

HOW TO BE A REALIST  
ABOUT *SUI GENERIS* TELEOLOGY  
YET FEEL AT HOME IN THE 21ST CENTURY

[S]uppose . . . you are convinced (as most of us are) that there really . . . are (for natural organisms) such things as proper function, damage, design, dysfunction, and all the rest. You think there really are these things and are unwilling to take the functionalist stance: then if you also think there is no naturalistic analysis of these notions, what you have is a powerful argument against naturalism. (Plantinga 1993a, 214)

Contemporary discussion of biological teleology has been dominated by a complacent orthodoxy. Responsibility for this shortcoming rests primarily, I think, with those who ought to have been challenging dogma but have remained silent, leaving the orthodox to grow soft, if happily. In this silence, champions of orthodoxy have declared a signal victory, proclaiming the dominance of their view as one of philosophy's historic successes.<sup>1</sup> But this declaration is premature at best—this would be neither the first nor probably the last time that a narrow school of philosophy has declared the resolution of age-old problems only to have those problems rise from the ashes of their better selves when a broader view is articulated. I propose to challenge orthodoxy by undermining its fundamental assumption and to enlist the help of others in articulating a formidable heterodox alternative to contemporary dogma concerning biological teleology, perhaps on the model I sketch below.

### I. THE ORTHODOX VIEW

The orthodoxy challenged here is defined by tacit acceptance of the thesis that biological teleology is either reduced (or eliminated) or depends on the intentions of a supernatural entity. This is, for instance, a suppressed premise in Plantinga's inference above, and it is this concep-

tual glue that ties his non-naturalist view to the dominant (reductivist) orthodox sect. The currently most popular reductivist view consists in evolutionary revisions of Larry Wright's 1970s work on functions as, for instance, in Millikan (1984; 1989) and Neander (1991a; 1991b; 1995). This approach operates on the assumption that its competition is exhausted by other naturalisms of reductivist and eliminativist varieties on the one hand and supernaturalism on the other. The possibility of non-reductive naturalistic realism has scarcely been considered.<sup>2</sup>

In light of this assumption it is unsurprising that philosophers have gravitated in overwhelming numbers toward eliminativism and reductivist-realism. Further, given the poverty of the supernatural view plus the tacit belief that supernaturalists are their only competitors, this group has felt very little need to justify this decision. On the one hand, they have rested content with shallow objections to alternative views. And on the other, given the dearth of alternate research programs, defenders have shown a like complacency in answering objections, which are handled as doctrinal disputes among co-religionists rather than as challenges to core commitments.

Before mounting my challenges to contemporary reductivist realism I should take a moment to review some assumptions I share with the dominant orthodox sect. First, an adequate account of biological teleology must be naturalistic with regard to both the epistemology and ontology of science. Second, I follow another orthodoxy, this one dating back to Aristotle, which focuses on *natural* or *biological* as opposed to *conscious* or *artifactual* functions as the philosophically central case. Both "kinds" of teleology involve *direction upon an end*, but conscious direction-upon-ends is no more (or less) mysterious than belief-desire psychology, and artifactual functions will be assumed to be accounted for derivatively through designs, intentions, or the like. It is biological or natural teleology, where minds, intentions, and designs appear absent, that makes teleology *qua* teleology a philosophical puzzle.

Finally, and perhaps most surprisingly to those not already immersed in the contemporary literature on biological teleology, I agree with the orthodox that an adequate account of biological teleology must be realist rather than eliminativist.<sup>3</sup> As the orthodox have correctly emphasized, the patterns, persistence, and apparent explanatory power of teleological commitment demand realism—that is, they do so as long as we give proper deference to the ontic authority of science.<sup>4</sup> Bigelow and Pargetter emphasize that

"How to Be a Realist About *sui generis* Teleology  
Yet Feel at Home in the 21st Century" by Richard Cameron,  
*The Monist*, vol. 87, no. 1, pp. 72–95. Copyright © 2004, THE MONIST, Peru, Illinois 61354.

patterns within function-attributions do not map interests; we are interested in things which have no functions and find functions in things which fail to interest us. Further, we believe that things would have had functions even if there were no one around to take interest in the structures that have them (1987, §II). Various authors appeal to the persistence of functional attribution: despite hundreds of years of philosophical antagonism to teleology, biological science has not removed teleological language from its explanations, and reflective biologists are positively resistant to the idea that they can or should do without teleology.<sup>5</sup> Finally, it is the *explanatory power* of teleological explanations that seems to account for this persistence. Karen Neander is perhaps most emphatic on this point:

The apparent explanatory power of teleological explanations which appeal to biological functions is quite robust. . . . That the bee's dance is for directing other bees to pollen does seem to explain why bees dance. I suppose it is just barely possible, perhaps, that this apparent explanatory power is illusory. . . . However the thesis that we are persistently irrational in this respect is psychologically implausible in contrast to a theory of functions that shows such explanations to be legitimate. (1991b, 127)

Neander calls teleology the “conceptual glue” of biology (1991b, 137) and notes that it would be “hard to exaggerate” the concept’s importance. (1995, 227)<sup>6</sup>

Recent discussions have taken these reflections seriously.<sup>7</sup> Philosophers have undertaken the challenge of understanding biological teleology—realistically construed—without resort to “the forces of darkness”: mentalism, vitalism, supernaturalism, panpsychism, entelechies, etc.<sup>8</sup> I endorse this project. Finally, the central role of teleological notions in biology has led to a tendency—which I will follow—to interpret the general metaphysical puzzle concerning teleology as a question in the philosophy of biology such that “[w]hat we principally want to understand,” as Karen Neander says, “is how the biological notion of ‘proper function’ can be both teleological and scientifically respectable” (1991b, 124).

This, however, is where agreement ends and fundamental challenge begins. Neander’s account may serve as a representative foil for my discussion of the orthodox view and its shortcomings. On her account,

It is a/the proper function of an item (*X*) of an organism (*O*) to do that which items of *X*’s type did to contribute to the inclusive fitness of *O*’s ancestors

and which caused the genotype, of which *X* is the phenotypic expression (or which may be *X* itself where *X* is the genotype) to increase proportionally in the gene pool. (1991a, 319)

Thus,

the function of your opposable thumb is to assist in grasping objects, because it is this effect which opposable thumbs contributed to the inclusive fitness of your ancestors, which caused the underlying genotype, of which opposable thumbs are the phenotypic expression, to be selected. In brief, grasping objects was what the trait, the opposable thumb, was selected for, and that is why it is the function of your thumb to help you grasp objects. (1991b, 130)

While there is much dissent about how to fine-tune such an account, some formulation along these broad lines is dogma among the orthodox.<sup>9</sup> Thus, orthodoxy endorses a reductivist project: “How can the biological concept of function, which is *prima facie* infected with final causation, be analyzed so as to make it compatible with a scientific world-view that countenances only efficient causation?” (Buller 1999, 6)

This is not the occasion for mounting a systematic case against reductionist realism’s claims to an historic philosophical success. (That case has been made well in other places, notably in Mark Bedau’s papers from the early 1990s.<sup>10</sup>) Only the broad outlines of the deepest objections will be canvassed here. Most fundamentally, if we trust intuitions as evidence,<sup>11</sup> then there are obvious hypothetical as well as non-obvious actual counterexamples to the orthodox account. Possible but non-actual “accidental-yet-instant creatures” would have parts with functions but no evolutionary history, so the orthodox view fails to provide a necessary condition for biological functions.<sup>12</sup> The existence of clays whose crystals undergo natural selection in stream beds without possessing functions undermines the sufficiency of the orthodox view.<sup>13</sup>

What such counterexamples reveal, I believe, is that our categorial intuitions balk at the idea that biological functions are historical properties.<sup>14</sup> A heart’s function of pumping blood is something it can have without having a past. And things with the right past may have no function. If intuitions are evidence, and if in particular *categorial intuitions* about which kinds of accounts can even possibly be correct are to be accepted as data against which theories must be tested (and it seems they must), then the

intuitions appealed to here count strongly against the orthodox view. Propositions cannot be donkeys, nor can they be sets<sup>15</sup>—categorical intuitions about the properties of each of these kinds disallow such reductions. Likewise, teleology cannot be a spatial relation such as *to the left of*, nor can it be a temporal (*cum* efficient-causal) relation as on the orthodox view. Categorical intuitions about what types of accounts can even possibly answer to traditional puzzles rule this story out.<sup>16</sup>

Further the attribution of a function to a thing carries with it norms of behavior. Norms appeal explicitly or implicitly to some good, where this supplies a regulative ideal in the evaluation of a thing's functioning. When we know that the heart's function is to pump blood we know what hearts are *supposed* to do, and it is both appropriate and informative to evaluate hearts as performing *well* or *malfunctioning*. Indeed, Karen Neander points out that a further reason for construing function-talk realistically is that biologists have found it impossible to categorize parts across species by reference to what they *do*: in biology, hearts are not the things that *do* pump blood, but the things that are *supposed to* pump blood (1991a, 327). Nevertheless, and *pace* protestations from the choir, the orthodox account of functions can make neither heads nor tails of their normativity.

On the orthodox view functions are correlates of adaptations: functions are (roughly) the tasks adaptations were selected for doing.<sup>17</sup> But while we say that a part was adapted *for* doing such and such, this use of the word 'for' carries no normative import, and it is (perhaps) the equivocation between these teleological and non-teleological senses of 'for' that have lent the orthodox view whatever plausibility it enjoys on this issue. Granted that *adaptation* is an important explanatory concept in biology, and even that there is a close empirical correlation between adaptations and functions, nevertheless this correlation does not establish an identity, nor does the non-normative concept of an adaptation provide the basis for an analysis of biological norms. Adaptations are selected *for* doing things only in the sense that I may select numbers from a set *for* their being prime.<sup>18</sup> My doing so, even repeatedly, even if I set up a practice of doing so which my descendants follow cultishly for generations, will not give the numbers functions, will not make *prime* what the numbers are *supposed to be* in any proper teleological or normative sense.<sup>19</sup> And likewise, that hearts were selected for pumping tells us nothing, except while under the influence of a particular orthodoxy, about the normative status of pumping for hearts.

There is neither purpose nor function *to* natural selection, nor resulting *from* natural (or artificial) selection. What is selected is simply selected, and what the selected does it merely does.<sup>20</sup>

The same point can be made with the counterexamples once again. An instant-creature's heart would be malfunctioning if, after a year, it suffered a heart attack, but it would have no history of selection. Certain clay crystals in river beds have the proper history of selection but they cannot malfunction.<sup>21</sup> History of selection is neither necessary nor sufficient for norms in nature. The parallel with the moral case is striking: we would not be licensed to conclude that men are *supposed* to be aggressive in either the moral or biological senses if we learned that such behavior was adaptive in evolutionary history.<sup>22</sup>

Responses to these kinds of objections tend not to run deep. Neander (1991a) offers the most sophisticated response, but even her treatment involves some dicey moves that attention to a broader spectrum of philosophical positions may have discouraged. To adopt the not entirely congenial rhetoric of the reductivists for a moment, note that the orthodox account appears to fail as a "conceptual analysis" of *biological functions* given the intuitions appealed to above. Neander can defend orthodoxy as both an adequate conceptual analysis *and* theoretical definition<sup>23</sup> of biological functions only by making two *ad hoc* moves. First, the orthodox view is taken to be a conceptual analysis only of *the experts'* intuitions; the laity's intuitions do not count, even when we love, respect, and make an amateur study of evolutionary biology. Second, "the experts" themselves must be restricted not simply to active workers in the field, but those among biologists working in the "right" fields—those that directly involve evolutionary analysis rather than, say, physiology or medicine, where functions play identical explanatory roles but where those explanations make no implicit or explicit reference to evolutionary history. Ruth Garrett Millikan's response is to repudiate conceptual analysis as "the misconceived child of a mistaken view of the nature of language and thought." She "rather brazenly" labels counterexamples such as mine above "fool's gold" (1989, 297, 300).<sup>24</sup> But while such assertions may appeal to the choir, they don't resonate outside the cozy confines of the church. Neither Neander nor Millikan takes sufficiently seriously the unity of function-talk across cases, times, theoretical backgrounds, and disciplines, nor the robustness of contrary intuitions even after the full ac-

ceptance of evolutionary theory. Yet these essays stand out in the literature for the lengths to which they go to speak to a broad audience. Clearly no one can force the orthodox to take the kinds of evidence sketched above as a serious threat to orthodoxy, but people who do take intuitions such as these seriously should begin to focus their attention on the problem of biological teleology with greater seriousness. There is much work to be done, and the narrow orthodoxy currently dominating discussion is not encouraging it.

This discussion has been quick and dirty, but I think ultimately defensible. Still, the discussion itself and the reactions I anticipate it will produce in different readers (especially the orthodox) deserves attention before moving on. Assessment of the dialectic that these kinds of arguments inspire hinges crucially on how we take the phrase with which I opened the discussion: *viz., if we take intuitions as evidence*. As I noted at the time, taking them as such is standard, defensible, and (even more strongly) *required*,<sup>25</sup> yet we should recognize that philosophers begin with distinct ideas about our epistemic abilities, work out a more or less rough and ready method for philosophizing on the basis of that conception, and so come to embody particular metaphilosophical positions on the nature and scope of philosophy in their approach to argument such as these. The orthodox tend toward deep suspicion of “conceptual analyses”; a different philosophical *zeitgeist* takes such arguments to be philosophical bread and butter. The issues that divide philosophers on these points play out in radically different approaches to mind, language, and the world; basic differences in epistemology determine the course of much further debate on narrower issues such as this one.

This metaphilosophical point is worth emphasizing because discussion concerning biological teleology has up until now been dominated by philosophers with a very particular, and narrow, bent on the broader issues. Viewed from other perspectives, perspectives that are acknowledged as both respectable and powerful in other branches of philosophy, the orthodox view seems clearly inadequate. And so it is past time for philosophers of other stripes to weigh in with seriously considered and plausible accounts of biological teleology for the 21st century—and past time that the orthodox felt challenged to defend their philosophical and metaphilosophical presuppositions more deeply than they have had to in what has been allowed to become a rather comfortable and clubby debate.

## II. HETERODOXY

This section presents an outline for a plausible alternate research program, one that respects both intuitions as evidence and the legitimate methodological and ontological constraints that contemporary science places on the philosophy of biology. Most importantly, heterodoxy rejects the assumption that eliminativism and reductivist realism exhaust the naturalistic alternatives to supernaturalism. After sketching a *tertium quid* between these views I move in the final section to defend heterodoxy against extant objections to non-reductivist views. As will be apparent, however, serious inquirers of all stripes should welcome a richer articulation of objections than can be culled from the contemporary literature. The philosophy of biology should thrive on *hard questions* as the philosophy of mind has in recent years; participants have settled too long for complacency born of the false belief that their only competition came from implausible and unscientific supernaturalisms.

My own proposal is emergentist, ontologically non-reductive, and accepts downward causation.<sup>26</sup> The notion of property emergence was explicitly developed in attempts to find a *tertium quid* between vitalism and mechanism in biology and also between materialism and substance-dualism in the philosophy of mind.<sup>27</sup> Emergentists claim the best of both worlds while rejecting the faults of each. From the vitalistic and dualist camps they take the notion that there may be properties of physical things that are irreducible to the physical but nevertheless (at least possibly) causally efficacious. From the materialistic and mechanistic camps emergentists take both a respect for the material continuity of all physical things and a firm commitment to the dependence of such emergent properties as there may be on their physical “realization bases.”<sup>28</sup> Microphysical explanation and causation are firmly entrenched in emergentist thinking despite the fact that they have neither the explanatory nor the causal hegemony they enjoy in widely popular monistic and reductionistic ontologies. Pluralism about levels and directions of dependence yields a messier ontology than orthodox tastes prefer, but not one where proponents need forget the virtues of microphysical explanation.

For my purposes we need only a rough-and-ready conception of ontological emergence.<sup>29</sup> Emergence is associated with the vague claim that a whole may be “greater than the sum of its parts,” and contrasted with the

denial of that claim. There are a number of ways of cashing this out, and these ways lead to various conceptions of emergence that need distinguishing. Clearly, however, all doctrines of emergence will be dealing with properties of complex physical systems composed of parts—systems such that only some of their parts exist outside of those complex systems. One core element of the brand of emergentism to be developed here is the rejection of the preformationist assumption.

*The preformationist assumption:* “there cannot be more in the effect than there is in the cause.” Alternately, the doctrine that an effect is not understood until and unless “the eye of reason could somehow discern it *in the cause*” (Lovejoy 1927, 20).<sup>30</sup>

The preformationist assumption is a “medieval” doctrine concerning causality in the sense that it was refuted decisively in the modern era by Hume. Ironically, the emergentist’s criticism of Hume’s heirs will be (in large part) that they have not taken this central result sufficiently to heart.

Fundamental to the emergentist’s position is Hume’s axiom that we cannot know *a priori* which things or which *kinds* of things<sup>31</sup> will or can be causally related; there are no non-trivial *a priori* constraints on what causal relations there are. As Hume says, we are in a “natural state of ignorance with regard to the powers of and influence of all objects” when we consider them *a priori* (1975, IV.ii.32; see also 1990, Book I.iii). Emergentists take this Humean point firmly to heart and affirm that there are no *a priori* bars on what types of events, properties, or entities might emerge from the causal interactions of complex groupings of entities, micro or macro. In particular, no causal relations are ruled out by their “opacity to reason” or “mysteriousness.” All causal relations—efficient causal or otherwise—are mysterious in the only sense that matters, but this sense ought not make us wary of postulating any particular kind of causal relations.

For our purposes, note in particular that we cannot know *a priori* that the interactions of strictly physical properties and entities will not causally give rise to *sui generis* mental properties such as consciousness or to the *sui generis* directedness upon and characteristic of teleology. Further, according to emergentists Hume’s axiom entails that there is no *a priori* bar on emergent properties entering into primitive and (from the micro-level per-

spective) *novel* causal relations with other entities, whether the causal relations be on the “same level” (i.e., between two emergent properties), “downward” (i.e., between a cause that is emergent and an effect at the level of its base), or “upward” (i.e., between a cause which is emergent and some emergent property at a higher level).

We thus have the following core commitments of an emergentist view.

1. *Emergentists accept an ‘ultimate physical ontology’.* “[Ultimate Physical Ontology] There are basic, non-emergent entities and properties, and these are material entities and their fundamental properties.” (Kim 1992, 122)
2. *The denial of preformationism (1): the affirmation of emergent novelty.* The causal relations micro-entities enter into in certain complex wholes may generate emergent novelties in the sense that some properties of wholes may be irreducibly different in kind from the properties, relations, and entities that generate them and upon whose interactions they depend for their instantiation.
3. *The denial of preformationism (2): the affirmation of “downward” causation.* Emergent properties may enter into novel causal relations. Thus, while emergent properties depend for their existence on the interactions of their base properties, they may influence the course of lower-level events in ways (a) compatible with their continuing to be instantiated and (b) which are best attributed as causal powers directly to them as opposed to being re-construed as the causal potentialities of base properties, relations, and entities expressed only in what may turn out to be highly artificial circumstances when we view things from the base perspective.

These basic theses can be formulated as a definition of an emergentist ontology strong enough for my purposes in challenging orthodoxy.

*Emergentism:* The ontological view that there exist or may exist properties  $P$  of a structure  $X$  with components  $a_1 \dots a_n$  such that (i)  $P$  properties depend causally for their existence on the interactions of  $a_1 \dots a_n$  in  $X$ ; (ii)  $P$  properties augment the ontology of

the world in the sense that they are not reductively identifiable with any of the properties or relations of  $a_1 \dots a_n$  in their interactions outside of structures relevantly similar to  $X$ ;<sup>32</sup> and (iii)  $P$  properties may have novel causal powers; the causal relations  $P$  enters into need not be wholly identifiable with any of the causal powers, mere potentialities, or relations of  $a_1 \dots a_n$  or their aggregates.

A few comments on this ontology are in order.

First, emergentism does not deny the fact or value of micro-explanation. But the coherence of emergentist ontologies does generate a kind of inevitable dialectic between reductionists and pluralists about the ontic makeup of the world. Emergentists may insist that there are no natural systems concerning which the search for further micro-level understanding will fail to pay dividends. They will, however, deny the hegemony of micro-level explanations at least in principle. Grant for the moment that we have an emergent property construed along the lines above. Even so the search for micro-level explanations need never be exhausted: it may always profit us to seek further and richer micro-level explanation. Despite the ever improving richness of our microphysical account, and despite the fact that we may get closer and closer (and perhaps even empirically *perfect*) correlations between the emergent phenomena and base physical entities, properties, and relations, none of these correlations will, by hypothesis, yield an ontological analysis of the emergent property as opposed to further information about its base. This means that even at the limit, when (and if) perfect correlations are established,<sup>33</sup> reductivists may be tempted to charge emergentists with obtuseness for hanging on to their intuitions despite the “fit” emergentists will admit to have been achieved between the micro-level phenomenon and the emergent property. But on the hypothesis that we have a genuine emergent property here, the emergentist is right in this case about the ontic structure of the world. The reductivist’s commitment to monism precludes her seeing the world as it is rather than as she wants it to be in this (possible) case. And so both excessive love of intuition and mystery as well as irrational fear of it can keep us from seeing the truth. Thus, reductivists and emergentists may be wrapped in difficult-to-resolve philosophical debates over whether the

latest correlation between an alleged emergent property and its base constitutes a successful reductive identification or a mere correlation. Further, there can come a point when more scientific research cannot settle the issue. Even in the current state of play, acceptance of emergentist ontology need not wait on a “finished” science.

Second, irreducible higher-level properties and causal relations are not incompatible with the pervasive dependency of higher-level entities and structures on lower-level entities and structures, nor on emergent properties interacting causally with their base properties. This is a simple entailment of Hume’s axiom, one whose invocation needs to be taken much more seriously than is fashionable in contemporary discussions. On the standard view, micro-to-macro causation rules to the exclusion of macro-to-micro causation. As Robert Klee says,

We find micro-explanation to be a powerful and impressive form of explanation. . . . [But w]e really have no established *model* of what a macro-determinative connection would be like. Direct determination from higher-levels to lower-levels seems somewhat mysterious when one attempts to construct a relatively precise scenario of the ‘how’ and the ‘why’ of it. (1984, 59–60)<sup>34</sup>

But there is no *a priori* bar on the existence of such causal relations. No causal relation of whatever kind between  $A$ s and  $B$ s is any more “mysterious” or “opaque to reason” than any other kind. And the demand that emergentists “fill in the causal gaps” between an alleged emergent property  $A$  and its base-level effect  $B$  by uncovering ever more intervening causal structure (on the model of our experience with physical-physical causal structures) must be recognized as illegitimate in principle on Humean grounds. As Humeans we must insist that if we discover, as we might, causal relations between entities or properties of distinct ontic types, then at some point—itsself to be determined through empirical work rather than armchair speculation—there will occur *basic* and *unmediated* causal relations between the two types. Reductivists must learn to live with this as a philosophically sound and scientifically legitimate feature of the emergentist view. That is, they must desist from taking this fundamental fact about ontically pluralist views as the basis for covert appeals to medieval assumptions concerning which types of causal relations are “mysterious” and must be modeled on other types on pain of being rejected out of court.

There is nothing inherently mysterious about a world more causally and ontically intertwined than the aesthetically pleasing exclusive micro-to-macro picture maintains.<sup>35</sup>

There is no *a priori* reason to suppose that reduction must succeed or that the history of science reveals that it will succeed.<sup>36</sup> The findings of science have never debarred teleology from the world. Science finds what scientists need in their explanations, and if scientists need teleology we ought to accept it regardless of our ability or inability to produce reductive accounts. Claiming that science debar teleology was misdirection from the start; medieval philosophical assumptions about causality, not science, have given *sui generis* teleology its status as blasphemy.

I have presented only one model for an alternate research program. Yet I suspect that confidence in heterodoxy's reflecting the ontic structure of the world will vary more or less directly with one's confidence in (a) and (b):

- (a) that naturalistic realism about biological functions is the only plausible game in town;
- (b) that reductive accounts appear doomed to failure.

In this essay I assume (a), and do so with the blessing of orthodoxy. And I have no argument for the impossibility of a successful reductive account of biological functions to offer in support of (b). Ultimately, the case for (a) and (b) rests on scientists' need for teleological concepts in biology, the ontic authority of science, the authority of intuitions as evidence in philosophy, and our judgments concerning the relative success and failure of each newly proposed account and type of account. And I know of no algorithm for making such complex philosophical judgments.

So the hard decisions revolve around how to determine whether (b) has been or is likely to be adequately supported, and so when we should jump on board the heterodox project. It would be rash to suppose that the objections to orthodoxy presented in Section I were sufficient by themselves to encourage a general stampede away from reductivist accounts. These issues require richer, deeper, and more focused discussion than they have received in this wide-ranging essay. But that is in fact my main thesis: we are not currently *getting* that richer and deeper discussion from those working on the issue, and this is not entirely their fault. Yes, the

arguments given above are strong enough to warrant both greater respect and richer responses than they have thus far received from the orthodox. But many deficiencies in the current debate are attributable to the silence of philosophers who respect intuitions as evidence but who have, thus far, remained silent on this particular issue.

We can now modify Plantinga's argument in the epigraph so that it expresses the correct inference. If we are convinced that we should be naturalists about our scientific concepts, that we have reasons to be realists about teleological commitment in particular, and that the prospects for reductive accounts are dim, then we have strong yet fallible scientific *cum* philosophical reasons for thinking that teleological directedness is a *sui generis* feature of the natural world.

### III. NATURALISM

Given the heterodox nature of the view outlined above, it is worth pausing to re-emphasize its firm commitment to naturalism as well as to both the methods and findings of modern science. Indeed these are respects in which my account is slavishly orthodox. The main motive for popular reductivist realism about biological teleology is the centrality of biological teleology to tremendously successful contemporary evolutionary biology. Thus, respect for the ontological authority of science demands acceptance of teleology realistically construed, and this is one reason my account fits snugly in the naturalist's camp. There are further substantive senses, however, in which this account is naturalistic in both its ontology and epistemology.

The ontological story told here is one that meets the negative ontological constraint on naturalistic accounts that they not be committed to supernatural entities or forces, or non-physical substances such as "entelchies."<sup>37</sup> Stated in positive terms, *sui generis* teleology is, on the picture sketched above, the emergent product of causal relations between natural things and is therefore itself just another natural outcome of lawlike causal interactions among the world's micro-parts. Teleology is a seamlessly integrated thread in the fabric of the natural world.

The account also satisfies the strong methodological constraint on naturalistic theories that they endorse only the methods of knowledge ac-

quisition employed in the sciences,<sup>38</sup> for my account is, again, firmly based on the supposition that biologists need teleology in their explanatory toolkit. Far from being the vacuous appeal to mystery it was lampooned to be by modern thinkers, teleology earned our good graces through its enduring centrality to successful scientific accounts of the world. To invoke *sui generis* teleology, then, is not to invoke “the forces of darkness,” but a core explanatory tool in contemporary science.

Finally, the emergentist picture sketched above provides a naturalistic account of our knowledge of biological teleology. On the picture presented here we may adopt a plausible causal account of the origins of empirical knowledge to explain both our acquaintance with and knowledge of teleological directedness as well as its core role in biological explanation. We know about teleology because we causally interact with it, and biologists have not shaken free of teleological explanation because it is genuinely explanatory—it involves its own kind of causal explanation, but it explains just the same. While my objections to reductionist accounts of the ontology of the physical world appeal to intuitions the orthodox tend to shun, the physical ontology I propose in place of their reductive account is naturalistic through and through, and our access to such an ontically structured world need not *itself* depend on the *aprioristic* intuitions deployed in Section I. This research program therefore respects both the philosophical data generated by intuition (in its rejection of contemporary reductive accounts) and the proper methodological and substantive constraints of modern science (in its account of the ontic structure of the natural world).

#### IV. OBJECTIONS

Heterodoxy deserves to be taken seriously in the literature to the extent that the objections to orthodoxy have been systematically underestimated while objections to plausible contrary views have been (almost) uniformly overrated.<sup>39</sup> They are overrated primarily because of the false dichotomy orthodoxy assumes between naturalist reductive (or eliminativist) views and supernaturalism. Given supernaturalism’s obvious ill fit with scientific explanations of the world, the orthodox have felt no need to generate powerful criticisms of non-reductive views—and so serious criticisms are not on offer. Making do with what is on offer, however, we can categorize traditional worries along three axes.

First, one may worry that a commitment to *sui generis* teleology would bring commitment to some *F* in its trail, where commitment to *F*’s is unacceptable in its own terms. Historical values for *F* have included: animism, panpsychism, the existence of a creator god, backwards causation, vitalism, *ad hoc* entities generally, the view that evolution is progressive, or the belief that the world is a “nice place.”<sup>40</sup> An adequate response to any charge along these lines is the simple assertion that it is false backed by an ontology that has no such commitments or entailments. The view articulated above, for instance, satisfies this constraint.

We may also include the following types of objection under this first heading. The philosophical literature contains a surprising number of gruff dismissals of *sui generis* teleology phrased in the rhetoric of hard-nosed realism.

[T]here might be extra, irreducible external relations, besides the spatiotemporal ones; there might be emergent natural properties of more than point-sized things. . . . But if there is suchlike rubbish, say I, then there would have to be extra-natural properties or relations that are altogether alien to this world. (Lewis 1986, x)

Charitably construed, such statements are nothing more than emphatic endorsements of a particular view. In practice, however, they serve as “argument stoppers,” rhetorical devices that cut off debate through theft rather than honest toil. Regardless of how they are taken, chest-thumping dismissals carry no weight in serious discussion.

Teleology’s oft-proclaimed mysteriousness is another non-starter. “Although strong emergence is logically possible, it is uncomfortably like magic. . . . such causal powers should be quite unlike anything within our scientific ken,” Mark Bedau informs us (1997, 377). But, to play the refrain one more time, Hume’s axiom ought to have disabused us of the idea that *a priori* pronouncements about the causal structure of the world deserve credence. This quote conveys the not uncommon rhetorical impression that science underwrites the mysteriousness of teleology. But such a view depends on either ignoring teleology’s centrality to biology or what amounts (in this context) to a question-begging assumption that biologists’ invocations of teleology come to nothing more than disguised efficient causality. The assumption itself is something that philosophical argument concerning the adequacy of reductive accounts, not science, will settle. This first group of objections depends on straw-person construals of teleologi-



cal commitment which need be taken no more seriously than the spirit in which they are offered.

Ontological worries form the second main set of criticisms. Moderns fret that *sui generis* teleology is incompatible with substantive scientific findings. But this widespread anxiety rests on an implicit acceptance of orthodoxy's false dichotomy between reductive (or eliminativist) naturalism and supernaturalism. An emergentist ontology is fully compatible with the findings of modern science. Indeed, a growing number of philosophers of science believe that the findings of quantum mechanics lend independent support to the view that the world has an emergentist ontology.<sup>41</sup> The fact that realism about teleology is compelling in conjunction with the poverty of available reductivist views provides warrant for pursuing research on teleology along ontically emergentist lines.

Finally, the third set of objections to *sui generis* teleology consists in methodological worries. To commit to teleology is, moderns argue, to court scientific irrelevancy, to introduce claims not subject to empirical test, and to open the floodgates to vacuous ("dormative virtue") explanations.<sup>42</sup> But these concerns need not detain us long either. To charge teleological explanation with scientific irrelevance is either to reveal a profound ignorance of contemporary evolutionary biology or, again, to assume orthodoxy itself. And to claim that teleology is beyond the realm of empirical test is apparently to ignore biology itself, where claims concerning functions are part of the bread and butter of debates between active researchers. Such debates are themselves neutral over the ontological status of entities and properties invoked—whether teleology turns out to be reduced or *sui generis*, we can be equally confident from the start that it has earned its place in successful practice. Concerns over the type of vacuity involved in "dormative virtue" explanations rely on implicitly holding teleological explanation to a standard that efficient causality could not meet, and is illegitimate wherever it is employed. Any type of causal explanation may be abused with vacuous "natural tendency" explanations, but the fact that a relation can be invoked in slipshod and unhelpful ways does not undermine its value when employed sensibly. Efficient causality and teleology stand or fall together in this regard, and I take this to mean that neither falls rather than that both do.<sup>43</sup>

Objections to *sui generis* teleological commitment current in the literature are far less serious than they have been taken to be. And objections to orthodoxy are substantially stronger than a survey of internecine debate

would suggest. The absence of focus on these core philosophical issues in the context of biological teleology is a sign not of orthodoxy's unassailability but of complacency.<sup>44</sup>

Richard Cameron

University of Alaska, Anchorage

#### NOTES

1. See, e.g., Buller (1999, 26) and Godfrey-Smith (1993, 185).
2. The closest I have found to an acknowledgement that these alternatives are not exhaustive comes from another critic of orthodoxy, Mark Bedau, who points out that *sui generis*, non-mentalistic, naturalistic teleology is a metaphysical and physical possibility (1992c, 286). Still, this dissent does not stray far from orthodoxy, for he concludes rather quickly, and on grounds that fail to take the aforementioned possibility very seriously, that such teleology "does not exist" (283). If I have missed other such brief acknowledgements, I of course, apologize, but the tendency to treat the alternatives as exhausted by reductionist realism, eliminativism, and supernaturalistic mentalism is pervasive.
3. From this point forward I will use variants on 'orthodoxy' to refer only to the dominant (reductivist) camp. Where I mean to include supernaturalists and/or eliminativists I will make this clear in the text. Contemporary eliminativist analyses tend to derive from Cummins (1975).
4. On the principle of the ontic authority of science, see especially Kornblith (1994), but see also Crane (1994, 480), Rosenberg (1996), Rudder Baker (2000, 23), and Healey (1991).
5. Mark Bekoff writes with Colin Allen that "Even a cursory scan of the theoretical literature reveals that biologists have found it difficult and even undesirable to eliminate teleological notions from their discussions of biological phenomena" (1995, 244).
6. See also Buller (1999, 6), Allen and Bekoff (1995, 244); Hull (1974, 120); Woodfield (1976, 32, see also p. 1); Nissen (1997, vii); Allen, Bekoff, and Lauder (1998, 1–2), Dretske (1988, 63); Neander (1991b, 127); and Bigelow and Pargetter (1987, 100).
7. This brief treatment makes no claims toward having fully defended realism about biological functions, only to have provided a *prima facie* defense of the view for the initially skeptical. Realism has the status of an assumption for the purposes of this paper, but this is not a controversial assumption among those currently working in the field. Thus, my argument in Section I may be construed as an internecine debate between realists.
8. To borrow David Chalmers's memorable phrase (1996, 128). For exceptions to this rule see Plantinga (1993b; 2002), Nissen (1997), and Searle (1995).
9. Note that this delimitation of orthodoxy excludes two groups in the naturalist's camp. First, there are the followers of Robert Cummins's eliminativist account of functions in his (1975). I pass over these accounts as insufficiently respecting the points above concerning grounds for contemporary realism about functions. Second, there is a recent trend to escape certain problems that bedevil "straight" or unmodified orthodox accounts by combining a Cummins-style analysis with the Wright-inspired line into "pluralist" accounts. I think both that this trend needs to mature, and that a thorough discussion would take us too far afield for my purposes. Most importantly, while some of my objections

below suggest pluralist criticisms of orthodoxy, neither of these exclusions fundamentally affects the positive theses for which I argue in Sections 2 and following—those arguments apply across the board.

10. See Bedau (1990, 1991, 1992a, 1992b, 1992c). Critics of the orthodox view come from many perspectives. See the eliminativists Cummins (1975) and Prior (1985), the mentalists Nissen (1997) and Searle (1995), and the supernaturalist Plantinga (1993a) for other perspectives.

11. For arguments that it is standard—and essential—to do this see Bealer (1992, 1998, 1999).

12. Is this intuition stable? Or is the thought that such a creature would have parts with functions derived from a confusion between this case and the case of a creature instantly created by a *designing agent such as a God*. In this latter case intuitions may suggest that the functions are derived not from natural selection (as on the orthodox view) but from the intentions of a designing agent. I believe the original intuition is stable. Consider: Neither physiologists nor medical scientists would have trouble identifying an accidental creature's parts independent of knowledge of its origins (chance, designed, or evolved), this despite the fact that parts are defined functionally in biology. Further, they would not be able to explain the interaction of the creatures' parts without appeal to functional notions. Neither the discovery nor the explanatory power of function talk requires knowledge of a thing's origin, although (of course) scientific investigation of a thing's natural or design history in actual cases is often *very* useful in furthering our knowledge of parts' functions. We shouldn't confuse this methodological fact with an analytical claim that such functions are to be identified with these histories, however, as this intuition reveals. Compare this response to Millikan's objection (discussed in n.13 below). My response here is relevant to her as well. I thank the editors of this journal for the objection.

13. See Bedau (1992b) for a rich discussion of the clay-crystal case. As an illustration of orthodoxy in action, note that Ruth Garrett Millikan responds to examples such as those provided by arguing that while "current properties and dispositions" of things are, in this world, *critical* for possessing functions, they provide merely a "*mark* of purposiveness," they do not *constitute* having a purpose (1989, 300–01). Millikan and I agree that analyses in terms of current *structural* or formal properties are inadequate to the purpose of analyzing functions, but if she means to rule out the kind of view outlined in the next section of the text then her argument is a *non sequitur*—it relies on orthodoxy as a suppressed premise.

14. Historical properties depend essentially on reference to the past; thus, that my car has 130,000 miles is an historical property of the car; it cannot have the property without having a past. See Healey (1991).

15. The example and model for this argument are from Plantinga (1987). Bealer (1992) provides additional support.

16. Again, functions derived from the conscious activity of agents (whether gods, humans, or other animals) will owe their status to a particular history. The argument of this paper assumes a focus on standard cases of biological or natural teleology, where such derivation appears absent.

17. See Elliot Sober's definition of biological adaptation (2000, 85).

18. The editors note that *numbers* and *organisms* are disanalogous in that only numbers are "unmodifiable," they have "unalterable properties," and this may explain the difference between the cases. But the counterexample appealed to in the next paragraph does not have this feature, and so while I do not think the disanalogy plays a role in the argument, I need not rest my case on this example.

19. Again, this is not to deny that even numbers can derive functions from the uses to which we put them, as in coding algorithms. I thank the editors for the example.

20. More precisely, what the selected does it merely does *qua thing with a history of selection*. The thing selected may in fact have a function, and indeed much of the plausibility of the orthodox account of functions derives from the fact that there is a strong correlation in the actual world between functions and selected effects. But history of selection cannot itself account for the normativity of functions.

21. Again, see Bedau (1992b) for the details of this case, and recall that nothing said here rules out crystals' deriving non-biological functions from a history of conscious design or intentions.

22. The reader should feel free to ignore this example if she finds it prejudicial in the sense that her moral intuitions might be infecting intuitions about biological norms. I am comfortable resting my case on the points above, but feel the moral parallel is worth drawing to highlight the implausibility of the contrary view when carried over into other normative contexts.

23. Roughly, conceptual analyses unearth *our concepts of things* whereas theoretical definitions elucidate scientifically important features *of things in the world* without regard to our concepts.

24. To be fair to Professor Millikan it must be noted that she does provide an elaborate justification for this move in her longer works, especially Millikan (1984). Nevertheless, the point remains that nothing she does in her (1989) moves the ball forward with regard to the objections canvassed here.

25. Again, see Bealer (1992, 1998, 1999) for support.

26. For rhetorical convenience I will often speak of the form of ontological emergence I articulate here as "emergentism" rather than, what it is, merely *an* emergentist view. See O'Connor and Wong (2002) for a good survey of emergentist views.

27. See especially Broad (1918–19, 1925), Lovejoy (1927), Goudge (1967), and McLaughlin (1992). But note that emergentism is not committed to vitalism, which (unlike *sui generis* teleological commitment) *has* been refuted by evolutionary biology.

28. Although I realize it raises a host of issues beyond the scope of this essay, I employ 'levels' and 'base' metaphors for convenience throughout.

29. Note, however, that we will be making an *ontological* rather than merely *epistemological* claim. The claim is not merely that we cannot *predict* what properties will result in various circumstances, but the stronger thesis that the resultant properties are *sui generis* irreducible threads in the fabric of the natural world.

30. Lovejoy is not alone among emergentists in drawing these connections. See also Goudge (1967) and Popper (1977).

31. Hume was concerned to combat not only the medieval assumption that bodies (as "inferior") could not causally affect minds, but also Berkeley's view that bodies could not enter into causal relations even with one another. Hume's arguments either work for both things and *kinds* of things or they work for neither.

32. Two caveats. First, Given Hume's axiom it will follow that which structures are "relevantly similar" is to be discovered through scientific investigation rather than armchair speculation. The principle for selecting such "relevant" groups employed in this paper is that we will have a case for emergence only when we have persistent patterns of robust scientific explanations that resist serious effort at reductive analysis. This subordinates our beliefs about the ontic structure of the natural world to the fallible and evolving evidence that science provides in a way that is wholly appropriate. Second, the definition relies on the vexed but useful and widely employed notion of an "intrinsic" property. This

is not the place to launch into a discussion of the wider metaphysical issues involved in explicating that notion.

33. And we should recall that contemporary reductivists have not achieved the hypothesized level of success—the correlations they now allege to constitute biological functions survive confrontation with neither actual nor hypothetical counterexamples, as I argued above in Section I.

34. See also Mark Bedau (1997, 377), quoted below.

35. For authors who stress this point see especially Broad (1918–19), Silberstein and McGeever (1999) and Humphreys (1995, 1996, 1997a, 1997b).

36. Indeed, the most common inductive arguments for “the causal closure of the physical” all assume that reductive accounts of teleology in biology have already succeeded. They work on the tacit assumption that of the two *prima facie* “big obstacles” to a physicalist ontology, mind and biological teleology, one (biological teleology) has already succumbed to the reductive or eliminativist axe and that the other is sure to follow. But to invoke such an argument *in this context* would be question begging, for the success of reductive accounts of teleology is precisely what is at issue here. If teleology has not been reduced, and there is still controversy over mind, then the inductive case for a monistic physical ontology is quite weak—it has achieved clear success in *neither* of the areas that are controversial even granting its wild success in areas where physical ontology should never have been controversial.

37. See McGinn (1991, 87), Katz (1998, 12) and Post (1995).

38. For this constraint see BonJour (1998, 69), and Katz (1998, 12). Of course, that the account satisfies the constraint need not constrain others—non-naturalists in epistemology—from accepting the result; the account is not the exclusive possession of naturalists in epistemology.

39. Woodfield and Bedau come closest to appreciating the weakness of these types of objections, but both back off from accepting the full implications of their insights.

40. See Buller (1999, 6), Jacobs (1986, 392), Nissen (1997, 96, 105, 134), Woodfield (1976, 34), Bedau (1992c, 283), and Mayr (1988, 40), who between them raise all these worries with greater or lesser seriousness.

41. See for instance Humphreys (1995, 1996, 1997a, 1997b), Teller (1986), Stapp (1993), Penrose (1995), Healey (1991), Silberstein and McGeever (1999), and Stairs (1990).

42. See Woodfield (1976, 8–9), and Allen and Bekoff (1995, 244; 1995, 9).

43. The argument derives from Woodfield (1976, 7–8).

44. Many thanks are due to the editors of this journal for their helpful and stimulating comments—the essay is substantially improved through their efforts. Thanks as well to Christopher Shields, Robert Pasnau, and Graham Oddie for insightful comments on and criticisms of earlier incarnations of the work, and especially to Jennifer Everett, whose critical eye and ear sharpens and clarifies whatever she encounters.

## REFERENCES

Allen, C., and M. Bekoff, 1995. “Biological Function, Adaptation, and Natural Design.” *Philosophy of Science* 62: 609–22. Reprinted in Allen, Colin, Marc Bekoff, and George Lauder, eds., 1998. *Nature's Purposes: Analyses of Function and Design in Biology*. (Cambridge, MA: M.I.T. Press), pp. 571–87. Also reprinted in Buller, David

J., ed. 1999. *Function, Selection, and Design*. (Albany, NY: State University of New York Press), pp. 243–56.

\_\_\_\_\_, 1995. “Function, Natural Design, and Animal Behavior.” In *Perspectives in Ethnology II: Behavioral Design*, edited by N. S. Thompson. (New York: Plenum), pp. 1–46.

Allen, Colin, Marc Bekoff, and George Lauder, 1998. “Introduction.” In *Nature's Purposes: Analyses of Function and Design in Biology*, edited by C. Allen, M. Bekoff and G. Lauder. (Cambridge, MA: M.I.T. Press), pp. 1–26.

Bealer, George, 1992. “The Incoherence of Empiricism—I.” *Aristotelian Society, Supp.* 66: 99–138. Reprinted in *Naturalism: A Critical Appraisal*. Steven J. Wagner and Richard Warner, eds., 1993. (Notre Dame, IN: University of Notre Dame Press), pp. 163–96.

\_\_\_\_\_, 1998. “Intuition and the Autonomy of Philosophy.” In *Rethinking Intuition: The Psychology of Intuition and Its Role in Philosophical Inquiry*, edited by M. R. DePaul and W. Ramsey. (New York; Rowman & Littlefield), pp. 201–40.

\_\_\_\_\_, 1999. “The A Priori.” In *The Blackwell Guide to Epistemology*, edited by J. Greco and E. Sosa. (Oxford: Blackwell), pp. 243–70.

Bedau, M., 1990. “Against Mentalism in Teleology.” *American Philosophical Quarterly* 27: 61–70.

\_\_\_\_\_, 1991. “Can Biological Teleology be Naturalized?” *The Journal of Philosophy* 85: 647–55.

\_\_\_\_\_, 1992a. “Goal Directed Systems and the Good.” *The Monist* 75: 34–51.

\_\_\_\_\_, 1992b. “Naturalism and Teleology.” In *Naturalism: A Critical Appraisal*, edited by S. Warner and R. Wagner. (Notre Dame, IN: University of Notre Dame Press), pp. 23–51.

\_\_\_\_\_, 1992c. “Where's the Good in Teleology?” *Philosophy and Phenomenological Research* 52: 781–805. Reprinted in Allen, Colin, Marc Bekoff, and George Lauder, eds., 1998. *Nature's Purposes: Analyses of Function and Design in Biology*. (Cambridge, MA: M.I.T. Press), pp. 261–91.

\_\_\_\_\_, 1997. “Weak Emergence.” *Philosophical Perspectives* 11: 375–99.

Bigelow, J., and R. Pargetter, 1987. “Functions.” *The Journal of Philosophy* 84: 181–96. Reprinted in Allen, Colin, Marc Bekoff, and George Lauder, eds., 1998. *Nature's Purposes: Analyses of Function and Design in Biology*. (Cambridge, MA: M.I.T. Press), pp. 241–60.

BonJour, Laurence, 1998. *In Defense of Pure Reason* (New York: Cambridge University Press).

Broad, C. D., 1918–19. “Mechanical Explanation and its Alternatives.” *Proceedings of the Aristotelian Society* 19: 86–124.

\_\_\_\_\_, 1925. *The Mind and its Place in Nature*. (London: Routledge & Kegan Paul).

Buller, David J., 1999. “Introduction: Natural Teleology.” In *Function, Selection, and Design*, edited by D. J. Buller. (Albany, NY: State University of New York Press), pp. 1–28.

Chalmers, David J., 1996. *The Conscious Mind: In Search of a Fundamental Theory*. (Oxford: Oxford University Press).

Crane, Tim, 1994. “Physicalism (2): Against Physicalism.” In *A Companion to the Philosophy of Mind*, edited by S. Gutteplan. (Oxford: Basil Blackwell), pp. 479–84.

Cummins, Robert, 1975. “Functional Analysis.” *Journal of Philosophy* 72: 741–65. Reprinted, with changes, in Allen, Colin, Marc Bekoff, and George Lauder, eds., 1998.

- Nature's Purposes: Analyses of Function and Design in Biology*. (Cambridge, MA: M.I.T. Press).
- Dretske, Fred, 1988. *Explaining Behavior: Reasons in a World of Causes*. (Cambridge, MA: M.I.T. Press).
- Godfrey-Smith, Peter, 1993. "Functions: Consensus Without Unity." *Pacific Philosophical Quarterly* 74: 196–208. Reprinted in Hull, David L., and Michael Ruse, eds., 1998. *The Philosophy of Biology*. (Oxford: Oxford University Press), pp. 280–92. Also reprinted in Buller, David J., ed., 1999. *Function, Selection, and Design*. (Albany, NY: State University of New York Press), pp. 185–97.
- Gouge, T. A., 1967. "Emergent Evolutionism." In *The Encyclopedia of Philosophy*, edited by Paul Edwards. (New York: Macmillan Publishing Co. and The Free Press), pp. 474–77.
- Healey, Richard A., 1991. "Holism and Nonseparability." *Journal of Philosophy* 88: 393–421.
- Hull, David, 1974. *Philosophy of Biological Science*. (Englewood Cliffs, NJ: Prentice-Hall).
- Hume, David, 1975. *Enquiries Concerning Human Understanding and Concerning the Principles of Morals*. Edited by L. A. Selby-Bigge and P. H. Nidditch. (Oxford: Clarendon Press).
- \_\_\_\_\_, 1990. *A Treatise of Human Nature*. Edited by L. A. Selby-Bigge and P. H. Nidditch, 2nd edition, ed. (Oxford: Oxford University Press).
- Humphreys, Paul W., 1995. "Understanding in the Not-So-Special Sciences." *Southern Journal of Philosophy* XXXIV, Supp.: 99–114.
- \_\_\_\_\_, 1996. "Aspects of Emergence." *Philosophical Topics* 24: 53–70.
- \_\_\_\_\_, 1997a. "Emergence, Not Supervenience." *Philosophy of Science* 64 (4): 337–45.
- \_\_\_\_\_, 1997b. "How Properties Emerge." *Philosophy of Science* 64: 1–17.
- Jacobs, Jonathan, 1986. "Teleology and Reduction in Biology." *Biology and Philosophy* 1: 389–99.
- Katz, Jerrold J., 1998. *Realistic Rationalism*. (Cambridge, MA: M.I.T. Press).
- Kim, Jaegwon, 1992. "'Downward Causation' in Emergentism and Nonreductive Physicalism." In *Emergence or Reduction*, edited by A. Beckermann, H. Flohr, and J. Kim. (Berlin: De Gruyter), pp. 119–38.
- Klee, Robert, 1984. "Micro-Determinism and Concepts of Emergence." *Philosophy of Science* 51: 44–63.
- Kornblith, Hilary, 1994. "Naturalism: Both Metaphysical and Epistemological." In *Midwest Studies in Philosophy*, edited by P. A. French, T. E. J. Uehling and H. K. Wettstein. (Notre Dame, IN: University of Notre Dame Press), pp. 39–52.
- Lewis, David, 1986. *Philosophical Papers*, vol. 2. (Oxford: Oxford University Press).
- Lovejoy, Arthur, 1927. "The Meaning of 'Emergence' and its Modes." In *Proceedings of the Sixth International Congress of Philosophy*. (London; Longmans, Green), pp. 20–33, reprinted in P. Wiener (ed.), *Readings in the Philosophy of Science*. (New York: Charles Scribner's Sons, 1953), pp. 585–96.
- Mayr, Ernst, 1988. "The Multiple Meanings of Teleological." In *Toward a New Philosophy of Biology: Observations of an Evolutionist*. (Cambridge, MA: Belknap Press of Harvard University Press), pp. 38–66.
- McGinn, Colin, 1991. *The Problem of Consciousness: Essays Towards a Resolution*. (Oxford: Blackwell).
- McLaughlin, Brian P., 1992. "The Rise and Fall of British Emergentism." In *Emergence or Reduction?*, edited by A. Beckermann, H. Flohr, and J. Kim. (Berlin: De Gruyter), pp. 49–93.

- Millikan, Ruth G., 1984. *Language, Thought and Other Biological Categories*. (Cambridge, MA: M.I.T. Press).
- \_\_\_\_\_, 1989. "In Defense of Proper Functions." *Philosophy of Science* 56: 288–303. Reprinted in Allen, Colin, Marc Bekoff, and George Lauder, eds., 1998. *Nature's Purposes: Analyses of Function and Design in Biology*. (Cambridge, MA: M.I.T. Press), pp. 295–312.
- Neander, Karen, 1991a. "Functions as Selected Effects: The Conceptual Analyst's Defense." *Philosophy of Science* 58: 168–84. Reprinted in Allen, Colin, Marc Bekoff, and George Lauder, eds., 1998. *Nature's Purposes: Analyses of Function and Design in Biology*. (Cambridge, MA: M.I.T. Press).
- \_\_\_\_\_, 1991b. "The Teleological Notion of 'Function'." *Australasian Journal of Philosophy* 69: 454–68. Reprinted in Buller, David J., ed., 1999. *Function, Selection, and Design*. (Albany, NY: State University of New York Press), pp. 123–41.
- \_\_\_\_\_, 1995. "Misrepresenting and Malfunctioning." *Philosophical Studies* 79: 109–41. Reprinted (in part) in Buller, David J., ed., 1999. *Function, Selection, and Design*. Albany, NY: State University of New York Press), pp. 221–31.
- Nissen, Lowell, 1997. *Teleological Language in the Life Sciences*. (New York: Rowman & Littlefield).
- O'Connor, Timothy, and Hong Yu Wong, 2002. "Emergent Properties." In *The Stanford Encyclopedia of Philosophy*, edited by E. N. Zalta. URL = <<http://plato.stanford.edu/archives/win2002/entries/properties-emergent/>>.
- Penrose, R., 1995. *Shadows of the Mind*. (Oxford: Oxford University Press).
- Plantinga, Alvin, 1987. "Two Concepts of Modality; Modal Realism and Modal Reductionism." *Philosophical Perspectives* 1: 189–231.
- \_\_\_\_\_, 1993a. *Warrant and Proper Function*. (New York: Oxford University Press).
- \_\_\_\_\_, 1993b. *Warrant: The Current Debate*. (New York; Oxford University Press).
- \_\_\_\_\_, 2002. "Introduction: The Evolutionary Argument Against Naturalism." In *Naturalism Defeated? Essays on Plantinga's Evolutionary Argument Against Naturalism*, edited by J. Beilby. (Ithaca, NY: Cornell University Press), pp. 1–12.
- Popper, Karl R., and John C. Eccles, 1977. *The Self and Its Brain*. (New York: Springer International).
- Post, John, 1995. "Naturalism." In *The Cambridge Dictionary of Philosophy*, edited by R. Audi. (Cambridge: Cambridge University Press), pp. 517–18.
- Prior, Elizabeth, 1985. "What is Wrong with Etiological Accounts of Biological Function?" *Pacific Philosophical Quarterly* 66: 310–28.
- Rosenberg, Alex, 1996. "A Field Guide to Recent Species of Naturalism." *The British Journal of the Philosophy of Science* 47: 1–29.
- Rudder Baker, Lynn, 2000. *Persons and Bodies: A Constitution View*. (Cambridge: Cambridge University Press).
- Searle, John R., 1995. *The Construction of Social Reality*. (New York: The Free Press).
- Silberstein, Michael, and John McGeever, 1999. "The Search for Ontological Emergence." *The Philosophical Quarterly* 49 (195): 182–200.
- Sober, Elliott, 2000. *Philosophy of Biology*, 2nd ed'n. (Boulder, CO: Westview Press).
- Stairs, A., 1990. "Quantum Mechanics, Mind and Self." In *Essays on Personal Identity*, edited by C. Taylor. (Cambridge, MA: Harvard University Press), pp. 453–72.
- Stapp, H. P., 1993. *Mind, Matter and Quantum Mechanics*. (Munich: Springer).
- Teller, Paul, 1986. "Relational Holism and Quantum Mechanics." *British Journal for the Philosophy of Science* 37: 71–81.
- Woodfield, Andrew, 1976. *Teleology*. (New York: Cambridge University Press).