but also changing some feature or even moving it. Indeed, purposefully refraining from changing some aspect of an object might suffice for satisfying this requirement. If I know that my neighbor is allergic to some plants that naturally grow in my garden, not cutting them intentionally counts as endowing them with the function of annoying my neighbor (for a similar case, McLaughlin, 2001: 43–44).

These caveats point at an important feature of this account. Although I defined two aspects of paradigm cases of function (an intentional and a reproductive one), each of them could in turn be decomposed into other aspects, some of which might

---

[11] Interestingly, it has been argued that even in the context of biological entities selection among variants is not required for a trait to have a function (Buller, 1998; Schwartz, 1999). Even if this is true, this is probably a marginal case of biological function (see Artiga, forthcoming), whereas here I am suggesting that it constitutes the paradigm case of artifact function.

be more important than others. For example, the intentional aspect might actually be divided into several dimensions, such as the intentions of designers, those of producers and those of users as well as the extent to which the agent has control over the object. Likewise, the reproduction aspect might be cashed out as involving a process of copy (where certain features might be more central than others) and so on. This fact vindicates the idea that the two aspects of DAT can be satisfied to various degrees, which means that there will be a range of intermediate cases.

Summing up, the Dual-Aspect Theory defines paradigm instances of function by appealing to intentional and reproductive aspects. At the same time, however, it remains a monist account: there are not two kinds of functions, but a single notion that admits of central and peripheral cases depending on how items score on certain dimensions. In the next section I will provide some reasons for thinking this account is on the right track.

4 A Defense of DAT

The goal of this section is to argue that the Dual-Aspect Theory is a promising approach. First, I will show DAT clearly fulfills all desiderata and that it can *explain* why artifact functions tend to have all these features. Second, I will argue that artifact functions are coextensional with effects that satisfy DAT in the following sense: paradigm instances of artifact functions clearly possess the two aspects, whereas marginal cases lack some of them. Third, I will defend that DAT is preferable to similar hybrid accounts. Potential objections will be addressed in the next section.

4.1 Accounting for the Desiderata

To show that DAT can accommodate all previous desiderata, I will argue that each of the claims included in DAT can explain some of the features of functions and both can account for all of them.

Consider the intentionalist aspect of DAT. It clearly satisfies ESSENTIAL/ACCIDENTAL because there is some room for a distinction between functions and accidental effects. Artifacts have many effects that are not intended by anyone, such as the noise of my laptop fan or the heat emitted by light bulbs (cf. Preston, 2003). The intentional aspect can also explain why functions set a normative standard, so it fulfills NORMATIVITY (Price, 1995: 159; Krohs & Kroes, 2009: 4; Baker, 2007: 55): If someone intends to use an object in order to F, but it fails to F, there is an obvious sense in which the object can be said to malfunction. EXPLANATION is also satisfied because appealing to the intentions of designers, producers and users contributes to explaining the existence of artifacts and their physical properties. For instance, soccer balls are air-filled spheres because their function is to be kicked and roll on the grass. The fact that they are designed, produced and used to this end explains the existence of this object and its physical structure. Finally, the intentional aspect can also easily accommodate INNOVATION and PHANTOM (Houkes & Vermaas, 2003; Preston, 2003). On the one hand, the first token of a new kind of artifact can have a

function F because (1) satisfying one of the two claims of DAT is sufficient for having a function, (2) designing, producing or intending to use an item to F suffices for satisfying condition 2 of DAT and (3) a subject can design, produce or intend to use a first exemplar of a new kind of object to F. It can also account for phantom functions: an item that is unable to perform F can still have F as its function in virtue of someone intending it to be used to F.[12] Accordingly, amulets or time machines can possess functions (although, as we will see, they are marginal cases). Thus, the intentionalist aspect can accommodate ESSENTIAL/ACCIDENTAL, NORMATIVITY, EXPLANATION, INNOVATION and PHANTOM.

In turn, the reproductive aspect can also account for some features of functions. On the one hand, it can draw the distinction between essential and accidental effects because only some effects account for an item's reproduction. On the other, functions explain why artifacts exist and have the structure they do, since this is the reason they have been reproduced. Moreover, the effect that accounts for the reproduction of an artifact sets a normative standard; it is an effect that the object *is supposed* to have. Finally, note that by appealing to this aspect DAT can account for latent functions: totem poles have the function of reinforcing group identity even if this was not explicitly intended by any participant, because this is the effect that accounts for its reproduction.[13] Therefore, this second aspect of DAT can account for ESSENTIAL/ACCIDENTAL, EXPLANATION and NORMATIVITY. Indeed, note that those who already accept an etiological theory for biological functions and hold that this theory satisfies ESSENTIAL/ACCIDENTAL, EXPLANATION and NORMATIVITY in the biological domain are probably forced to accept that an analogous process can ground these features in the context of artifacts. The only way one could avoid this consequence is to implausibly reject the multiple realizability of functions (see Elder, 2007: 49; Soavi, 2009).

Finally, given the way that the intentional and reproductive aspects are joined in this theory, this approach also complies with the last two meta-theoretical desiderata. Firstly, it satisfies UNIFICATION since it does not multiply the senses of function. A single property is attributed in every instance of artifact function, although two aspects need to be satisfied for an item to clearly possess a function. In the same way that Godfrey-Smith's (2009) analysis of 'Darwinian population' in terms of inheritance, integration or reproductive specialization provides different aspects that are relevant for applying a single concept (and it would be wrong to understand him as suggesting that there are multiple concepts of 'Darwinian population'- see footnote 9) DAT provides an account of the concept of 'artifact function' and identifies

---

[12] Preston (2009, 2013, ch. 5) argues that intentionalist approaches cannot accommodate all phantom functions because in some cases what accounts for the reproduction of an item x is not that people intend to use x to F or even believe that it can perform F; reproduction might be due to tradition, authority, etc. However, this is only an objection against theories that assume that the intention establishing an artifact's function has to explain why the item has been reproduced. This is not an assumption of DAT.

[13] DAT requires non-intentional functions to be reproduced effects, so the first token of a new kind that has no intended function cannot have a function (not even a 'latent' one). That seems correct to me. The examples of latent functions that one typically finds in the literature involve effects that partly explain why the item or practice has been maintained. It is not obvious why we should classify as a function a one-shot effect that has neither been intended by anyone nor explain the reproduction of the object or practice.

two aspects that are relevant for qualifying as a paradigm case.[14] Consider a different example: Queller and Strassman (2009) define what they call the 'paradigm organism' as an entity with high cooperation and low conflict among its parts (note that these two conditions can vary independently). These authors are not multiplying the senses of 'organism', but providing an analysis of this concept in terms of two relevant dimensions. Likewise, if one holds a prototype theory of concepts and maintains that a paradigmatic instance of bird should be able to fly, lay eggs and possess feathers, she is not multiplying the senses of 'bird' but specifying different dimensions that are relevant for correctly applying this concept. Emus and penguins would still qualify as birds, but not as central cases. Consequently, DAT is not a disjunctive theory that merely gives a distinctive label to entities that have reproductive and intentional functions, but a genuinely integrated account that considers these two aspects as dimensions of a single category.

Last but not least, DAT does not draw a hard line between artifact and biological functions and highlights their close connections, so it satisfies RELATION. Certainly, as I argued in Sect. 2, the desiderata for biological and artifact functions are different and some entities with biological functions lack artifact functions and vice versa (see below), so we use the concepts 'biological function' and 'artifact function' to capture different phenomena. Nonetheless, there are interesting connections between them, and DAT illustrates some of these relations. For example, if some form of etiological theory is on the right track for biological entities, then the conditions for having an artifact function partly overlap with the conditions for having a biological function (Artiga, forthcoming). For instance, if having a biological function F depends on being selected for F, and the process of natural selection requires being reproduced because of F, then some artifacts with biological functions might possess a marginal artifact function.[15] Note, however, that paradigm cases of biological function still differ from paradigm cases of artifact function. As I will argue in the next section, I think this result corresponds with a standard classification of examples.[16] Likewise, a theory based on different aspects can readily account for intermediate cases (e.g. biotechnical examples). I also believe that thinking in terms of 'aspects' makes the distinction between biological and artifact functions more fluid.

---

[14] There are significant differences between Godfrey-Smith's (2009) approach and mine: for one thing, he offers a multidimensional proposal, whereas DAT only appeals to two dimensions; for another, we are probably not engaged in the same kind of project (e.g. one of my main goals is to provide a monist account, whereas this is not even an issue in his proposal). Nonetheless, I also think there is an important analogy: I offer an analysis in terms of different dimensions and adopt the paradigm/marginal distinction, and in that respect my account is similar to his. Thus, if his proposal is not taken to multiply the senses of 'Darwinian Population', then this is an argument for interpreting my analysis in a similar way. I want to thank an anonymous reviewer for pressing me on this issue.

[15] It is worth emphasizing, though, that DAT requires that in order to possess an artifact function some agent must be in *control*: artifact reproduction probably requires that some agent has control over the object, and I argued this is also true of the intentional aspect. As a result, most biological entities would not even possess a marginal instance of artifact function.

[16] This argument assumes that some version of the etiological theory of biological function is on the right track. If this presupposition fails, then the extent to which DAT meets this RELATION should be reassessed.
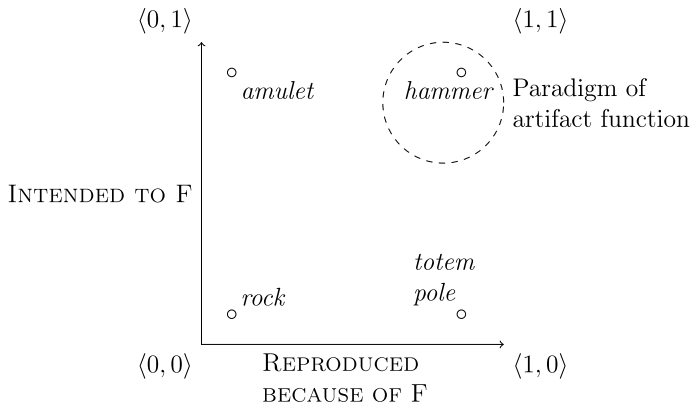
Fig. 1 Spatial representation of the effects of some objects according to the Dual-Aspect Theory (amulet's effect: protecting from evil's eye; hammer's effect: driving nails; totem pole's effect: reinforcing cooperation among group members; rock's effect: blocking wind)

Consequently, DAT not only meets RELATION, but it implies a particularly close connection between artifact and biological functions, since the conditions for possessing a function in one case partly overlap with the conditions for having a function in the other.

Therefore, the two aspects of DAT can account for all properties of functions as well as the two meta-theoretical desiderata and can explain why functions have them. At least, I think they do a better job in accommodating them than any of the alternatives.

4.2 Coextensional with 'Function'

The second strategy to defend DAT is to assess whether the set of entities satisfying DAT and the set of objects with artifact functions are coextensional. In short, the idea is to consider some examples and show that DAT classifies them correctly. In addition, it will allow us to explain why some effects that we would intuitively qualify as paradigm or marginal functions are rightly categorized as such.[17]

On the one hand, according to DAT paradigm cases of function should be effects that are intended by designers, producers and users as well as effects that explain why objects of the same type have been reproduced. I think most clear cases of function possess these two aspects. Hammers, umbrellas, soccer balls or laptop fans are designed, produced and used with the intention that they

---

[17] As a reviewer pointed out, DAT *presupposes* the general distinction between paradigm and marginal cases, so DAT cannot explain this distinction. Nonetheless, DAT makes specific predictions about particular cases and in this way I think it can shed some light on them. For example, intuitively the fact that hammers drive nails is a paradigmatic case of function and a very important explanatory property of them, whereas the protective function of amulets is somehow less paradigmatic and explanatory (see below). I think DAT can vindicate and explain these judgments.

comply with their functions and they are also reproduced because often enough exemplars actually perform them. One way of illustrating this idea to draw a graph and represent objects according to their score on the two aspects of DAT. The outcome is shown in Fig. 1.

On the other hand, a prediction of DAT is that effects that only satisfy one aspect are marginal in some respect. Although this consequence might look surprising at first glance, I think it highlights and important feature of many artifacts. Amulets or time machines fail to possess the reproductive aspect and they seem to be far from the paradigm in various respects. For one thing, these functions are much less explanatory of the artifact's structural features. Hardly any property of an amulet can be predicted from knowing that its function is to protect its bearer from evil's eye (compare it to knowing the function of umbrellas or soccer balls). Likewise, think about naturefacts, i.e. natural objects which humans have not created but which we use for certain purposes, such as a piece of wood exhibited in a museum or a seashell horn (Oswalt, 1973; Hilpinen, 2011). Naturefacts only satisfy the intentional aspect of DAT, and it seems they are marginal cases of function; at most, their function can explain some of their less central properties, such as their location or maintenance, but it cannot explain why they exist or why they exhibit a specific form. Furthermore, if an item has a function just because someone intends to use it for F, this function might be impossible to carry out. Baker (2007:56) expresses a related thought when she argues that entities that have an intended function that is impossible to perform cannot malfunction. It seems to me this suggestion goes too far (since these items are *supposed to* have an effect, they can be normatively assessed), but it nicely illustrates the idea that they should be considered marginal in various respects. Consequently, artifacts that possess functions just in virtue of being intentionally produced or used for a certain purpose fail to possess some of the properties of paradigm cases.

There are reasons as well for thinking that items that only satisfy claim 2 of DAT are far from the paradigm. Producing artifacts is primarily a human capacity and even if some artifacts can have function F without any agent intending them to F, this can hardly be considered a central case. For one thing, with respect to artifacts that have functions only in virtue of the reproductive aspect we lack the sort of epistemic privilege that usually accompanies functions (Thomasson, 2003). Thus, in these cases what counts as an essential or as an accidental effect might be hidden to us. The users of totem poles, for example, probably ignored their real function. Furthermore, note that this process cannot account for the existence of new or phantom functions, so there are grounds for thinking these cases are marginal in various respects.

Finally, some effects do not satisfy any of these two conditions, so the theory predicts they are not functions. The mere fact that a rock hinders wind flow, for instance, is correctly classified as lacking any function. Therefore, DAT rightly classifies some examples as having or lacking artifact functions and distinguishes paradigm from marginal cases.

4.3 DAT is Preferable to Similar Hybrid Approaches

Now, let us suppose that one agrees with the main tenets of the Dual-Aspect Theory. As a friendly suggestion, one could propose a way of simplifying the definition I provide: functions can be identified with 'reasons for existence'. After all, both reproductive and intentionalist approaches define functions by appealing to a process that accounts for the object's existence (Longy, 2013: 206) and this is a strong motivation for some accounts (Neander, 1991). Unfortunately, this proposal is probably too liberal: not any reason for existence grounds functions, only reproduction and intentional processes do. As a result, adopting this broad approach would not provide any substantial advantage and would make the theory much more vulnerable to counterexamples, such as a hornet buzzing having the function of frightening a farmer because that is the reason he schrinks from killing it (Boorse, 1976: 75). Moreover, in certain extreme cases of merely intentional functions, the interpretation of 'reason for existence' should be stretched too far. Seashell horns have a function as musical instruments, but it is hard to see in which respect producing certain sounds accounts for their existence.

Likewise, I think DAT fares better than similar approaches that seek to combine intentionalist and non-intentionalist features. Some of the key ideas of the Dual-Aspect Theory are shared by other theories of artifact functions such as Millikan's (1984, 1999) and Sperber's (2007), yet I think some significant disagreements remain.[18] I would like to stress four remarkable differences. Firstly, these hybrid approaches tend to unnecessarily multiply functions because they do not satisfy UNIFICATION. For instance, it seems to follow from Millikan's account that umbrellas have two functions with exactly the same content (protecting bearers from rain), coming from a direct and a derived function, respectively. The same result follows from Sperber (2007: p. 130) account, who admits that 'prototypical cultural artifacts are (...) characterized by the coincidence of two types of function: an artifactual function and a cultural teleofunction.' Secondly, some important elements are not shared; for example, I add a 'control' requirement and also accept that intended use can bestow an object with functions (cf. Millikan, 1999). Thirdly these approaches are committed to some additional controversial claims. For instance, Millikan's proposal essentially appeals to 'derived functions', which some people think is a confused notion (Preston, 1998, 232–242; cf. Millikan, 1999). Likewise, Sperber assumes that the same notion of 'propagation' applies to cultural and biological entities (although the mechanisms of propagation might differ). None of these claims is required by DAT. Fourthly, these views fail to seriously take into account the distinction between paradigm and marginal cases; Millikan's theory does not provide any reason for thinking that artifacts that are intended to F and have been reproduced for

---

[18] Another interesting hybrid account is the ICE-Theory, developed by Houkes and Vermaas (2010). Nonetheless, their proposal is primarily an account of the *justified ascription* of functions, rather than a theory of function possession (Houkes & Vermaas, 2010: 78). Since it is a different sort of project from the theoretical definition intended here (see Sect. 1), a comparison with the present account is not straightforward.

F should be more paradigmatic than others that are merely intended to F, whereas I argued in Sect. 4 that this distinction is important for accommodating certain aspects of amulets, totem poles or naturefacts.[19] I think developing an approach in terms of different *aspects* of a single functional property makes some progress in alleviating these worries and opens the door to new and interesting research projects: are there other aspects that are relevant for qualifying as a paradigm instance of artifact function? Can the reproductive and intentional aspects be further decomposed in other dimensions? How should we understand entities that have both biological and artifact functions? Can this approach be employed in the context of social functions? These remain important questions to be addressed in future work.

In conclusion, I think there are compelling reasons for adopting the Dual-Aspect Theory of functions. The two aspects included in DAT can accommodate the different properties of functions, the extension of artifact functions seems to fit the predictions of the theory and DAT has significant advantages over similar hybrid approaches. To conclude my defense, in the next section I will address some objections.

5 Objections

The first difficulty I would like to discuss derives from an additional desideratum put forward by some authors (Houkes & Vermaas, 2003, 2010; Longy, 2006: 90). According to it, an object can possess a function F only if it can reasonably be expected to produce effect F. More precisely, an object can have a function only if there 'exists a measure of support for ascribing a function to an artifact, even if the artifact is dysfunctional or if it has a function only transiently' (Houkes & Vermaas, 2010: 5).

What is the motivation for adding this desideratum? In short, the idea is that this is the only way of excluding far-fetched attributions of functions to objects (Longy, 2013). A tea bag cannot have the function of bringing someone to the moon and a piece of cardboard with holes cannot have the function of converting carbon dioxide into methane (Holm, 2013: 710). According to this proposal, these objects lack functions because they do not provide any measure of support for these effects. DAT, however, cannot rule out these cases, since it suggests that satisfying the intentional aspect probably suffices for having a function. Although I include some constrains based on control, DAT does not require a measure of support. Should we modify DAT to accommodate this aspect?

I think we should resist adding this desideratum for three main reasons. Firstly, it seems to me that in some cases evidence-resistant beliefs can ground functions without any measure of support. Although homeopathic dilutions have the function

---

[19] Certainly, some of these theories could be modified so as to include the marginal-paradigmatic distinction (the same could be said of other pluralist approaches, such as Preston's or the ICE theory). I think that would definitely be a move in the right direction. Nonetheless, some of the arguments I presented would still support my proposal overs these refined versions.

of treating or curing certain diseases (such as pharyngitis, otitis or depression), it is widely regarded as ineffective by the scientific community. For instance, the preparation of Oscillococcinum involves a 200C dilution of duck liver and heart, which actually amounts to a ratio of a part of duck offal to 10^{400} parts of water. Now, when scientists argue that this composition fails to provide a measure of support for treating or curing diseases, they are not denying that Oscillococcinum has a function—they are precisely assuming that it has it and objecting that it cannot be achieved. In other cases, it might even be unclear what the requirement of 'support' amounts to. Consider, for instance, amulets or time machines: what would be for an object to support the function of protecting an individual from devils' eye? How can an object support time travel? Objects can have functions that are impossible to fulfill. Thus, I do not feel there is a strong motivation for adding this aspect as a general constrain on theories of function.

Secondly, DAT can actually explain why in general we should not *expect* farfetched functions. Tea bags do not have the function of traveling to the moon because they are certainly not reproduced because of this effect and it is very odd for anyone to ever intend to use a tea bag to that end. More generally, artifacts tend to provide a measure of support for their functions just because, on the one hand, satisfying the reproductive aspect implies that this kind of object usually provides such a support and, on the other, people tend to be reasonable about what to expect from objects. Thus, an effect that either satisfies the reproductive or the intentional aspect is likely to provide some support for that function. If this is true, then we can account for the fact that most artifacts do not have unrealistic functions by appealing to past performance and reasonable expectations. As a result, an important motivation for adding this constrain vanishes.

Thirdly, there is some tension between this desideratum and Normativity. In particular, requiring that objects should have a measure of support makes the theory incompatible with some sort of malfunctions. If I have a severely broken cell phone, which I don't expect to work anymore due to severe damage to the motherboard, then I will probably think my cell phone has a function that (alas!) it will never be able to fulfill. Adding the support requirement, however, would force me to say that it does not even have the function (so it does not malfunction), because it cannot support it.[20]

Finally, note that in principle the support desideratum is compatible with DAT, so if one thinks this is an important requirement, it could be added as a constraint on the intentional aspect. Consequently, I do not think this objection provides any reason for abandoning DAT (either as it stands or a in a slightly modified form).

A second objection against DAT is also directed at the intentionalist side of the theory. Many people think that artifacts are individuated functionally; screwdrivers

---

[20] As a response, Houkes and Vermaas (2010, ch. 5) suggest that in this sort of cases fulfilling the support desideratum depends on whether the object can be repaired. This is an interesting suggestion but, unfortunately, I think it raises more problems than it solves. For one thing, reparation depends on the technology available; does that mean that the very same object can lose or acquire a function just by inventing a new way of repairing a particular kind of damage? Does not the very notion of 'repair' presuppose that there is some function that the object possesses and should be recovered?

are objects used for inserting or removing screws and umbrellas are objects used to protect their bearers from rain or sunlight. However, if objects are individuated by their function and intending an object to F suffices for it to acquire a function (even if it does not suffice for it to be a paradigm case), then a mere intention to use an object in a certain way transforms the object into a new kind of entity (Houkes & Vermaas, 2010). This conclusion, however, is very implausible. We do not want to say that a pipe cleaner becomes a coffee machine just because someone intends to use it in that way (Holm, 2013: 710). A coin would still be a coin even if I intend to use it as a screwdriver.

There are different ways to address this interesting challenge. On the one hand, it relies on the dubious premise that artifacts are individuated exclusively by appealing to their function. This view sits uneasily with the fact that some artifacts such as artworks or sandcastles might lack functions (Juvshik, forthcoming), or with the idea that artifacts can change their main function (e.g. aspirin used to be employed as a pain-killer, but nowadays it is mainly used as a blood-clotting preventer—see Carrara & Vermaas, 2009; Olivero, 2019). Furthermore, psychological evidence gathered over the last 20 years strongly suggest that, although functions often play an important role, artifact categorization also depends on other features. Malt and Johnson (1992), for instance, asked subjects to categorize objects in which there was a mismatch between physical features and function, and they showed that in many cases the former were more important for individuating objects than the latter. Currently, many psychological accounts of artifact categorization accept the idea that aspects other than function are taken into account in categorization (Bloom, 1996; Ahn, 1998; Sloman & Malt, 2003; Malt & Sloman, 2007; Gelman, 2013). Hence, the objection that DAT has counterintuitive consequences is based on a highly controversial premise. On the other hand, note that most objects posses a wide variety of functions, some of them being more central than others. So even if we grant for the sake of the argument that objects are exclusively individuated functionally, some effects might be more important. In particular, following DAT, functions that an object possesses just in virtue of satisfying the intentional aspect will be much less relevant for categorization than others that satisfy both aspects. This is why, for instance, a coin does not become a screwdriver just by intending to use it in certain ways: it has a more paradigmatic function as measure of exchange.[21]

6 Conclusion

Time to wrap up. In this essay I put forward and defended the Dual-Aspect Theory of artifact function, which is a monist account according to which an artifact's function depends on intentional and reproductive aspects. I argued that this theory should be understood as a theoretical definition, and provided some reasons for thinking it is on the right track. I would like to conclude by making two final points.

---

[21] This discussion also shows that DAT is fully compatible with a distinction between central and peripheral functions (see footnote 1).

We began by suggesting that some desiderata of both biological and artifact function are shared (e.g. NORMATIVITY), whereas others are not (INNOVATION and PHANTOM). There is also a significant overlap between the Dual-Aspect Theory of artifacts and the etiological theory of biological functions, even though they remain distinct. Likewise, while paradigm instances of a biological function F are selected for F (which usually includes a process of reproduction), I argued that paradigmatic artifact functions F are reproduced because of F. This partial overlap along different dimensions between biological and artifact functions can perhaps explain why some people thought that an account of biological functions could straightforwardly be applied to artifacts, and at the same time, why other people considered that we needed a radically different theory. As usually happens in philosophy, I think both were partly right and I hope the Dual-Aspect Theory can capture these two intuitions in a sensible framework.

Finally, irrespective of the virtues and problems of defining functions in terms of intentional and reproductive aspects, I think that the project of primarily looking for paradigm cases and identifying those features that are relevant (rather than becoming obsessed with a quest for necessary and sufficient conditions) is a move in the direction of a more fruitful discussion. I hope that even those who disagree with my positive proposal welcome the idea of providing a more constructive perspective on an old and difficult problem.

References

Ahn, W. (1998). Why are different features central for natural kinds and artifacts?: The role of causal status in determining feature centrality. *Cognition, 69,* 135–178.

Allen, C., & Bekoff, M. (1995). Biological function, adaptation, and natural design. *Philosophy of Science, 62,* 609–622.

Artiga, M. (forthcoming). Biological functions and natural selection: A reappraisal. *European Journal for Philosophy of Science*.

Baker, L. R. (2007). *The metaphysics of everyday life: An essay in practical realism*. Cambridge University Press.

Bloom, P. (1996). Intention, history, and artifact concepts. *Cognition, 60*(1), 1–29.

Boorse, Ch. (1976). Wright on functions. *Philosophical Review, 85*(1), 70–86.

Boorse, C. (2002). A rebuttal on functions. In A. Ariew, R. C. Cummins, & M. Perlman (Eds.), *Functions: New essays in the philosophy of psychology and biology* (pp. 63–112). OUP.

Buller, D. (1998). Etiological theories of function: A geographical survey. *Biology and Philosophy, 13,* 505–527.

Carrara, M., & Vermaas, P. E. (2009). The fine-grained metaphysics of artifactual and biological functional kinds. *Synthese, 169,* 125–143.

Carrara, M., Garbazc, P., & Vermaas, P. E. (2011). If engineering function is a family resemblance concept: Assessing three formalization strategies. *Applied Ontology, 6,* 141–163.

Cummins, R. (1975). Functional analysis. *Journal of Philosophy, 72,* 741–765.

Elder, C. (2007). On the place of artifacts in ontology. In E. Margolis & S. Laurence (Eds.), *Creations of the mind: Theories of artifacts and their representaion* (pp. 33–51). OUP.

Evnine, J. (2016). *Making objects and events: A hylomorphic theory of artifacts, actions, and organisms.* Cambridge University Press.

Gelman, S. (2013). Artifacts and essentialism. *Review of Philosophy and Psychology, 4*(3), 449–463.

Griffiths, P. (1993). Functional analysis and proper functions. *British Journal for the Philosophy of Science, 44*(3), 409–422.

Godfrey-Smith, P. (1994). A modern history theory of functions. *Noûs, 28*(3), 344–362.

Godfrey-Smith, P. (2009). *Darwinian populations and natural selection.* Oxord Philosophy Press.

Holm, S. (2013). Organism and artifact: Proper functions in Paley organisms. *Studies in History and Philosophy of Science Part C, 44*(4), 706–713.

Holm, S. (2017). The problem of phantom functions. *Erkenntnis, 82*(1), 233–241.

Hilpinen, R. (2011). Artifacts. In *Stanford encyclopedia of philosophy* (Winter 2011 Edition).

Houkes, T. (2009) The open border: Two cases of concept transfer from organisms to artifacts. In *Functions in biological and artificial worlds: Comparative philosophical perspectives* (pp. 227–242). MIT Press.

Houkes, W., & Vermaas, P. (2003). Ascribing functions to technical artefacts: A challenge to etiological accounts of functions. *British Journal for the Philosophy of Science, 54,* 261–289.

Houkes, W., & Vermaas, P. (2010). *Technical functions.* Springer.

Juvshik, T. (forthcoming). Function essentialism about artifacts. In *Philosophical studies.*

Krohs, U. (2009). Structure and coherence of two-model-descriptions of technical artefacts. *Techne: Research in Philosophy and Technology, 13*(2), 150–161.

Kroes, P. (2012). *Technical artefacts: Creations of mind and matter.* Springer.

Krohs, U., & Kroes, P. (2009). *Functions in biological and artificial worlds.* MIT Press.

Lewens, T. (2004). *Organisms and artifacts: Design in nature and elsewhere.* MIT Press.

Lewens, T. (2004). Innovation and population. In U. Krohs & P. Kroes (Eds.), *Functions in biological and artificial worlds: Comparative philosophical perspectives* (243–258). MIT Press.

Longy, F. (2006). Function and probability: The making of artefacts. *Techné: Research in Philosophy and Technology, 10*(1), 71–86.

Longy, F. (2009). How biological, cultural, and intended functions combine. In U. Krohs & P. Kroes (Eds.), *Functions in biological and artificial worlds: Comparative philosophical perspectives* (pp. 51–68). MIT Press.

Longy, F. (2013). Artifacts and organisms: A case for a new etiological theory of functions. In P. Huneman (Ed.), *Functions: Selection and mechanisms* (pp. 185–211). Springer.

Lyman, R. L., & O'Brien, M. J. (2000). Measuring and explaining change in artifact variation with clade diversity diagrams. *Journal of Anthropological Archaeology, 19*(1), 39–74.

Malt, B. C., & Johnson, E. C. (1992). Do artifact concepts have cores? *Journal of Memory and Language, 31*(2), 195–217.

Malt, B. C., & Sloman, S. A. (2007). Category essence or essentially pragmatic? Creator's intention in naming and what's really what. *Cognition, 105,* 615–648.

McLaughlin, P. (2001). *What functions explain: Functional explanation and self-reproducing systems.* Cambridge University Press.

Merton, R. K. (1968). *Social theory and social structure.* The Free Press.

Mesoudi, A. (2011). *Cultural evolution. How Darwinian theory can explain human culture and synthesize the social sciences.* University of Chicago Press.

Millikan, R. (1984). *Language, thought and other biological categories.* MIT Press.

Millikan, R. (1989). In defense of proper functions. *Philosophy of Science, 56*(2), 288–302.

Millikan, R. (1999). Wings, spoons, pills, and quills: A pluralist theory of function. *The Journal of Philosophy, 96*(4), 191–206.

Mossio, M., Saborido, C., & Moreno, A. (2009). An organizational account of biological functions. *British Journal for the Philosophy of Science, 60*(4), 813–841.

Nagel, E. (1977). Functional explanations in biology. *Journal of Philosophy, 74*(5), 280–301.

Neander, K. (1991). Functions as selected effects: The conceptual analyst's defense. *Philosophy of Science, 58*(2), 168–184.

O'Brien, M., Darwent, J., & Lee Lyman, R. (2001). Cladistics is useful for reconstructing archaeological phylogenies: Palaeoindian points from the southeastern United States. *Journal of Archaeological Science, 28,* 1115–1136.

Olivero, I. (2019). Function is not enough. *Grazer Philosophische Studien, 96*(1), 105–129.

Oswalt, W. H. (1973). *Habitat and technology: The evolution of hunting*. Holt, Rinehart, and Winston Inc.

Perlman, M. (2009). Changing the mission of theories of teleology: DOs and DON'Ts for thinking about function. In U. Krohs & P. Kroes (Eds.), *Functions in biological and artificial worlds: Comparative philosophical perspectives* (17–36). MIT Press.

Preston, B. (1998). Why is a wing like a spoon? A pluralist theory of function. *The Journal of Philosophy, 95*(5), 143–160.

Preston, B. (2003). Of marigold beer: A reply to Vermaas and Houkes. *The British Journal for the Philosophy of Science, 54*(4), 601–612.

Preston, B. (2009). Philosophical theories of artifact function. In A. Meijers (Ed.), *Philosophy of technology and engineering sciences* (pp. 213–233). Elsevier.

Preston, B. (2013). *A philosophy of material culture: Action, function and mind*. Routledge.

Preston, B. (2018). Artifacts. In *Stanford encyclopedia of philosophy* (Summer 2018 Edition).

Price, C. (1995). Functional explanations and natural norms. *Ratio, 8*(2), 143–160.

Queller, D., & Strassman, J. (2009). Beyond society: The evolution of organismality. *Philosophical Transactions of the Royal Society, 364,* 3143–3155.

Schwartz, P. (1999). Proper function and recent selection. *Philosophy of Science, 66,* S210–S222.

Searle, J. (1995). *The construction of social reality*. The Free Press.

Sloman, S. A., & Malt, B. C. (2003). Artifacts are not ascribed essences, nor are they treated as belonging to kinds. *Language and Cognitive Processes, 18,* 563–582.

Soavi, M. (2009). Realism and artifact kinds. In U. Krohs & P. Kroes (Eds.), *Functions in biological and artificial worlds: Comparative philosophical perspectives* (pp. 185–202). MIT Press.

Sperber, D. (2007). Seedless grapes: Nature and culture. In E. Margolis & S. Laurence (Eds.), *Creations of the mind* (pp. 124–137). Oxford University Press.

Thomasson, E. (2003). Realism and human kinds. *Philosophy and Phenomenological Research, 67*(3), 580–609.

Thomasson, E. (2007). Artifacts and human concepts. In E. Margolis & S. Laurence (Eds.), *Creations of the mind: Theories of artifacts and their representaion* (pp. 52–73). Oxford University Press.

Vermaas, P., & Houkes, W. (2003). Ascribing functions to technical artifacts: A challenge to etiological accounts of function. *British Journal for the Philosophy of Science, 54*(2), 261–89.

Vermaas, P. (2013). The coexistence of engineering meanings of function: Four responses and their methodological implications. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing, 27,* 191–202.

Wouters, A. (2005). The function debate in philosophy. *Acta Biotheoretica, 53*(2), 123–151.

Wright, L. (1973). Functions. *The Philosophical Review, 82*(2), 139–168.