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Why Materialism Is False, and Why It Has Nothing To Do with the Mind

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Abstract
Materialism claims that everything is physical; everything can be exhaustively described and explained in principle by physics. For over half a century challenges to materialism have focused on mental phenomena such as consciousness, reason, and value. The tacit assumption among most materialists – one shared by most of their critics – has been that more basic biological phenomena, such as metabolism and reproduction, do not pose a serious obstacle to the materialist program, that these can be easily accommodated within a materialist framework. But there is reason to think that this assumption is false. Thomas Nagel has recently argued that materialism cannot countenance biological phenomena at large. Like so many anti-materialist arguments, however, his focuses on mental phenomena. After explaining why this is a liability for him and other would-be critics of materialism, I advance an anti-materialist argument that appeals directly to biology. Materialism is false, it says, because our best empirical descriptions and explanations of biological phenomena appeal to biological organization or structure, and there is good reason to think that these appeals cannot be eliminated, reduced to, or paraphrased in favor of descriptions and explanations framed in exclusively physical terms. As a result, not everything can be described and explained exhaustively by physics. Materialism must be false. The reason, however, has nothing to do with mental phenomena specifically.

Materialism claims that everything is physical; everything can be exhaustively described and explained in principle by physics.[1] For

[1] Philosophers sometimes use the term 'materialism' to refer to much weaker claims, such as the claim that everything has physical properties, that all properties supervene on physical properties, or that everything is composed of physical parts. These weaker claims are compatible with things having nonphysical properties in addition to physical ones. Materialism in the strong sense I have in mind rules this out. It implies the core materialist thesis, the claim that everything is physical. According to materialism in this strong sense, every individual, every feature it has, and every behavior in which it engages can be described and explained

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over half a century challenges to materialism have focused on mental phenomena such as consciousness, reason, and value. The tacit assumption among most materialists – one shared by most of their critics – has been that more basic biological phenomena, such as metabolism and reproduction, do not pose a serious obstacle to the materialist program, that these can be easily accommodated within a materialist framework. But there is reason to think that this assumption is false. Thomas Nagel has recently argued that materialism cannot countenance biological phenomena at large,[2] but like so many anti-materialist arguments, his focuses on mental phenomena. After explaining why this is a liability for him and other would-be critics of materialism, I advance an anti-materialist argument that appeals directly to biology. Materialism is false, it says, because our best empirical descriptions and explanations of biological phenomena appeal to biological organization or structure, and there is good reason to think that these appeals cannot be eliminated, reduced to, or paraphrased in favor of descriptions and explanations framed in exclusively physical terms. If we are committed to countenancing the entities postulated by our best descriptions and explanations of reality, and we think those descriptions and explanations derive from empirical sources, then scientific appeals to structure make a serious ontological demand. The most direct way of meeting that demand is to take scientific appeals to biological structure at face value – to claim that biological structure is a real and basic ontological and explanatory principle on par with but different from the principles postulated by physics. As a result, not everything can be described and explained exhaustively by physics. Materialism must be false. The reason, however, has nothing to do with mental phenomena specifically.

1. Nagel's argument against materialism

Thomas Nagel has argued that materialism cannot provide an adequate explanation of life because it cannot provide an adequate

exhaustively using only the conceptual resources of physics. It is possible, in other words, at least in principle, for physics to provide us with descriptions and explanations that leave out nothing but give us the complete story about what there is, what it does, how it does it, and why.

[2] Thomas Nagel, *Mind and Cosmos: Why the Materialist Neo-Darwinian Conception of Nature Is Almost Certainly False* (Oxford University Press, 2012).

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explanation of mind. Adequate explanations must imply that the phenomena they explain are not mere chance occurrences but expected outcomes. Since mental phenomena such as consciousness, reason, and value are the most recent outcomes of the same process that was responsible for the emergence of more basic biological phenomena, Nagel argues, any adequate explanation of life's origins must imply that consciousness, reason, and value were expected outcomes of the process that resulted in the basic emergence of life. But materialist views are incapable of providing explanations of this sort. To support this claim Nagel considers what he takes to be the materialist theories that have the best chance of being true. These include emergentism, reductionism, and panprotopsychism – all of which he groups, somewhat confusingly, under the one heading of 'materialism'.

Emergentism claims that physical properties produce emergent mental properties – new, nonphysical properties that make a causal difference to their bearers beyond the differences made by physical properties. Reductionism (what many philosophers would call, contrary to Nagel's usage, 'materialism' or 'physicalism' proper) claims that everything can be exhaustively described and explained by physics. And panprotopsychism claims that the basic elements of nature have proto-mental properties – not the full-blown mental properties that you and I have, but simpler versions of them that in combination give rise to full-blown mental properties in something like the way the masses of your fundamental physical constituents give rise to your full mass.

According to Nagel, all of these theories fail to explain consciousness, reason, and value for reasons that are well rehearsed in the philosophical literature. Emergentism faces the familiar problem of psychophysical emergence: it must posit laws of emergence as brute, unexplainable matters of fact; as a result, it fails to provide the kind of understanding we seek. The problem with reductionist views, on the other hand, which include forms of behaviorism, psychophysical identity theory, and what most philosophers would call forms of 'nonreductive physicalism', is that they leave out subjective appearances. Finally, panprotopsychism faces the so-called combination problem, the problem of understanding how a number of proto-mental states might combine to form full-blown mental states.

In addition to the problems with specific kinds of materialism, moreover, Nagel argues that materialist theories in general would have to give an account of how consciousness emerged by appeal to blindly operating efficient causes, but it is difficult to see how such

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an account could render the emergence of consciousness more than a chance occurrence, and in that case it is difficult to see how it could provide the kind of understanding we seek in explaining something's origins. Even if a materialist explanation succeeds in identifying the physical causes, correlates, and antecedent conditions of consciousness, therefore, it cannot render the emergence of consciousness intelligible.

The same is true of reason, according to Nagel. When we accept claims in light of reason we transcend our own subjective points of view. Moreover, we achieve a kind of knowledge whose transparency and immediacy provides greater warrant than anything that could be based on perceptual judgments or empirical hypotheses alone. These features of reason pose difficulties for reductionism and panprotopsychism, for they make it difficult to see how reason could be reduced to something non-rational or decomposed into proto-rational properties had by an individual's physical constituents. Reason appears to be instead a characteristic that could only belong to a whole conscious subject. But even emergentist theories will have trouble countenancing reason, Nagel argues, for any materialist theory, unless it endorses theism or the kind of natural teleology he favors, must claim that reason's emergence was a chance occurrence, and for reasons already mentioned, Nagel thinks that appeals to chance make unacceptable explanations.

The emergence of value poses a final problem for materialists, Nagel argues. He assumes at the outset a realist account of value which he contrasts with what he calls a 'subjectivist' one. The latter claims that value is reducible to something else such as human motivational dispositions. Moral realism, by contrast, claims that value is something basic; facts about value are not disguised facts about something else, nor are moral judgments mere expressions of moral sentiment; they are instead cases in which we grasp reasons that favor or disfavor various courses of action on account of their values. Nagel thinks that moral realism is incompatible with the standard Darwinian account of natural selection based on an argument advanced originally by Sharon Street.[3] Very roughly, the argument claims that a capacity to discern moral truth (by contrast with, say, a capacity to discern truths about potential threats in the environment) would not confer any selective advantage on its possessors. But if we are products of natural selection, then we are likely endowed only with capacities that confer some type of selective

[3] Sharon Street, 'A Darwinian Dilemma for Realist Theories of Value', *Philosophical Studies* **127** (2006), 109–66.

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advantage, and hence we are likely not endowed with a capacity for discerning moral truth. Unlike Street, however, who takes the argument to show that moral realism is false, Nagel takes it to show that the standard account of natural selection is false. If natural selection as materialists understand it does not have the resources to explain the emergence of moral value, then that gives us good reason to reject their understanding.

Nagel concludes that consciousness, reason, and value are stumbling blocks on which all materialist theories falter, and since these theories fail to explain the emergence of consciousness, reason, and value, they fail to explain the emergence of life in general. We thus need an alternative – not the theistic one favored by intelligent design theorists, but instead one inspired by Aristotle: natural teleology. Aristotle may have been wrong about the scope of teleological explanation (he believed wrongly that even the basic physical elements, earth, air, fire, and water, operated teleologically), but according to Nagel the jury is still out when it comes to the paradigmatic teleological entities: living things like us. To explain our origins he proposes that the fabric of the cosmos includes a (non-intentional) predisposition to produce life, value, reason, and consciousness. Such a predisposition provides the additional conceptual resources needed for an adequate explanation of life and mind, and in that sense it has more going for it than materialism.

Opponents of materialism might feel heartened by Nagel's arguments, but there are reasons to be cautious. In particular, there is a worry that Nagel relies too much on existing arguments in the literature. One example is his reliance on Street's argument that moral realism and natural selection are incompatible. The argument's key premise is that a capacity to discern moral truth would contribute nothing to reproductive fitness beyond what a capacity merely to act as if there were moral truth would contribute. By analogy someone might argue that an organism does not actually have to perceive environmental threats to act in ways that contribute to its reproductive fitness; in many circumstances it is enough for it to act as if it perceives a threat. False positives may be as effective promoting survival and reproduction as true positives. But there are surely limits to this reasoning. For example, something must explain how a capacity that generates false positives could manage to contribute to reproductive fitness, and in many cases, the explanation will be that the same capacity also produces true positives. In the perceptual case an explanation along these lines seems clear enough: a disposition to act as if there are environmental threats contributes to reproductive fitness because sometimes there really are

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environmental threats. But then parity of reasoning suggests a conclusion opposed to Nagel's: a disposition to act as if there are moral truths contributes to reproductive fitness because sometimes there really are moral truths. Hence, moral realism and natural selection are not incompatible.

To illustrate this point further, consider Nagel's example of pain:

> …the real badness of pain and the ability to recognize that badness are completely superfluous in a Darwinian explanation of our aversion to pain. The aversion to pain enhances fitness solely in virtue of the fact that it leads us to avoid the injury associated with pain, not in virtue of the fact that pain is really bad. So far as natural selection is concerned, pain could perfectly well be in itself good… though we are naturally blind to the fact.[4]

The worry here is that there is a plausible way of understanding pain that is amenable to a materialist explanation. It says that pain is not bad in itself; it is in fact good for organisms like us to be capable of pain since pain motivates us to avoid things that can harm us – things that really are bad for us. This account fits into the aforementioned pattern of explanation. A disposition to act as if something is harmful (a disposition pain-capable organisms typically possess) contributes to reproductive fitness because sometimes things really are harmful. On this view of the matter, the real goodness of pain-capability and the real badness of harmful environmental factors are not completely superfluous to a Darwinian explanation of our aversion to pain, as Nagel says. Nagel does not argue directly against such an account. Perhaps he takes it to be a form of the subjectivism he rejects at the outset, or perhaps he is implicitly committed to a certain understanding of value that rules it out. Whatever the case, it seems that more needs to be said on this point.

Second, Nagel claims that the success of an explanation of life depends on the success of an explanation of consciousness, reason, and value. I've already described the general reasoning behind this premise, but it is often difficult to see how it applies to specific cases. Consider Nagel's criticism of panprotopsychism. Nagel claims that in order to explain the emergence of life, panprotopsychists would have to assign to the proto-mental properties of fundamental physical particles a central role. But why would panprotopsychists have to do this? Why couldn't they endorse a two-stage explanation: physical properties explain the origins of basic biological processes, and proto-mental properties are powers that remain latent

[4] Op. cit., 108–9.

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until basic biological processes first appear, at which point they become active and operate to bring about consciousness? Think by analogy of devices whose powers are activated in stages. The explosion of a hydrogen bomb has fission and fusion stages. The detonation of a fissile core creates temperatures hot enough to trigger the detonation of a fusile core. Couldn't the physical properties of the fundamental particles create conditions that subsequently trigger the activation of latent proto-mental properties? In that case, the account of life's origins, that is the origins of the biological processes that at a bare minimum qualify something as living, would not have to appeal to proto-mental properties; those properties would have to be invoked only to explain how something that qualified as living also qualified as conscious.

Nagel does suggest a response. He argues that because mental properties and behavior are 'internally connected' in the lives of macroscopic organisms, proto-mental properties and proto-behavioral physical properties would have to be internally connected in a similar way at the level of their microscopic parts. Proto-mental properties would thus have to have physical implications at the microscopic level just as full-blown mental properties do at the macroscopic level. Yet, even if there are internal connections between proto-mental properties and physical ones, as Nagel thinks, it is still not evident why physical properties could not be sufficient by themselves to explain the emergence of basic biological processes, for this hypothesis is compatible both with physical properties necessitating the activation of proto-mental properties and with physical properties being necessitated by them. It thus seems possible that proto-mental properties could factor into an explanation of basic biological processes in either of two ways: (a) they could explain the physical conditions that were directly responsible for the emergence of those processes, or else (b) they could play no role in explaining the emergence of basic biological processes, but only play an explanatory role at the level of consciousness. Nagel says nothing that rules out this kind of view, but in that case it is no longer clear that a successful materialist explanation of life must depend on a successful materialist explanation of consciousness, as he insists.

A similar point holds for reason. Nagel's arguments that materialism cannot accommodate reason depend on an essentially Cartesian picture of mind:

> [R]eason connects us with the truth directly. Perception… only indirectly. When I see a tree… I am aware of it because the tree

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> causes a mental effect in me in virtue of the character of my visual system… So it is only in a complicated and indirect sense that when I see a tree, I see it because it is there. But suppose I observe a contradiction among my beliefs and "see" that I must give up at least one of them… It is not adequate to say that, faced with a contradiction, I feel the urgent need to alter my beliefs to escape it, which is explained by the fact that avoiding contradictions, like avoiding snakes and precipices, was fitness-enhancing for my ancestors… [E]ven if some of our ancestors were prey to mere logical phobias and instincts, we have gone beyond that: We reject a contradiction just because we see that it is impossible, and we accept a logical entailment just because we see that it is necessarily true.[5]

But there is an alternative picture of mind. It takes the ability to recognize and respond to contradictions to be like the ability to recognize and respond to tactical patterns on a chessboard: the result of training and habituation. Not only would this explain why some people apparently feel no compulsion to reject either of a pair of contradictory beliefs, it would also fit in with what most of us know about practical affairs; namely, people sometimes think and act in contradictory ways. Weakness of will, hypocrisy, and similar phenomena are examples. If this alternative understanding of mind is correct, if responsiveness to reasons, theoretical and practical, is a learned behavior, then an explanation of it will not appeal directly to natural selection as Nagel suggests in the passage quoted above; it will appeal instead to learning. In that case, however, it is possible to endorse a multi-stage explanation for rational capacities that separates the task of explaining reason's emergence from the task of explaining life's emergence. According to this explanation natural selection explains our ability to learn, learning explains our ability to recognize and respond to reasons, and both factors are separate from the physico-chemical occurrences that explain the emergence of basic biological processes. As a result, it is once again unclear why a successful materialist explanation of life must depend on a successful materialist explanation of mind.

Nagel does not address views of the foregoing sort directly. The reason, I think, is that their falsity is implied by the Cartesian picture of mind he assumes at the outset. The foregoing remarks should make it evident at the very least that this picture relies on contentious assumptions in the philosophy of mind. Those assumptions,

[5] Op. cit., 82–3.

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moreover, might have elements that are guaranteed to generate insoluble problems – like a Sudoku puzzle with a misprint. One reason for suspecting this is suggested by Nagel himself. The vocabulary in terms of which scientific descriptions and explanations are framed, he tells us, is a vocabulary that was developed precisely by ignoring or abstracting away from subjective appearances. Science, which aims at objectivity – a view from nowhere, as he has referred to it – could not have gotten off the ground without bracketing mentality in this way. It was for this reason that the development of science in the sixteenth and seventeenth centuries led inevitably to mind-body problems, for the features of subjective experience that we describe in pedestrian psychological terms are precisely the features from which scientific endeavor looks to distance itself. Because scientific concepts are evacuated of any psychological content, we become puzzled how mental phenomena could fit into the world described by science. If Nagel is right about the conceptual gap between the mental and the physical, it seems to make little difference whether we take the world to operate teleologically, as Nagel would have it, or not. If there are basic teleological laws that prescribe the emergence of consciousness, reason, or value from physical processes, the view begins to look simply like a variation of the emergentist view he criticizes: a view that posits brute, unexplainable laws of emergence. It thus becomes unclear whether the alternative he favors really marks a genuine advance.

Nagel concedes that solving mind-body problems will require a revision of our concepts more radical that anything he has to offer. Perhaps one step in the direction of such a revision is to claim, contrary to Nagel's Cartesianism, that during the Scientific Revolution subjectivity was not so much discovered as invented. The notion of subjectivity is just the residue left by our interest in viewing things from nowhere, and in that sense it is as much an artifact of human endeavor as science itself. On this alternative view of things, the world is not made up of mental phenomena, which are described in psychological terms, and physical phenomena, which are described in scientific ones, as so many philosophers since Descartes, including Nagel, have thought. Rather, the world contains among other things beings like ourselves who are so complex that we can only understand them piecemeal by focusing on a limited range of their characteristics while at the same time ignoring others. This piecemeal approach yields a variety of methods and conceptual frameworks each with its own distinctive vocabulary and concepts. None of these frameworks, however, can be expected to contain within itself resources for understanding how it fits together with other frameworks into a

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synoptic vision of the whole, for none of them was crafted with an eye to accomplishing this integrative task; each was rather designed to achieve a more limited understanding. On this view of things, the repeated mistake of philosophers since the seventeenth century has been to conflate the fairly limited task of achieving a scientific understanding of some things with the unlimited task of providing an exhaustive understanding of everything. Nagel seems to agree with something like this diagnosis, but he doesn't appreciate that rejecting his own view of subjectivity could be taken as a corollary. Seen in the light of this alternative account, the Cartesian conception of mind that Nagel assumes at the outset is not canonical but contentious, not a pre-theoretical datum that cries out for explanation, but instead a theoretical posit, something entailed by a particular philosophical outlook that we are not compelled to accept and that there might be good reason to reject.

For these reasons and others, would-be opponents of materialism should be reluctant to embrace Nagel's arguments. The principal liabilities of those arguments, I've suggested, derive from their reliance on contentious assumptions in the philosophy of mind. In the sections that follow I'll advance an alternative argument against materialism. Like Nagel's, it claims that materialism cannot accommodate biological phenomena, but unlike Nagel's, it does not rely on assumptions in the philosophy of mind. It instead appeals directly to biology.

2. Biological structure

Biological descriptions and explanations make frequent appeal to organization, structure, order, configuration, and related notions. Here is one example taken from a popular college-level biology textbook:

> Life is highly organized into a hierarchy of structural levels… Biological order exists at all levels… [A]toms… are ordered into complex biological molecules… the molecules of life are arranged into minute structures called organelles, which are in turn the components of cells. Cells are [in turn] subunits of organisms… The organism we recognize as an animal or plant is not a random collection of individual cells, but a multicellular cooperative… Identifying biological organization at its many levels is fundamental to the study of life… With each step upward in the hierarchy of biological order, novel properties emerge that were not present at the simpler levels of organization… A molecule such as a protein has attributes not exhibited

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> by any of its component atoms, and a cell is certainly much more than a bag of molecules. If the intricate organization of the human brain is disrupted by a head injury, that organ will cease to function properly… And an organism is a living whole greater than the sum of its parts… [W]e cannot fully explain a higher level of order by breaking it down into its parts.[6]

This passage suggests that the way things are structured, organized, or arranged plays an important role in them being the kinds of things they are, and in explaining the kinds of things they can do. There could not be an organism without the right cooperative arrangement or organization of cells. Moreover, what the organism and structured wholes like it can do depends on that organization: destroy the organization of the brain, and you destroy its functional capacities. Organization or structure is thus something real, with real explanatory significance.

It's important to note that this notion of structure is not the same as others that have appeared in the literature. It is not the same, for instance, as the notion of structure that has been operative in discussions of grounding in metaphysics.[7] Nor is it the same as the notion that is operative in debates about scientific realism.[8] Nor is it the same as the notion David Chalmers sometimes employs when he speaks of structure and dynamics.[9] The notion of biological structure is instead closer to the notion of organization that philosophers like David Armstrong and John Heil occasionally appeal to:

> For a Materialist, a man is a physical object, distinguished from other physical objects only by the special complexity of his physical organization.[10]

[6] Neil A. Campbell, *Biology*, 4th Edition (The Benjamin/Cummings Publishing Company, Inc., 1996), 2–4.

[7] Jonathan Schaffer, 'On What Grounds What', in *Metametaphysics: New Essays on the Foundations of Ontology*, (eds) David Chalmers, David Manley, and Ryan Wasserman (Oxford University Press, 2009), 347–383. Theodore Sider, *Writing the Book of the World* (Oxford University Press, 2012).

[8] John Worrall, 'Structural realism: The best of both worlds?' *Dialectica*, **43** (1989), 99–124. James Ladyman and Don Ross, *Every Thing Must Go: Metaphysics Naturalized* (Oxford University Press, 2007).

[9] David Chalmers, 'Consciousness and Its Place in Nature', in *Philosophy of Mind*, (ed.) David J. Chalmers (Oxford University Press, 2002), 258.

[10] D. M. Armstrong, *A Materialist Theory of the Mind* (London: Routledge & Kegan Paul, 1968), 11.

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> If you take the billiard ball's constituents… and organize them just so, you have something of which it is true that it is a billiard ball… The organization is important. Differently organized, or widely dispersed, the billiard ball's constituents do not amount to a billiard ball.[11]

According to both Armstrong and Heil, organization operates as an ontological principle; it serves to distinguish a unified whole (a man, a billiard ball) from other things.

We can tease out the notion of biological organization or structure using a simple example; we can call it *the squashing example*. Suppose we put Godehard in a strong bag – a very strong bag since we want to ensure that nothing leaks out when we squash him with several tons of force. Before the squashing the contents of the bag include one human being; after they include none. In addition, before the squashing the contents of the bag can think, feel, and act, but after the squashing they can't. What explains these differences in the contents of the bag pre-squashing and post-squashing? The physical materials (whether particles or stuffs) remain the same; none of them leaked out. Intuitively we want to say that what changed was the way those materials were organized or structured. That organization or structure was responsible for there being a human before the squashing, and for that human having the capacities it had. Once that structure was destroyed, there no longer was a human with those capacities. Structure is thus a basic ontological principle; it concerns what things there are; and it is also a basic explanatory principle; it concerns what things can do.

The idea that structure is a basic ontological and explanatory principle is echoed by others. Consider William Bechtel, a philosopher of neuroscience:

> [T]he organization of… components typically integrates them into an entity that has an identity of its own… Organization itself is not something inherent in the parts… Accordingly, investigators who already understand in detail how the parts behave are often surprised by what happens when they are organized in particular ways… In virtue of being organized systems, mechanisms do things beyond what their components do… Not only can one study the performance of a mechanism without knowing its component parts and their operations, but what the mechanism as a whole does is typically quite different than

[11] John Heil, *The Universe as We Find It* (Oxford University Press, 2012), 8.

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> the operations performed by its parts… As a result, organized mechanisms become the focus of relatively autonomous disciplines… This autonomy maintains that psychology and other special sciences study phenomena that are outside the scope of more basic sciences but which determine the conditions under which lower-level components interact. In contrast, the lower-level inquiries focus on how the components of mechanisms operate when in those conditions… The fact that mechanisms perform different activities than do their parts manifests itself in the fact that the activities of whole mechanisms are typically described in different vocabulary [sic] than are component operations. Traditional accounts of theory reduction implicitly recognized this fact by requiring bridge principles to connect the different vocabularies used in different sciences, but little notice was given as to why different sciences employ different vocabularies. The vocabulary used in each science describes different types of entities and different operations – one describes the parts and what they do, whereas another describes the whole system and what it does.[12]

According to Bechtel, a complex whole – what he calls a 'mechanism' – consists of parts plus an organization that confers on it capacities not had by its parts taken in isolation.

In addition, Bechtel brings out a related point: descriptions of structured wholes and explanations of their behavior are irreducible to descriptions and explanations of their unstructured parts. This was implicit in Campbell's claims that complex wholes have novel properties not seen at lower levels of organization, and that we do not fully explain the behavior of complex wholes by breaking them down into their parts. Bechtel makes the point explicit. If he is right, then higher-level empirical disciplines and lower-level ones have different subject-matters on account of the ways things are organized or structured. Moreover, because higher- and lower-level disciplines deal with different subject-matters, they have different vocabularies, and provide different kinds of explanations, something that makes higher-level disciplines autonomous – irreducible to lower-level disciplines in the traditional philosophical sense. Philip Kitcher makes a similar observation about the implications of biological organization for reductionism:

[12] William Bechtel, 'Reducing Psychology while Maintaining its Autonomy via Mechanistic Explanations', in *The Matter of the Mind*, (eds) Maurice Schouten and Looren de Jong, Huib (Blackwell Publishing, 2007), 174, 185–186.

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> [T]o the extent that we can make sense of the present explanatory structure within biology – that division of the field into subfields corresponding to levels of organization in nature – we can also understand the antireductionist… claim that… the current division of biology [is] not simply… a temporary feature of our science stemming from our cognitive imperfections but [is] the reflection of levels of organization in nature.[13]

Bechtel, Campbell, and Kitcher are not alone in conceiving of organization or structure as a real and irreducible ontological and explanatory principle. Consider the biologists Camazine, et al. and their distinguished forebears J. B. S. Haldane, G. G. Simpson, and Ernst Mayr, respectively:

> [P]attern formation often is achieved by systems without external guidance. The mechanism of self-organization in biological systems differs from those in physical systems in two basic ways. The first is the greater complexity of the subunits in biological systems…The second difference concerns the nature of the rules governing interactions among system components. In chemical and physical systems, pattern is created through interactions based solely on physical laws… Of course, biological systems obey the laws of physics, but in addition… the subunits in biological systems acquire information about the local properties of the system and *behave* according to particular genetic programs that have been subjected to natural selection. This adds an extra dimension to self-organization… because in [biological] systems selection can finely tune the rules of interaction. By tuning the rules, selection shapes the patterns that are formed and thus the products of group activity can be adaptive… [I]nteractions among system components can be surprisingly simple, even when extremely sophisticated patterns are built.[14]
>
> [L]ife is essentially a pattern of chemical happenings… What is common to all life is the chemical events… [T]he chemical changes which go on in the leaves, bark, and roots of a tree… are surprisingly like those which go on in human organs… In fact, all life is characterized by a fundamentally similar set of chemical processes arranged in very different patterns… Shakespeare's plays consist of words… It is important to know

[13] Philip Kitcher, '1953 and all That: A Tale of Two Sciences', *Philosophical Review* **93** (1984), 369, 373.

[14] Scott Camazine, et al., *Self-Organization in Biological Systems* (Princeton University Press, 2001), 12–13.

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this, as it is important to know that life consists of chemical processes. But the arrangement of the words is even more important than the words themselves. And in the same way life is a pattern of chemical processes… [E]nzymes and other proteins can be purified and will carry on their characteristic activities in glass bottles. And no biochemist would say they were alive… [T]o suppose that one can describe life fully on [chemical] lines is to attempt to reduce it to mechanism, which I believe to be impossible. On the other hand, to say that life does not consist of chemical processes is to my mind as futile and untrue as to say that poetry does not consist of words.[15]

[T]o understand organisms one must explain their organization… [O]ne must know what is organized and how it is organized… The aim of biology is to understand the structure, functioning… and history of organisms.[16]

All biologists are thorough-going "materialists" in the sense that they recognize no supernatural or immaterial forces, but only such that are physico-chemical… [T]he modern biologist rejects in any form whatsoever the notion that a 'vital force' exists in living organisms which does not obey the laws of physics and chemistry. All processes in organisms, from the interaction of molecules to the complex functions of the brain and other whole organs, strictly obey these physical laws… But [modern biologists] do not accept the naïve mechanistic explanation of the seventeenth century and disagree with the statement that animals are 'nothing but' machines… Where organisms differ from inanimate matter is in the organization of their systems. Organismic biologists stress the fact that organisms have many characteristics that are without parallel in the world of inanimate objects. The explanatory equipment of the physical sciences is insufficient to explain complex living systems.[17]

When people think of structure they often think of something static such as the relatively unchanging spatial relations among atoms in a crystal. But the philosophers and scientists we're considering don't view structure so narrowly. Although we can refer to the sum of

[15] J. B. S. Haldane, *What Is Life?* (New York: Boni and Gaer, 1947), 54–56.

[16] G. G. Simpson, *This View of Life: The World of an Evolutionist* (New York: Harcourt, Brace and World, 1964), 113.

[17] Ernst Mayr, *The Growth of Biological Thought: Diversity, Evolution, and Inheritance* (Cambridge, MA: The Belknap Press of Harvard University, 1982), 2, 52.

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spatial relations among something's parts as a structure, the structures that are likely to interest us most – the kinds of structures that, say, distinguish living things from nonliving ones – are not static spatial relations, but dynamic patterns of environmental interaction, what Kit Fine calls 'principles of variable embodiment', and what Mark Johnston calls 'dynamic principles of unity'.[18] The neurophysiologist Jonathan Miller brings out the idea of dynamic structure in the following way:

> [T]he physical universe tends towards a state of uniform disorder… In such a world the survival of form depends on… [either] the intrinsic stability of the materials from which the object is made, or the energetic replenishment and reorganisation of the material which is constantly flowing through it… The configuration of a fountain… is intrinsically unstable, and it can retain its shape only by endlessly renewing the material which constitutes it; that is, by organising and imposing structure on the unremitting flow of its own substance… The persistence of a living organism is an achievement of the same order as that of a fountain… it can maintain its configuration only by flowing through a system which is capable of reorganising and renewing the configuration from one moment to the next. But the engine which keeps a fountain aloft exists independently of the watery form for which it is responsible, whereas the engine which supports and maintains the form of a living organism is an inherent part of its characteristic structure.[19]

Likewise, the biologist J. Z. Young brings out the idea that distinctively biological structures are dynamic by describing living organization as a complex activity:

> The essence of a living thing is that it consists of atoms… caught up into the living system and made part of it for a while. The living activity takes them up and organizes them in its characteristic way. The life of a man consists essentially in the activity he imposes upon that stuff.[20]

[18] Kit Fine, 'Things and Their Parts', *Midwest Studies in Philosophy* **23** (1999), 68–79. Mark Johnston, 'Hylomorphism', *Journal of Philosophy* **103** (2006), 663–4.

[19] Jonathan Miller, *The Body in Question* (New York, NY: Random House, 1978), 140–1.

[20] J. Z. Young, *An Introduction to the Study of Man* (Oxford: The Clarendon Press, 1971), 86–7.

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The foregoing quotes from biologists and philosophers of biology gesture toward a certain view of structure in the natural world. According to it, structure is a real principle of unity, persistence, and power. It is responsible for setting something apart as a discrete individual distinct from the rest of the physical universe. It explains why such an individual can exist one and the same over time. It also explains why that individual can do many of the things it does: why it has many of the powers it has, including the powers that classify it as a living being. Finally, an individual's structure explains the autonomy of various empirical disciplines that would look to describe and explain its behavior.

We can express the theoretical roles that structure plays on this view with some slogans:

> **Structure matters**: it operates as an irreducible ontological principle, one that accounts at least in part for what things essentially are.
>
> **Structure makes a difference**: it operates as an irreducible explanatory principle, one that accounts at least in part for what things can do, the powers they have.
>
> **Structure counts**: it explains the unity of composite things, including the persistence of one and the same living individual through the dynamic influx and efflux of matter and energy that characterize many of its interactions with the wider world.

What I plan to argue is that biological science, with its frequent appeals to organization or structure, provides the basis for a direct argument against materialism, one that needn't detour through psychology or the philosophy of mind.[21]

3. Four approaches to biological structure

Many philosophers find claims about organization or structure like those discussed in Section 2 obvious and unremarkable: How could anyone question (and hence why would anyone bother to mention) that structure factors into things? But the notion of structure does not come for free, at least not if we endorse *ontological naturalism*, the idea that when it comes to determining what exists, empirical

[21] I provide a fuller exposition of the aforementioned notion of structure in *Structure and the Metaphysics of Mind: How Hylomorphism Solves the Mind-Body Problem* (Oxford University Press, 2016).

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investigation – paradigmatically science – is our best guide. John Dupré has endorsed a similar thesis:

> I place myself firmly in the philosophical tradition that sees empirical, often scientific, inquiry as providing the most credible source of knowledge of how things are.[22]

Replacing the phrase 'how things are' in Dupré's statement with 'what there is' yields what I am calling 'ontological naturalism'.

Ontological naturalism can be understood as the conjunction of a broadly Quinean thesis about ontological commitment with a broad empiricism. The broadly Quinean thesis maintains that we are committed to all the entities postulated by our best descriptions and explanations of reality, and a broad empiricism maintains that our best descriptions and explanations of reality derive from empirical sources such as the natural and social sciences. Suppose we take the natural-language sentences in which our best descriptions and explanations are formulated and reformulate those sentences in a quantifier-variable idiom the way Quine suggests.[23] In that case, says the Quinean thesis, we would be committed to the existence of all the entities needed to make those descriptions and explanations true. Two remarks are in order.

First, ontological naturalism does not imply that the sciences are the only sources of empirical knowledge. It does not rule out a guiding role for common sense or even legend or myth in determining what exists, nor does it imply that empirical knowledge is our only guide to what exists. It is weaker than Wilfrid Sellars' *scientia mensura*: science is the measure of all things, of what is that it is and of what is not that it is not.[24] Ontological naturalism does nevertheless accord to empirical sources a privileged role in determining what exists, and it takes the sciences as paradigmatic examples of such sources.

Second, it's likely that our understanding of ontological commitment should be expanded somewhat beyond Quine's original boundaries. Empirical methods and techniques appear to provide important

[22] John Dupré, *The Disorder of Things: Metaphysical Foundations of the Disunity of Science* (Cambridge, MA: Harvard University Press, 1993), 1.

[23] W. V. Quine, 'On What There Is', *Review of Metaphysics* 2(1948), 21–38. Reprinted in *From a Logical Point of View* (Harvard University Press, 1953), 1–19.

[24] Wilfrid Sellars, 'Empiricism and the Philosophy of Mind', in *Science, Perception and Reality* (London: Routledge and Kegan Paul, 1963), 173.

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sources of ontological commitment as well.[25] The idea is roughly that in constructing and executing experiments we are often implicitly committed to a range of assumptions that carry ontological commitments of their own but that might nevertheless remain unstated in the more canonical descriptions and explanations we give. If this is the case, then we need to expand the basic Quinean thesis to accommodate these further commitments. On this expanded understanding, ontological naturalism says that we are committed not only to the existence of the entities needed to make our best empirical descriptions and explanations true, but also to the existence of the entities needed to make our best empirical methods and techniques effective.

I plan to take ontological naturalism as a working assumption in what follows. Defending it would take us beyond the scope of the present inquiry, so I will leave its defense for a later date. Its significance for our purposes is this: If our best empirical descriptions, explanations, and methods posit entities of kind K, then that gives us good prima facie reason to think that Ks exist. Consider, then, empirical descriptions and explanations that posit various kinds of biological structure. If ontological naturalism is true, these descriptions and explanations give us good prima facie reason to think that biological structures exist. They therefore make of us a serious ontological demand. The most straightforward way of meeting that demand takes empirical claims about structure at face value. It says that structure really is an irreducible ontological and explanatory principle. But there are at least three alternatives that are worth mentioning. They have in common the assumption that everything can be exhaustively described and explained *without* appeal to structure.

First, *structure eliminativism* claims that empirical statements about structures like the ones discussed earlier are literally all false. In reality, say eliminativists, there is no such thing as structure or organization, nor is talk of structure or organization useful for serious descriptive and explanatory purposes – the sorts of purposes that drive scientific endeavor. Talk of structure or organization is instead the byproduct of a defective way of trying to describe and explain the behavior of things. When we finally give a complete

[25] The idea that the nature of things is revealed not just in description and explanation but in the methods or techniques we use to study them is defended by Hacking in *Representing and Intervening: Introductory Topics in the Philosophy of Natural Science* (Cambridge University Press, 1983), and it plays a major role in many of Nancy Cartwright's arguments in *The Dappled World: A Study of the Boundaries of Science* (Cambridge University Press, 1999).

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scientific account of what living things are and why they behave as they do, that account will not appeal to structure or organization any more than a complete scientific account of the weather appeals to the Greek gods.

Second, *structure reductivism* claims that at least some empirical statements about structure are true, and that appeals to structure can do serious descriptive and explanatory work, but according to structure reductivists, statements about structure can do this only because the structures they postulate can be identified with conditions that can be exhaustively described and explained without appeal to structure. The structure of the human brain, for instance, can be identified in principle with some nonstructural condition *C*, and as a result, say reductivists, claims about human brain structure can be rewritten as claims about condition *C* by the substitution rule for identity. This is true across the board for structural discourse, say reductivists: structures can in general be identified with nonstructural things. It is thus possible in principle for nonstructural discourse to take over all the descriptive and explanatory jobs that appeals to structure perform. Structural discourse is reducible to nonstructural discourse.

A third view, *nonreductive structure antirealism*, tries to steer a middle course between reductivism and eliminativism. Like reductivists and unlike eliminativists, nonreductive structure antirealists try to countenance talk of structure, but like eliminativists and unlike reductivists, they try to avoid countenancing the entities to which structural discourse appears to commit us. Nonreductive structure antirealists agree with reductivists that structural discourse has genuine descriptive and explanatory legitimacy, but they reject the idea that this legitimacy is grounded in the identification of structures with nonstructural conditions. It is grounded instead in our descriptive and explanatory interests – interests that nonstructural discourse is incapable of satisfying. Even though everything can be exhaustively described and explained in nonstructural terms, say nonreductive structure antirealists, we often have descriptive and explanatory interests that cannot be satisfied unless we employ talk of structure. Appeals to structure are useful, therefore, not because there is something other than what can be exhaustively described and explained without appeal to structure, nor because structures can be identified with nonstructural conditions; appeals to structure are useful rather because they satisfy descriptive and explanatory interests that would otherwise go unsatisfied.

Nonreductive structure antirealism is the kind of view Mark Johnston describes in the following terms and subsequently rejects:

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> When certain items come to stand in certain relations… there then comes to be some further item which has those original items as parts. That is… how we have such complex items as model airplanes, trains, and molecules… [J]ust why are those relations… "item-generators", while other relations… seem impotent in the production of new items?… Could it just be a projection of our idiosyncratic way of experiencing and conceptualizing reality, so that things considered in themselves are not complex, but are so only relative to a scheme of clumping or bundling? Somehow, I doubt it.[26]

But perhaps the best example of nonreductive structure antirealism is the view Daniel Dennett calls 'mild realism' about patterns.[27] According to Dennett, we postulate patterns with an eye to predicting the behavior of things in ways that are more efficient (if less precise) than the conceptual resources of physics allow. Patterns can be considered real to the extent that postulating them allows us to make predictions more efficiently (if less precisely) than physics does. According to Dennett, however, it is possible for two different and incompatible conceptual frameworks to postulate patterns, and yet for there to be no way of determining which framework is more accurate. 'The choice of a pattern', he says, 'would… be up to the observer, a matter to be decided on idiosyncratic pragmatic grounds'.[28] For Dennett, then, whether there are patterns and what patterns there are is ultimately determined by our practical idiosyncrasies.

Nonreductive structure antirealists look to retain the sparse nonstructural ontology that motivates eliminativism and reductivism without either denying the legitimacy of structure talk or carrying the empirical burden of identifying structures with nonstructural things. According to them, our descriptive and explanatory interests ground the legitimacy of structural discourse without positing entities other than those posited by nonstructural discourse, and without issuing promissory notes for the identification of structural entities with nonstructural ones. Instead they promise to provide paraphrases of statements about structure that aim at minimizing their ontological seriousness. When, for instance, neuroscientists say that the debilitating effects of head injuries result from disruptions to the delicate structure of the brain, nonreductive structure antirealists look to describe and explain the debilitating effects of

[26] Op. cit., 652.

[27] Daniel C. Dennett, 'Real Patterns', *Journal of Philosophy* **88** (1991), 27–51.

[28] Op cit., 49.

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the head injury without appealing to the structure of the brain. Neuroscientists employ talk of brain structure, they say, simply because it satisfies certain special interests that neuroscientists have – interests in, say, formulating counterfactual-supporting generalizations that cannot be formulated in nonstructural terms,[29] or in predicting behavior in a way that is more efficient than predicting it without appeal to structures.[30] Whatever the details, nonreductive structure antirealists will look to countenance the neuroscientist's talk of structure – its legitimacy, usefulness, or success – without compromising their commitment to the idea that everything can be exhaustively described and explained without appeal to structure, and without identifying structures with nonstructural conditions.

Importantly, nonreductive structure antirealism implies that structural discourse is not reducible to nonstructural discourse. Even if the world is fundamentally nonstructural, say nonreductive structure antirealists, we still describe it in many different ways that satisfy many different kinds of interests including interests different from those that nonstructural discourse satisfies. If nonstructural discourse cannot satisfy all the descriptive and explanatory interests we have – if, in particular, it cannot satisfy the interests we use structural discourse to satisfy – then nonstructural discourse is incapable of taking over the descriptive and explanatory roles that structural discourse plays.[31] Structural discourse, in other words, is irreducible to nonstructural discourse not because there is something other than what can be exhaustively described and explained in nonstructural

[29] Jerry Fodor, 'Special Sciences, or The Disunity of Science as a Working Hypothesis', *Synthese* **28** (1974), 114.

[30] Dennett, op. cit., 37ff.

[31] Another argument to this effect appeals to intertheoretic identities: If theory T_A is reducible to theory T_B, then T_B can take over all the descriptive and explanatory jobs of T_A, but this kind of takeover requires that entities postulated by T_A be identical to entities postulated by T_B (Lawrence Sklar, 'Types of Inter-Theoretic Reduction', *British Journal for the Philosophy of Science* **18** (1967), 109–24; Kenneth Schaffner, 'Approaches to Reduction', *Philosophy of Science* **34** (1967), 137–47; Robert L. Causey, *Unity of Science* (Boston: D. Reidel Publishing Co., 1977). According to nonreductive structure antirealists, however, structural and nonstructural discourse are not related in straightforward ways that would allow us to identify structures with nonstructural things. Consequently, nonstructural discourse cannot take over the descriptive and explanatory roles of structural discourse, and hence structural discourse is not reducible to nonstructural discourse.

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terms, but rather because we have special interests that the conceptual resources of nonstructural discourse cannot satisfy.

Let us now return to the very first approach to structure mentioned above – the straightforward realist approach that takes empirical claims about structure at face value. Unlike the approaches just described it claims that appeals to structure cannot be reduced to, or paraphrased, or eliminated in favor of nonstructural descriptions and explanations. Call this view *structure realism*.[32]

Structure realists agree with nonreductive structure antirealists that structural discourse is irreducible to nonstructural discourse, but they anchor their antireductionism in metaphysical soil. Structure, they say, is a real and irreducible ontological and explanatory principle that exists independent of our descriptive and explanatory interests, and that is distinct from anything nonstructural. Like structure reductivists, moreover, structure realists take the ontological implications of structural discourse at face value; they do not think it is possible to paraphrase appeals to structure in ways that minimize the seriousness of those implications. Unlike reductivists, however, they deny that structures can be identified with things that can be exhaustively described and explained in nonstructural terms. Structure realists thus countenance talk of structure together with the entities to which that talk appears to commit us, but they do so by denying that everything can be exhaustively described and explained without appeal to structure. Structure, they say, is a real feature of things distinct from any nonstructural conditions that exist. Descriptions and explanations that appeal to structure cannot be reduced to claims about nonstructural conditions, nor can they be accurately paraphrased in ways that do not appeal to structure.

Structure realism by itself is compatible with a wide variety of positions on what there is. It is, for instance, compatible both with

[32] Structure realism should not be confused with *structural* realism, which is a position in debates about scientific realism (Ladyman and Ross, op cit.). Structural realism claims that scientific theories have structures that remain invariant across instances of theory change. If would-be scientific realists commit themselves only to those structures, say structural realists, and not to the ontologies of particular theories, then realism will be immune to anti-realist arguments that appeal to theory change. This view is altogether different from what I am calling *structure* realism. Structure realism in the sense I intend is not a position in the scientific realism debate. It is instead defined by its rejection of the assumption the aforementioned three approaches to structure have in common, namely the assumption that everything can be exhaustively described and explained without structure.

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materialism and with substance dualism. Consider the former. Materialism claims that everything is physical; everything can be exhaustively described and explained by our best current or future physics. Suppose that materialism is true, and that our best physics ends up postulating real, irreducible structures. In that case, structure realism ends up being true as well. Structure realism is thus compatible with materialism. Consider now substance dualism. It claims that persons, such as you and I, are not physical entities; we are not, for instance, human organisms. Suppose that substance dualism is true, and suppose further that human organisms consist of physical materials that are structured in certain ways. Structure, in other words, is a basic principle that factors into descriptions of what human organisms are and what they can do; it simply doesn't factor into descriptions of what we, nonphysical persons are and what we can do. The upshot is a substance dualistic view that is committed to structure realism. Structure realism is thus compatible with substance dualism.

Yet neither materialism nor substance dualism accurately represents the kind of view expressed in the foregoing passages from philosophers and biologists. Contrary to substance dualism, that view is committed to the claim that we are organisms or at least physical beings of some sort. Contrary to materialism, on the other hand, that view is committed to the claim that there are basic structures other than those postulated by physics. It distinguishes what physics by itself can describe and explain from what appeals to biological, or psychological, or social structure enable us to describe and explain. Because of this its exponents claim that organisms are not mere machines, as Mayr puts it, but have characteristics – 'emergent properties,' to use Campbell's term – not found among nonliving things. This leads them to conclude in turn that the explanatory apparatus of physics is insufficient to describe and explain living behavior, that physics gets at 'only half the truth', as the cyberneticist Gerd Sommerhoff puts it.[33] What physics misses, say exponents of this view, are things that can only be described and explained by appeal to structure at a biological, psychological, or social level. I'll reserve the term 'hylomorphism' for a structure realist view of this sort.[34]

[33] Gerd Sommerhoff, 'The Abstract Characteristics of Living Systems', in *Systems Thinking: Selected Readings*. F.E. Emery, ed. (Harmondsworth: Penguin, 1969), 147–8.

[34] 'Hylomorphism' is a compound of the Greek words *hyle* and *morphe*, which are typically translated 'matter' and 'form' respectively. Because the label is not new it's worth mentioning that the hylomorphic view I have in mind differs from those of Kit Fine, Mark Johnston, David Oderberg,

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4. Structure realism

Hylomorphism, of the sort I've described, is opposed to materialism. When materialists look at the physical universe, they see a vast sea of matter and energy that is described or will be described by our best physics, and they claim that this vast sea is all there is. When hylomorphists look at the physical universe, they see the same sea of matter and energy, but they see something more besides: scattered throughout it are tiny localized pockets of order or arrangement – semistable, self-maintaining patterns of flow, like eddies in a river, with distinctive structures or forms. According to hylomorphists, the behavior of these structured pockets or eddies cannot be described and explained using the conceptual resources of physics alone – not even in principle. Physics enables us to describe the matter and energy that flow through structured individuals. It enables us to describe the interactions among the fundamental physical particles or stuffs in them, but it does not enable us to describe the overall pattern that makes this collection of fundamental physical interactions a human, a dog, or an oak tree. Understanding the physical materials that are caught up into these pockets or eddies will tell us something about the characteristics and behavior of the whole, but it won't tell us everything. It won't tell us, for instance, what sets the whole apart as a unified individual distinct from the inanimate materials that surround it. The materials, after all, can exist without

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Kathryn Koslicki, Michael Rea, Anna Marmodoro, and Robert Koons. In addition, I cannot vouch for its similarities to those of Aristotle, Aquinas, Leibniz, Merleau-Ponty, or the other philosophers whose views have been labeled 'hylomorphic'. The view is nevertheless very similar to the one Montgomery Furth attributes to Aristotle: '[The world] is an Empedoclean, finite three-dimensional mass, entirely filled with the four elements… [W]e now observe that scattered through this three-dimensional mass there are innumerable *knots*, regions where the matter is elaborately and intricately worked up into an organic unity… highly convoluted but relatively stable eddies in the general commingling-and-separation [of elements]… Aristotle thinks the "principle" called "form" must be brought in on top of the Empedoclean basis, to explain the stability of the knots and the complex specific character that they manifest as long as they last… a material individual (i.e., animal) is… a semipermanent warp or bend informing the local matter, which the matter flows through at various rates during the organism's life history… while the form imposes the continuity…' ('Transtemporal Stability in Aristotelian Substances', *Journal of Philosophy* **75** (1978), 638–9).

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being caught up into the whole, and the whole can exist without the materials that are caught up into it at any given moment. In addition, the materials by themselves won't tell us why the whole possesses powers that the materials by themselves do not possess such as the powers to perceive, or think, or feel. There must be some further principle that accounts for the unity and also the persistence of the whole – a principle that explains why numerically one and the same whole can exist at different times despite the constant flux of materials that are caught up into it, and that explains the distinctive powers of living things. That principle, say hylomorphists, is structure, the persistent dynamic structures we find in living things. These structures are what confer unity on the various material bits that are caught up into them, and they are what confer on living wholes powers not had by the material bits taken in isolation. Those structures, hylomorphists insist, can only be described using the conceptual resources of biology. And depending on the kinds of living things we are talking about, something analogous might be true of other special sciences such as psychology and economics.

Describing the patterns of environmental interaction that set perception, feeling, thought, goal-directed movement, and the other activities of complex living things apart from the rest of the ebb and flow of matter and energy in the universe might require the distinctive conceptual resources these other sciences provide. That is why hylomorphism, if true, implies that materialism is false. If there are distinctively biological, or psychological, or social structures, then there are things that cannot be described and explained exhaustively by physics. Physics aims at understanding physical phenomena in general, not just those that fall under the heading of life. Understanding the latter is the special task of biology, and accordingly, its vocabulary comprises predicates and terms suited specifically to the task, including ones that frame appeals to biological structure. If structure realism is true, then we have good reason to take these appeals seriously; we have good reason to think that biological structures exist, and that appeals to them cannot be eliminated, reduced to, or paraphrased in favor of descriptions and explanations that do not appeal to them including ones framed exclusively in the vocabulary of physics. If structure realism is true, therefore, we have good reason to think that biological phenomena elude the net of physical description and explanation. Materialism must be false: not everything can be exhaustively described and explained by physics. But is structure realism true?

We have seen that there are at least three alternatives consistent with ontological naturalism, each of which claims that it is possible

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in principle to describe and explain everything without appeal to structure. If one of these alternatives is true, then descriptions and explanations that appeal to biological structure give us no reason to think that distinctively biological structure exists. Those descriptions and explanations can instead be reduced to or eliminated or paraphrased in favor of descriptions and explanations that make no mention of biological structure. I content, however, that there are reasons for preferring structure realism to the alternatives.

First a dialectical point: structure realism is the simplest, most direct explanation for why appeals to structure in biology, neuroscience, and other scientific disciplines are successful. The reason they are successful, it says, is that there really are structures. Given the simplicity and directness of this explanation, structure realism should operate as our default position. We should take talk of structure in the sciences at face value in the absence of compelling reasons to do otherwise. If there is a better explanation, the burden of proof is surely on structure's opponents to provide it.

Second, structure realism enjoys certain advantages over the alternatives. The reason for preferring structure realism to structure eliminativism is a familiar reason for preferring realism to antirealism in general. Hilary Putnam stated it as follows: 'The positive argument for realism is that it is the only philosophy that doesn't make the success of science a miracle'.[35] We appeal to structure in our scientific dealings very effectively, and this effectiveness requires some type of explanation. The most obvious explanation is that there really is such a thing as structure. If there is not, then it is unclear how the effectiveness of appeals to structure in the sciences can be explained. If there really is no such thing as, say, the structure of the brain, then how do descriptions and explanations that appeal to brain structure manage to enjoy any success at all? Eliminativists do not appear to have a good answer, but realists do: descriptions and explanations that appeal to brain structure manage to be successful because there really is such a thing as brain structure. Structure realism's ability to explain the success of empirical appeals to structure is a reason to prefer it to structure eliminativism.

There are also reasons to prefer structure realism to structure reductivism and nonreductive structure antirealism. For one thing, the latter alternatives have a much heavier evidential burden than structure realism. Consider by analogy one of the reasons Putnam

[35] Hilary Putnam, 'What Is Mathematical Truth?' in *Mathematics, Matter, and Method: Philosophical Papers, Vol. 1* (New York: Cambridge University Press, 1975), 73.

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gave for preferring functionalism to the psychophysical identity theory:

> [W]e identify organisms as in pain… on the basis of their *behavior*. But it is a truism that similarities in the behavior of two systems are at least a reason to suspect similarities in the functional organization of the two systems, and a much *weaker* reason to suspect similarities in the actual physical details….[36]

According to Putnam, any behavioral evidence that supported the identity theory also supported functionalism, and it supported functionalism more strongly since identity theorists had to supply additional evidence to support the psychophysical identities they postulated. Functionalists thus had a lighter burden of proof than identity theorists: it was evidentially easier to be a functionalist than an identity theorist.

For analogous reasons it is evidentially easier to be a structure realist than a structure reductivist. Structure reductivists have to show that the structures we posit in our empirical descriptions and explanations can be identified with things that can be exhaustively described and explained without appeal to structure. Likewise, nonreductive structure antirealists have to show that all references to structure can be paraphrased in ways that have no implicit or explicit commitment to it. Both of these are very ambitious projects. Hylomorphists do not have a priori arguments that these projects cannot be carried out. From their perspective, the feasibility of these projects needs to be evaluated empirically. The important point, they insist, is that they needn't carry out any analogous project. Biologists, neuroscientists, and others successfully describe and explain things by appeal to structure, and the success of their descriptions and explanations does not depend on a further assumption that what they say can be reduced to or paraphrased in favor of nonstructural descriptions and explanations. If it is possible exhaustively to describe and explain things without appeal to structure, as structure realism's opponents claim, then the burden is on them to establish this. Reductivists must establish that nonstructural discourse can take over the descriptive and explanatory roles of structural discourse, and nonreductivists must establish that appeals to structure can always be paraphrased in nonstructural ways. To date, however, neither of these points has been established. Reductivists and nonreductivists must instead issue promissory notes. The advantage for

[36] Hilary Putnam, *Mind, Language, and Reality: Philosophical Papers, Vol. 2* (Cambridge University Press, 1975), 436.

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structure realists is that they needn't issue any such notes. Because structure realists take empirical claims about structure at face value, they do not have the additional burden of showing that we can in principle do without descriptions and explanations that posit structure. It is thus easier evidentially to be a structure realist than either a structure reductivist or a nonreductive structure antirealist.

In addition, nonreductive structure antirealism appears to face a problem analogous to the problems facing structure eliminativism. According to nonreductive structure antirealists, we have many different descriptive and explanatory interests, and because of that we tend to describe and explain things using many different vocabularies including a structural vocabulary. By using structural predicates and terms we satisfy descriptive and explanatory interests that we could not satisfy if we limited ourselves to nonstructural ones. By using predicates and terms such as 'structure' and 'organized', however, we are not describing any features of the world that cannot in principle be described and explained nonstructurally. When biologists speak of the structures of cells or the organization of the nervous system, they are not describing anything over and above unstructured processes; they are simply describing unstructured processes in a different way. Structure is not something written in the book of nature as it comes off the press; it represents instead notes we jot in the margins – our commentary on a text written entirely in nonstructural terms. If this is the case, however, then how do appeals to structure manage to enjoy any descriptive, predictive, or explanatory success if fundamentally everything is unstructured? Simply because appeals to structure satisfy some of our interests does not guarantee that those appeals will manage to be successful at describing, predicting, or explaining anything. Accounting for the descriptive, predictive, and explanatory success of structural discourse requires something in addition to its ability to satisfy our interests.

In addition, if nonreductive structure antirealists are right, and we use structural predicates and terms simply because they enable us to satisfy peculiar descriptive and explanatory interests, it seems reasonable to ask why we have the interests we do, and why structural discourse is able to satisfy them. Surely, say hylomorphists, the best explanation is that we are interested in describing and explaining the real behavior of things, and that behavior involves various kinds of structure. Consequently, the best explanation for the descriptive and explanatory interests we have – the very interests nonreductive structure antirealists appeal to – is that structure really does correspond to something deep in reality. Until these challenges are answered satisfactorily, say hylomorphists, there are good reasons to

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reject nonreductive structure antirealism in favor of the more direct realist alternative.

Consider now a general argument that opponents of structure realism might advance. It appeals to Ockham's razor. In general, says the argument, we should not multiply entities beyond necessity. Other things being equal, we should choose the most ontologically parsimonious theory we can. Consequently, if the behavior of bodies can be exhaustively described and explained in nonstructural terms, we should not seek to explain the behavior of bodies by appeal to structure as well. Hence, a view that rejects structure should be our default position.

Hylomorphists can respond to this argument in at least two ways. First, while it might be true that we should prefer a more parsimonious theory all things being equal, all things might not be equal. Ontological parsimony only becomes a decisive factor in theory choice when competing theories are all coherent, all consistent with the empirical data, and equal in explanatory power. If theories that reject structure are not coherent, if they have insoluble philosophical problems, if they are not consistent with the scientific data, or lack the explanatory power of a theory that endorses structure, then it does not matter how parsimonious their ontologies are, these other factors trump their parsimony. We saw a moment ago, moreover, that according to hylomorphists, opponents of structure have yet to establish that their theories are consistent with the empirical data, and have explanatory power to rival a theory that endorses structure; they have yet to establish that we can describe and explain living behavior without appeal to structure, or that we can reduce or paraphrase appeals to structure. It remains unclear, therefore, whether an appeal to parsimony gains any traction here.

Second, hylomorphists can argue that a theory can have complexities that offset its greater ontological parsimony. There are different ways of reckoning a theory's simplicity. Counting the kinds of entities in a theory's ontology is one. Another concerns the system of predicates, terms, laws, and other bits of machinery that enable the theory to perform its descriptive and explanatory jobs. The complexity of these other things can offset the simplicity of its ontology. Consider the debate between realists and nominalists about universals. Nominalism has a simpler ontology since it comprises only particulars instead of particulars plus universals. Realists argue, however, that nominalists purchase this simplicity at a price: they have a complex and often unsystematic semantics for predicates and abstract nouns, and this semantic complexity is a theoretical liability that offsets nominalism's ontological simplicity. Structure realists

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can argue against their opponents in a similar way. Consider, for instance, how this kind of argument could be advanced against nonreductive structure antirealists.

First, there is a sense in which nonreductive structure antirealism does not have a simpler ontology than structure realism. It claims that talk of structure is successful because it satisfies our descriptive and explanatory interests. Interests thus play a role analogous to the role that structure itself plays in structure realism: interests and structures both explain the success of empirical appeals to structure. Second, it seems clear that nonreductive structure antirealism will be more complex than structure realism since any story that nonreductive structure antirealists tell about the success of structure talk will require a semantics for structure talk that is more complicated than the semantics of structure realism. As a result, hylomorphists can say, even if parsimony ends up cutting against structure in the end, there are other considerations that cut equally against nonreductive structure antirealism.

The foregoing considerations give us some reason to find structure realism preferable to the alternatives. But if there is reason to prefer structure realism, then there is reason to think that materialism is false. Materialism claims that everything is physical; everything can be exhaustively described and explained in principle by physics. But if structure realism is true, appeals to structure in the biological sciences give us good reason to think that there are distinctively biological structures, ones that cannot be described or explained using the conceptual resources of physics alone.

I've argued that materialism is likely false if we take seriously the ontological demands of our best empirical descriptions and explanations of biological phenomena. The argument makes no appeal to consciousness, reason, value or other mental phenomena, and because of that it does not have the liabilities of arguments that do.

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