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Does Biology Need Teleology?

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To ask the function of short-term memory one might ask, “What is short-term memory for?”¹ Or, to ascribe a function to eyelashes one might say, “Eyelashes divert airflow to protect the eye.”² If a function of x is to z , it is *for z-ing* or is there *to z*. This manner of speaking has a teleological flavor, but do biologists really use a teleological notion of function in contemporary biology, and, if so, what (if any) scientific purpose is it serving?

TELEOLOGY

The word “teleology” invokes ideas of intentional design or purpose, and mainstream contemporary biologists do not believe that organic systems result from intentional design or purpose, setting aside special cases of domestic breeding and genetic engineering and the like. But a more general characterization of a teleological explanation is that it is *forward-looking*. It purports to explain the means by the ends.

In contrast, ordinary causal explanations cite preceding causes, or maybe phenomena occurring at the same time as what is explained. In an ordinary causal explanation that describes a sequence of events at roughly the same level of analysis, Sally’s throwing a rock at the window explains the window’s breaking only if she threw the rock before the window broke; if she threw it later, her rock throwing was not the cause. In explaining how mechanisms perform a process (e.g., photosynthesis), we describe contributions by components (e.g., chlorophyl) that contribute to the process. These contributions might be made during the process being explained. But, again, if we start describing what occurs after the process has run to completion (e.g., the later release of chemical energy to fuel the plant), we are no longer explaining how the process (in this case, photosynthesis) occurred.

Yet teleological explanations refer to a result of what is supposed to be explained. If we are told that Lauren jumped into the water to save the child, that the cat prowls to catch a bird, that the lever on the sewing machine is there to raise and lower the needle, or that

eye lashes are for reducing air flow across the eye, the means is seemingly explained by the ends. The item explained (such as the jumping, prowling, machine lever, or set of eyelashes) is seemingly explained by what it brings about or might bring about.

At a glance this could seem to invoke backward causation, but a second look soon reveals that at least some of these explanations do not invoke backward causation. If Lauren tells us that she jumped into the pool to save the child from drowning, her explanation is correct if it points to a precedent of the jump: her *intention* to save the child. The explanation of the cat's prowling can be given a similar treatment, if the cat has intentional mental states. Functional explanations of artifacts are similar. How can the lever's raising and lowering the needle explain the lever's presence on the machine if it can raise and lower the needle only once it is already on the machine? The answer is, plausibly, that when we ascribe functions to artifacts we ascribe intentions to those who design or use them.³ For example, we imply that someone added the lever to let the user raise and lower the needle.

So, in *purposive-teleological* explanations, such as purposive explanations of behavior or functional explanations of artifacts, the looking forward to ends served by the means is a way to look back to past intentions on the part of those supplying the means. Purposive-teleological explanations have Form 1 on their surface, but dig deeper and Form 2 is revealed.

Form 1: End at time t_3 explains means at earlier time t_2 .

Form 2: Event at t_1 (involving an intentional attitude to end at t_3) explains means at t_2 .

Teleological explanations in contemporary biology are *prima facie* more problematic. A creationist might think that plants and animals are God's artifacts and seek to explain their traits in terms of God's intentions, but mainstream post-creationist neo-Darwinian biologists do not. Once special cases (domestic breeding and genetic engineering and the like) are set aside, the traits of organisms are not thought to depend on agent intentions. Biologists still speak of the "species' designs," the "purpose" of naturally occurring traits, the "reason" why traits were selected by natural selection, and so on; however, they know perfectly well that natural selection is a blind mechanical force. Their talk of "design" in this context is not intended to refer to intentional design. Such talk is metaphorical, or has by now become dead metaphor (i.e., it has acquired a new literal meaning).

How, then, can teleological functional explanations be respectable in contemporary biology? One answer is that they cannot. For instance, Morton Beckner (1959: 112) declares: "Only the most Paleozoic reactionary would claim that 'plants have chlorophyll' is explained by 'plants perform photosynthesis.'" And, along similar lines, Robert Cummins (1975) maintains that such explanations are a hangover from a creationist past or a result of a basic misunderstanding of evolutionary theory. These strong claims precede more recent philosophical analyses in support of the opposing view, which is that Darwin did not eliminate teleology from biology, but instead provided a naturalistic interpretation of it. A now popular view (though still to some extent controversial) is that there is a respectable naturalistic *teleonomic* notion of function in use. A teleonomic function is like a teleological function of an artifact, except it is (as a matter of stipulation) mind independent in the way naturalism requires.

TELEONOMY AND THE ETIOLOGICAL THEORY

One way to develop this idea is to argue that functional explanations of biological traits have a similar although non-identical structure to that of functional explanations for artifacts (Neander 1991). Consider the kangaroo's pouch, seemingly explained by its function to carry and protect joeys. Obviously, a pouch can carry and protect joeys only once a kangaroo has already inherited and developed the pouch. So, if we explain the pouch in terms of its functions, we explain the means by the ends, and this is the forward-looking aspect of this explanation. But there is also a backward-looking aspect if the function ascription implies that the pouch is an adaptation for carrying and protecting joeys.

That something is an *adaptation* is a historical fact about it, whereas whether it is *adaptive* depends on its fit with its current environment. Something is an adaptation for *z-ing* only if it was selected for *z-ing* in the past. Something is adaptive only if it presently contributes to fitness. Since natural selection operates over types, which increase or decrease in proportional representation in a population, *x* is an adaptation for *z-ing* only if items of *x*'s type were selected for *z-ing*. For this to be the case, at least these three conditions must be met: (i) traits of *x*'s type did *z*, (ii) their *z-ing* was on average adaptive for the individuals with the *x* type of trait in the relevant population, and (iii) in consequence, there was selection of the mechanisms responsible for the inheritance and development of *x*s. (More needs to be said, for instance to accommodate changes in the direction of selection over time—think here of such cases as the emu's vestigial wings and the penguin's flippers, which are no longer adaptations for flight, despite past selection for flight in the lineage of these forelimbs.)

This understanding of teleonomy in biology is supported by *etiological theories* of function (e.g., Millikan 1989; Neander 1991). The details vary with different versions, but these theories generally tell us that a/the function of a naturally occurring biological trait depends on its history of selection: (roughly) an item's function is to do *z* if items of the type were selected to do *z*. Given this type of theory, function ascriptions of the form "the function of *x* is to *z*" can (in part) explain *x*s because "the function of *x* is to *z*" entails that *x*s were selected for *z-ing*. In the case of teleological functions of artifacts, intentional selection is involved (and it can apply to token artifacts as well as to types, depending on what was intentionally selected). But in the case of the teleonomic functions of naturally occurring biological traits, a non-intentional (and in that sense) *natural* process of selection is involved.

Evolution by natural selection involves the random generation of heritable variations that differ in fitness and in their rates of replication due to such differences. (See Lewens, Chapter 1 this volume, for discussion of how ideas regarding natural selection have developed since Darwin.) Phylogenetic natural selection involves generations of individuals, but analogous ontogenetic processes occur within the lifespan of a single organism (e.g., antibody selection and perhaps some of the processes involved in learning) and these can also ground teleonomic functions, on this view.⁴

Reasonable concerns about how the process of evolution by natural selection is being understood may still arise, but they should now take a subtler form. For instance, one might worry whether the purported teleonomic explanations are overly adaptationist. But they need not be, because the friends of the etiological theory of functions can readily agree that not every trait has a function, and that those with functions are only in part

explained by selection for them. They can readily agree that natural selection operates within the constraints of a changing environment on variants that happen to randomly arise and are not eliminated by drift, and within restrictions imposed by hard to change developmental pathways and architectural and physical requirements. But many good explanations are partial, and an explanation's being partial is no good reason to consider it illegitimate as opposed to incomplete.

A second worry is sometimes expressed concerning what exactly natural selection explains. Can it contribute to creating complex adaptations or does it affect only their distribution in a population? Does it really help answer Paley's question about how wondrous adaptations arise, or not? Clearly, a once off "sieving" of pre-existing traits can affect only their proportional representation in a population. But cumulative selection does more. By selecting an adaptive trait, selection increases the chances that further random alterations to it will arise (since, given selection, the relevant mechanisms of inheritance and development are replicated more frequently than they would otherwise have been. Then, subsequent rounds of selection can select the beneficial alterations and eliminate the deleterious ones (Neander 1995). In any event, even if natural selection explained only the distribution of traits in a population, as some claim (Sober 1984: ch. 5), function ascriptions could explain the presence of traits of a type by explaining their preservation in a population over time.

Cummins (2002) raises a third kind of worry when he argues that, for example, avian wings cannot have the function to enable flight in virtue of being selected for enabling flight because they were *not* selected for enabling flight. He rightly points out that natural selection requires alternatives from which to select. And, more tendentially, he claims that if wings were selected for flight, then there must have been other forelimbs in the same dinosaur population at the same time that did not enable flight, against which wings that enabled flight were selected. Flight-enabling avian wings evolved gradually (probably from forelimbs adapted for gliding from tree to tree). Cummins claims that there was never selection for flight as opposed to no flight. There was only ever selection for incremental improvements, such as more energy-efficient flight, faster flight, or more maneuverable flight.

There are two things to keep in mind here. One is that even traits "gone to fixation" require maintenance selection to weed out deleterious mutations, or else capacities will tend to deteriorate. In the case of wings, deleterious mutations that prevent flight can still occur. The other thing to keep in mind is that the fineness of the lens with which we view a selection history will need to match the fineness of the description of the relevant function. To speak of avian wings having the function of flight is an extremely coarse-grained way of speaking, warranting a sweeping view across many lineages and vast spans of time (a hundred million years or so). From that perspective, selection for more energy-efficient flight, faster flight, or more maneuverable flight, is selection for flight. The coarse-grained function ascription is also consistent with more fine-grained ascriptions of function to particular features of wings in specific lineages during specific periods of time.

The etiological theory of functions descends from an early account offered by Larry Wright (1973, 1976) in which teleological-purposive explanations as well as teleonomic explanations in contemporary biology appeal to "consequence etiologies." A consequence etiology is a history of an item in which one or more of its consequences plays a role. In

a consequence etiology, the item is where it is or in the form that it is in owing to one or more of its effects. The details of Wright's account of functions proved to be problematic (see e.g., Boorse 1976), but his core idea of a consequence etiology is in effect retained in later versions.

ALTERNATIVE ACCOUNTS OF THE TELEONOMIC NOTION OF FUNCTION

Proponents of other theories of function also claim that their theories can account for or allow for the teleological flavor of function ascriptions in contemporary biology. For instance, some argue that the functions of traits are those of their effects that make them presently adaptive. On this view, functions are (roughly) their present species-typical contributions to the survival and/or reproduction of the individuals who possess them, or their typical contributions within a more restricted reference-class, such as a sex and/or age group in a species (Boorse 1977, 2002).

If a theory of this type were true, "x has the function to z" would not entail "xs were selected for z-ing." Nevertheless, knowing a trait's function could still cast some light on its history, given a background understanding of evolutionary theory and the past environment. If a polar bear's fur has the function to keep it warm because it keeps polar bears warm and this is adaptive on average now, learning the function of the fur could suggest that it might have been adaptive in the past too, and might have been selected for that reason. What is presently adaptive might not have been adaptive in the past and what was adaptive in the past might not be adaptive now, since environments change, but the current functions of traits can, on this type of ahistorical-statistical theory, provide clues to relevant selection histories.

A related suggestion is that the function of a trait is what it does that makes it apt for selection in the future in a creature's "natural habitat" (a notion not well elucidated). John Bigelow and Robert Pargetter (1978) contend that this propensity theory of functions best captures the "forward looking" nature of functional explanations. Note, though, that it does not capture the way in which teleological explanations look back by looking forward.

One last type of theory that is of interest in this context draws to some extent on other parallels between teleonomic functional explanations in biology and teleological explanations. In this case the focus is on goal-directed processes or behaviors and cybernetic or homeostatic systems. Homeostasis is the property of a system such that it regulates its inner states to preserve stability in the face of perturbations on some dimension, and cybernetics is the study of feedback mechanisms that can be used to do so. For example, a thermostat turns a house into a homeostatic system when it monitors the temperature and turns the heating or cooling on or off to keep the temperature within a set range. Similarly, there are many somatic homeostatic systems that contribute to maintaining stable states (e.g., a stable body temperature or a stable level of glucose in the blood, despite fluctuations in the surrounding temperature or supply of glucose). Goal-directed processes or behaviors are not always directed at maintaining a stable state, but they tend to involve feedback mechanisms that produce resilience (persistence and plasticity) in the pursuit of a goal. For example, one creature chasing another shows resilience when it moves around obstacles to continue the chase. The performance of some functions

(involved, for instance, in maturation or reproduction) will disrupt as opposed to preserve a stable state in an organism. Thus some versions of this type of theory consider survival and reproduction or the maintenance of a recurring life cycle to be the apical goal to which the parts of a living system have the function to contribute, and hence this type of theory might be blended with the ahistorical-statistical theory.⁵

In any event, the teleological flavor of function ascriptions might again be viewed as due to an implied or suggested consequence-etiology. For, on this view, when a trait performs its function it tends to contribute to its own preservation by maintaining the individual organism whose trait it is, or it tends to contribute to the inheritance and development of traits of the type by perpetuating the relevant life cycle. For instance, when a token heart performs its function, it tends to help maintain the individual to whom the heart belongs, and so tends to help preserve itself and/or (depending on how the details of the theory are spelt out) it tends to perpetuate the life cycle of individuals of the same kind and so furthers the production of hearts of that type.

My view has long been that an etiological theory is the best theory of the relevant notion of function in biology, but it is not the only theory that can lay claim to explaining the notion's teleological or teleonomic flavor. Which is the best overall theory? This is not a question to try to settle here, since it calls for a more detailed and lengthy comparison of the main theories that can be provided here (but see Garson 2016). In what follows, this chapter instead outlines some aspects of the theoretical role that this notion of function might be serving in contemporary biology. Even if the relevant notion of function is scientifically respectable, it remains up in the air whether it plays a significant scientific role. I believe it does but this remains controversial.

THE FUNCTION/DYSFUNCTION AND FUNCTION/NON-FUNCTION DISTINCTION

At this point it helps to acknowledge two distinctions to which a teleonomic notion of function is sensitive: the function/dysfunction and function/non-function distinctions.

There can in this sense of "function" be malfunction. A statement of the form "x has the function to z" is consistent with "x lacks the capacity to z (owing to dysfunction on x's part)."⁶ Even without malfunction, a token trait might not perform its function because the opportunity never arises or the environment is uncooperative, but a trait that malfunctions will lack the capacity to perform one or more of its normal or proper functions (or lack the disposition to perform one or more of them normally or properly) even when the opportunity arises and the world cooperates. A pancreas, for example, can have the function to produce insulin even if it lacks any capacity to produce insulin. Nor is there any apparent conceptual incoherence in the idea that functional impairment (lung impairment, for example) might become typical in a population for a time, in a pandemic or due to environmental disaster or degradation.

The relevant notion of function also allows that not all effects of even properly functioning traits are their functions. Consider an artifact case for a moment: a belt buckle deflects a bullet and saves the life of the soldier wearing it. The buckle has the function to buckle the belt and help hold up the trousers. It does not have the function to stop a bullet, though it might do that too. It might *serve the function* of stopping a bullet or

act as a bullet stopper, so to speak, without having the function to do so. Similarly, some effects of biological traits are not their functions. Hearts have the function to pump blood rather than make lub-dub sounds, but they do both. At least intuitively, hearts might even make frequent adaptive contributions to the survival and reproduction of the individuals whose hearts they are without those contributions being their functions. For instance, by making lub-dub sounds, they might also assist doctors in diagnosing treatable disease.

On the etiological theory, the function/dysfunction and function/non-function distinctions are due to functions being grounded in the past selection of ancestral traits, rather than in the present dispositions of current instances, as well as what there was selection *for* (what past adaptive effects contributed to the selection) as opposed to merely whatever was done by what was selected. In what follows I assume that the teleonomic notion is sensitive to the function/dysfunction and function/non-function distinctions. The proponents of different theories of this notion of function draw these distinctions in somewhat different ways in line with their preferred theories, but none reject these distinctions altogether,⁷ nor could they without changing the subject.

The question of whether a teleonomic notion of function plays a significant scientific role in biology is in large part the question of what role the function/dysfunction and function/non-function distinctions play.

FUNCTIONAL EXPLANATION

This section considers the role of these distinctions in explanation. For the sake of brevity of exposition, I assume the etiological theory to do so, leaving it as an exercise for readers to reflect on the implications of other theories. One kind of functional explanation has already been mentioned, but without any discussion of its significance for biology. Moreover there are two kinds of functional explanation to consider.

The kind of functional explanation mentioned in earlier sections ascribes a function to something to answer a why-question concerning its origin, presence, or persistence. Why is there chlorophyll? Why do veins have valves? On an etiological theory of functions, to be told that the function of chlorophyll in plants is to perform photosynthesis is to be told why chlorophyll was selected, and to be told that the function of veins in valves is to prevent blood from flowing backward and help return it to the heart is to be told why veins in valves were selected.

Asking and answering why-questions can be illuminating, not only for understanding the evolutionary history of some trait but also for understanding how complex organic systems operate. In the 17th century, Harvey's initially surprising and controversial discovery that the blood circulates is in part attributed to his asking and answering a series of quite specific why-questions (e.g., why do veins have more valves than arteries?). Harvey's 1628 book, which describes his discoveries, often speaks of ends and purposes. He might have imagined that the "Nature, who does nothing in vain" was the Christian God, since he was a Christian, but (setting aside the Panglossian implications, as well as the idea of divine design) analogous thinking about natural selection may play a similar role in discovery. For instance, asking why we have eyelashes more recently led researchers to test the hypothesis that mammalian eyelashes, which are about a third of the length of the eye, are the best length for reducing airflow toward the eye and protecting it from particle deposition and excessive evaporation. While not in the same league as Harvey's

discovery, this helps illustrate the point that large and small discoveries can be facilitated by asking and answering why-questions. Both the function/dysfunction and function/accident distinction are relevant for this type of reverse engineering, given that a trait's function(s) and not its pathological effects or other non-function effects are why traits of the type were selected.

A second kind of functional explanation answers how-questions. How does photosynthesis occur? How does the circulatory system circulate blood? Biologists answer such questions by conceptually decomposing a system into its component parts and ascribing diverse functions to them. This can be done at multiple *levels* of analysis. That is, a system that is conceptually decomposed into its main parts can be further decomposed into sub-parts, and the sub-parts further decomposed into yet simpler sub-sub-parts, and so on. In a componential analysis of a system, the simpler and simpler parts are ascribed simpler and simpler causal roles, and thus the circulation of blood, for instance, can be explained at various levels of analysis.

It might at first glance seem that this latter type of explanation does not involve a teleonomic notion of function, but instead a mere notion of a causal contribution. Other scientists also give componential analyses of complex systems, decomposing mechanisms into parts at different levels of analysis, and without ascribing teleonomic functions to the components. The formation of a planetary system is a complex process that cosmologists try to explain at multiple levels of analysis, from supermassive black holes and the galaxies surrounding them to sub-atomic particles. Yet contemporary cosmologists do not claim that stars have the function to send heavy elements into the interstellar medium to help form vast clouds of molecular matter, that pre-planetary clumps of matter have the function to collide and accrete into larger clumps, or that the different elements and compounds have functions to do what they must if a solar system like ours is to form. They do not, anyway, ascribe malfunction-permitting functions. Stars do not malfunction.

It is true that cosmologists and biologists both give componential or mechanistic explanations (in the sense elucidated by Craver & Darden 2013). Biologists, however, ascribe teleonomic functions when explaining how complex living systems operate. But why use the teleonomic notion of function in this kind of context? One might think that it ought not to be used because physiological outcomes, just like cosmological ones, depend on the causal contributions qua causal contributions of the parts involved (Cummins 1975; Godfrey-Smith 1993). Physiological outcomes depend on whether certain causal contributions are made, not on whether these contributions are functions, pathological effects, or non-function effects. So one might think that the teleonomic notion of function can have no scientific significance in this type of componential (aka mechanistic) explanation, even if one wants to allow that it could have some other sort of significance, such as a moral or social significance in clinical medicine. This opinion is sometimes accompanied by the claim that functional norms are interest-laden (e.g., see Cummins & Roth 2010).

Against this is the view (supported by Boorse 1977 and Neander 2015 among others) that a (teleonomic) notion of function has a role in generalization. Consider the problems biologists face when trying to give useful general descriptions of how complex living systems *of a type or kind* operate. Describing the operation of a single cell is a huge challenge by itself. Describing the operation of a single multicelled organism is vastly more so. Add to this that each individual changes over time. Now add that there are usually billions of individuals in a species. Consider how the multiplicity of individuals, combined with

their complexity, creates a momentous challenge with respect to providing useful general explanations of how living systems of a type or kind operate. The more complex a system, the more variables there are that can vary from one individual to the next. *Sui generis* genomes and complex developmental and maturational interactions with the environment ensure that a great deal of this potential variation is realized in a species. And, in addition to normal variation, there are countless ways in which complex multicelled organisms can malfunction.

Describing the actual causal contributions qua mere causal contributions of each component part of each individual in a species is of course not a remotely viable option in practice. The experimental work of biologists often focuses day to day on discovering the causal roles of a few features of a few individuals in a few controlled circumstances. But this work is almost always intended to further the larger collective enterprise of giving useful general descriptions of some type or kind of system as well—of the normal human immune system or of the normal human visual system, for example.

If the etiological theory of function is correct, a so-called “normal system” is, in the first instance, one in which each part that was selected to do something is disposed to do what it was selected to do. I say “in the first instance” because the description of the normal system could also include a description of other aspects of the system.⁸ For instance, it could include a description of universal features that cannot be changed due to developmental or architectural constraints, along with any adaptive or for that matter maladaptive effects they have.

This style of idealization to normal or proper functioning might be useful for a number of reasons. Natural selection tends to drive adaptive traits to fixation, and most organisms are mostly normal most of the time, and so the composite portrait of the system that functions “as designed” (in the neo-Darwinian sense) has useful generality. But there are different ways to be normal in a species (e.g., there are sex- and age-related differences in adaptations, adaptations to local environments, polymorphisms that have resulted from distribution-sensitive effects on fitness, and so on), and the relevant notion of function can accommodate these differences. A description of the system that functions “as designed” also captures the way in which diverse parts of the system are, to a first approximation, co-adapted to work together. The description of the normal system is not a description of mere heterogeneity, but of *organized complexity*. While the description of the normal system abstracts from malfunction, the practice of describing normal systems does not simply ignore malfunction. The function/dysfunction distinction is a useful tool for understanding how normal systems operate, because to understand what happens when something goes wrong, and learn which capacities associate and dissociate when they do, is a useful tool for probing normal functional dependencies. Pathology is also efficiently described and understood against a background description and understanding of normal functioning, as specific deviations from normal functioning. The practice of describing normal systems, in this sense of “normal,” also gives biologists across different laboratories, generations, and continents a stable descriptive target. What is normal will change with time, but at the slow pace of evolution (at least on the etiological theory, and when the selection is phylogenetic). It will not change with mere changes in researcher experimental techniques, lab conditions, or ways of recording and reporting data.

Again, this idealization strategy does not commit physiologists to thinking that *every* trait of a living system has a function, that traits that have functions were *optimally*

designed for them, or that selection *as opposed to* other things (such as the random production of alternatives, drift, or developmental or architectural constraints) are responsible for preserving traits in populations. Selection operates within constraints, alongside drift, on alternatives that randomly arise, and it can certainly result in less than optimal designs. Descriptions of normal systems (even in the etiologist's sense) are consistent with this.

To understand whether the relevant notion of function plays a useful role, we also need to think about how the generalization problem might be solved without it. An alternative idea is that biologists specify *ceteris paribus* laws in this kind of context. These are "laws" or at least generalizations concerning how certain types or kinds of systems behave in certain circumstances, when "all else is equal" or (roughly) in the absence of interfering factors. But this approach invariably allows malfunction to count as an important source of interference; when a human immune system or human visual system malfunctions all else is not equal. So this reintroduces the relevant notion of function, even though it does not give it a central place. In my opinion, by lumping the possibility of malfunction together with the possibility of meteor strikes and the like, those who support this idea fail to appreciate how central is the role of the relevant notion of function in componential analyses of living systems in biology.

A second alternative one finds in the literature is a hand wave at statistics. In relation to this, note that an ahistorical-statistical theory of the relevant notion of function is a genuine alternative to an etiological theory of that notion. Thus I am distinguishing mere hand waving at statistics from the attempt to offer a serious, detailed ahistorical-statistical theory of function. Mere hand waving at statistics is no real answer since there are many ways to collate statistics with respect to complex organic systems. Even if functional norms were basically statistical, we would need an account of how the statistics are sorted and reported to capture the function/dysfunction and function/non-function distinctions. Serious ahistorical-statistical theories of function try to address this issue. Merely gesturing at the use of statistics to provide some sort of idealization does not.

Since it is easy to misunderstand my aim here, I repeat that it is not to argue for the etiological theory against other theories of the relevant notion of function (such as the ahistorical-statistical, propensity, or cybernetic theories). The topic is whether biology needs a *teleonomic* notion of function, one that at least intuitively has a teleological flavor and in any event respects the function/dysfunction and function/non-function distinctions. The etiological theory of this notion is popular and in my opinion is correct. But readers might disagree with this, and yet agree that the relevant notion has a significant scientific role to play.

FUNCTIONAL CLASSIFICATIONS

A brief discussion of the possible role of teleonomic functions in typing traits is included in this penultimate section. Its most obvious role in this respect concerns analogous categories of traits. Analogous categories are contrasted with homologous categories. Standardly, two structurally similar traits in two separate species are said to be homologous if they were inherited from a common ancestor, regardless of whether they have the same function. For example, vertebrate forelimbs (e.g., human arms, horse forelegs, bird

wings) are homologous, as are some of the bones involved in hearing in mammals (the malleus and incus) to certain jawbones in reptiles. In contrast, two traits are analogous if they share the same function as a result of independent evolution. Thus avian wings, bat wings, and insect wings are analogous, since these wings evolved independently as an adaptation for flight in several separate lineages. Analogous categories are always functional categories. Homologous categories need not be.

Analogous categories are of interest in understanding the extent to which similar selection pressures or ecological opportunities lead to similar strategies. But they might not be considered genuine natural kinds, or not especially interesting ones, since the similarities among members of an analogous category might be few or superficial, making the role of the concept of the category inferentially poor as opposed to rich (Amundson & Lauder 1994).

It is, however, a mistake to equate functional categories with analogous categories, since trait classifications can use multiple criteria. There can be cross-classification involving function and homology (e.g., pectoral fins), involving function and taxon (e.g., Pterodactyl wings), or involving function, morphology, and taxon (e.g., low aspect ratio versus high aspect ratio avian wings), to mention a few ways in which function could combine with other criteria to determine non-analogous classifications of traits. The significance of the teleonomic notion of function for trait classification therefore does not rest on how useful analogous categories are.

Many categories of traits, as with many categories of artifacts, are malfunction-inclusive. Must a mousetrap be able to catch a mouse? Or does a broken mousetrap still count as a mousetrap? I take the answer to be affirmative. Similarly, a broken, deformed, diseased or paralyzed Pterodactyl wing is still a wing, even if it does not enable flight. If having a certain function is *required* for membership in such a category, the notion of function is malfunction-permitting (and not simply a notion of a causal disposition) since being able to perform the function is not required. The issues hereabouts are admittedly complicated by the fact that trait types can be malfunction-inclusive without directly involving a teleonomic notion of function. For example, Pterodactyl forelimbs can be broken and yet still count as Pterodactyl forelimbs. But the claim that teleonomic function often plays a role alongside other criteria (homology, morphology, molecular signature, the mechanisms of inheritance and development, taxon, and so on) is plausible. It is plausible, for instance, that the individuation (as opposed to the identification) of distinct mechanisms in an organism relies on functional considerations. It is also plausible that, even when the functional criteria are replaced with other criteria in an operational definition (such as a specific molecular signature), the motivation for individuating the mechanism in that way, as opposed to in another way, often involves functional considerations (Garson 2013).

One objection raised against the claim that functional considerations play a role in trait classification is that circularity threatens. If a token trait's function depends on what type of trait it is, and how it is typed in turn depends on its function, this seems circular. And almost every theory of functions assigns functions in the first instance to traits *of a type*. For example, the etiological theory says that the function of a token trait x is to do z only if traits *of x 's type* were selected for z -ing. How, then, can x being of the x -type in turn depend on it having the function to z ? There might appear to be just two options here: deny that an item's being of the x -type depends on its having the function to z , or deny that its having the function to z depends on its being of the x -type. Unusually, Bence

Nanay (2010) argues in favor of the second option, thus allowing for functional categorizations. But I believe there is also a third option, which is that being a trait of a certain type and having a certain function can co-supervene. In other words, the circularity is not vicious. According to the etiological theory, the trait type and the function can supervene on the same selection history (Neander & Rosenberg 2013). A token trait's being a wing *and* having the function to enable flight, for instance, co-supervenes on the token's location in a lineage (in terms of its relations of ancestry and descent), and on whether selection for flight operated on the part of the lineage to which it belongs. If we draw lines in the lineage with respect to when selection for flight started and/or stopped, a (non-vestigial) wing that has the function of flight belongs to a part of the lineage during which there was selection for flight.

So it remains plausible that the teleonomic notion of function plays a significant role in trait classification, especially given its role in explanation. But since there are many different trait classifications, which may use different criteria in different combinations in delineating them, as well as a number of different philosophical analyses of the teleonomic notion of function, the role of this notion in trait classification is not something that can easily be settled.

CONCLUDING REMARKS

Contemporary philosophers who maintain that biology still needs “teleology” rarely mean that it needs the idea of intelligent or divine design. What they usually mean is that biology needs a teleonomic notion of function, which is sensitive to the function/dysfunction and function/non-function distinctions, and which can be given a naturalistic analysis. One analysis of this notion is given by the etiological theory, which tells us (roughly) that the function of an item is to do what it was (or items of the type were) selected to do by natural selection, but there are other competing analyses on offer. This notion seems to play a role in two different kinds of functional explanations. One is explicitly teleonomic. Such functional explanations explain items (in part) in terms of their functions; on the etiological theory, in terms of what they were selected to do. While these kinds of explanations are derivative of selectional explanations, there is an important role in discovery for asking and answering why-questions. The other kind of explanation is an operational explanation of how a living system operates when it functions normally or properly, which is a componential analysis or mechanistic explanation of a normal system. This provides for some useful generality in the face of variation. Further, the teleonomic notion of function might also play a role in trait classification, although the issues here are not easily disentangled. In assessing the significance of its classificatory role, we need to keep in mind that analogous categories of traits might only be one kind of functional category, since teleonomic function might play a role along with other criteria, such as homology or morphology.

NOTES

1. Baddeley & Hitch (1974: 86).
2. This is the title of Amador et al. (2015).
3. The nature of the everyday concept of an artifact is in part an empirical question. See, for example, Kelemen & Carey (2007) for some empirical backing.

4. For details, see Garson 2012 and 2016.
5. There are strands of discussion sympathetic to this idea in Nagel 1977, Wimsatt 1972, Boorse 1976, McShea 2012, and Trestman 2012.
6. Christopher Boorse (2002) prefers to say of a token x that's dysfunctional with respect to z that normal x s have the function to z , and that token x would have the function to z if it were normal. For present purposes, however, we can treat this way of speaking as a terminological variant.
7. For example, Boorse offers responses to the possibility of typical dysfunction in his 1977 and 2002. In the latter he relies on functions pertaining to typicality in a time-extended population.
8. Boorse (1977: 557) aptly calls this the "composite portrait" of a species.

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