

Chapter 6.

An Ontology for Aristotelian Teleology.

Mightn't it still be open to *us* to embrace a systematically teleological world-view? Is there any rational reason why we should not switch back to an Aristotelian conceptual framework? (Woodfield 1976, 14)

In light of the previous chapter's analysis of state of the art attempts to do away with *sui generis* Aristotelian teleology in accounting for biological functions, the goal of this chapter is to develop an ontology in which *sui generis* Aristotelian teleology can find a natural home, and which meets the following three nontrivial constraints.¹

- C1: The ontology should be independently motivated.
- C2: The ontology should make clear how unreduced Aristotelian teleology makes a difference in the causal structure of the physical world.
- C3: The ontology should respect the legitimate claims and achievements — both methodological and ontological — of modern science.

The crux of the problem of teleology is contained in a combination of the second and third constraints. Teleology appears to be a causal factor in the life cycles of living things generally, and an account of teleology should explain not just the heuristic usefulness of teleological language in highlighting relevant causal features of organisms, but also teleology's peculiar causal contribution to the life cycles of organisms.²

The goal of this chapter is resolve the tension between these constraints through the development of a scientifically respectable ontology that is independently motivated and in which teleology finds a natural home. If this goal can be achieved, my account of teleology should have strong

¹ Unless otherwise specified I use 'teleology' and its cognates to indicate a *sui generis* irreducible real causal factor in the structure of the world.

² David Charles (1988, esp. pp. 38-9) explains how teleology can be metaphysically robust in a 'static' sense. On his view, teleology is explanatory because it picks things out by their essential features. This, while perhaps true, is insufficient to solve the traditional problem of how biological teleology can be explanatory; the traditional problem seeks a metaphysical basis or understanding of how it is that final causality makes a causal contribution to say, the growth and behavior of plants. How is it that 'seeking the sun' can explain the leaves' turning? Charles' explanation while valuable in itself cannot help us to answer this question, and it is the latter sort of problem that I attempt to address in this chapter.

appeal given the persistence and apparent explanatory fruitfulness of teleological explanations in the life sciences and the failure of modern naturalistic accounts of teleology.³

In this chapter I will approach the problem of teleology by first surveying historical objections to positing Aristotelian teleology in the modern world. This survey will eliminate from consideration irrelevant (but nonetheless common) objections to Aristotelian teleology, and focus our attention on the core of the explanatory task facing any theorist looking to make a place for Aristotelian teleology in a physical ontology adequate to modern science. The main objection to *sui generis* Aristotelian teleology is that it appears to have no home in the ontology of the physical world as revealed by science in the modern era. I respond that it is not modern science but certain philosophical presuppositions of modern science that has seemed to bar teleological causation from inclusion in our physical ontology. In fact, there is mounting independent evidence from the science of quantum mechanics that we must abandon the presuppositions that exclude teleology in order to make sense of certain physical phenomena. This strong evidence is sufficient to show the substantive and methodological compatibility of science with an ontology in which teleology fits naturally, and I develop and defend the ontology necessary in what follows.

First, however, we turn to a critical survey of the main contemporary objections to biological teleology.

6.1. Objections to Aristotelian teleology.

Given that teleological explanations have been enormously controversial for the whole of the modern period, we must survey the reasons for this controversy before we can enter into a productive discussion of purported solutions to the problem Aristotelian teleology. I here present a compilation of supposed problems with Aristotelian teleology taken from contemporary biological and philosophical literature on the subject.

- O1.** Aristotelian teleology is inextricably bound up with *X*, and a commitment to *X* is unacceptable; *X* may take the form of one or more of the following:

³ Both of these claims are defended in the previous chapter of this dissertation.

- a. the belief that the world is a nice place.⁴
- b. the belief that evolution is progressive; i.e., that evolution is itself teleologically directed toward some end.⁵
- c. the existence of a creator God.⁶
- d. animism or panpsychism; the existence of minds in things which do not have minds.⁷
- e. backwards causation.⁸
- f. vitalism or certain *ad hoc* entities.⁹

O2. Aristotelian teleology is incompatible with the methodological constraints of modern science:

- a. The progress of science has shown reference to teleology to be irrelevant to scientific explanation.¹⁰
- b. Teleological explanation is inevitably vacuous; it is committed to phony (and often parodied) 'natural tendency' explanations which offer a redescription of the explanandum as if that constituted a genuine explanation.¹¹
- c. Teleological claims are not (but must be) open to empirical test.¹²

O3. Aristotelian teleology is ontologically unacceptable because it is incompatible with the ontology of the physical world as revealed by modern science.¹³

Aristotelian teleology is often rejected on the contemporary scene for a combination of the above reasons. The adequacy of the account offered in this chapter, then, will depend upon my having surveyed the best and strongest objections to teleology and on my ability to mount an adequate defense against the objections. Let us take the objections in turn.

⁴ See Bedau (1992b, 283).

⁵ See Bedau (1992b, 283).

⁶ See Bedau (1992b, 283), Mayr (1988, 40), Nissen (1997, vii, 128, 162) , and Woodfield (1976, 3).

⁷ See Buller (1999, 6), Jacobs(1986, 390), Mayr(1988, 40), Nissen(1997, vii, 128, 162), and Woodfield(1976, 3).

⁸ See Buller (1999, 6), Jacobs(1986, 392), Mayr (1988, 40), Nissen (1997, 96, 105, 134), and Woodfield (1976, 34).

⁹ See Bedau (1992b, 283), Mayr (1988, 40).

¹⁰ See Woodfield (1976, 8-9).

¹¹ See Woodfield (1976, 7).

¹² See Allen and Bekoff (1995, 244; 1995, 9).

¹³ See Mayr (1988, 40).

6.1.1. Guilt by association.

The problems under (O1) have a common form: Aristotelian teleology is claimed to be bound inextricably to unacceptable commitments and suffers guilt by association. It is no doubt true, of course, that teleology has been thought by some of its supporters at some times to be bound up with each of (O1a-f). Nevertheless, it is equally clear that Aristotelian teleology need be committed to none of these unacceptable views. Aristotelian teleology may find its home in a world which isn't 'nice' (O1a), and where evolution isn't progressive in the sense that the evolutionary process itself (rather than some of its products) is directed towards goals (O1b).¹⁴

Less clearly perhaps, but true nonetheless, teleological directedness may be immanent in natural things and hence independent of and not derivative upon a creator God (O1c) and free from panpsychical worries (O1d). This is a result of Hume's subtle reflections on the nature and observability of the causal relation. We cannot know *a priori* what sorts of causal connections there are in the world, and thus the supposition that Aristotelian teleology must be either modeled on mentalistic teleology or be non-existent (e.g., because it cannot be modeled on 'billiard ball' causation or some other paradigm case of efficient causality) rests on the false presupposition that *sui generis* Aristotelian teleology cannot exist precisely because it cannot be *sui generis*. But whether or not some particular sort of causal relation is instantiated is not something we can know *a priori*. The causal relations that exist and deserve our acceptance need not 'pass muster' in front of our intuitions as to whether they match up to models of causation that are supposed to be 'intuitive'. The existence (or nonexistence) of a kind of causal relation reveals itself to us (if at all) through experience, and it is our duty to accept the kinds we find with 'natural piety'. We have an especially *strong* duty to accept those our best sciences appear unable to do without.

The backwards causation worry has always been a red herring inspired by misunderstanding teleology as if it were efficient causality running backwards in time.¹⁵ On this supposition, teleological causation *just is* efficient causation, but working backward rather than forward in time; the goal of a

¹⁴ Good discussion of the three aspects of evolution's 'blindness' to progress can be found in Campbell (1974) and Falk (1981). See also the articles collected in Part IX: Progress, of Hull and Ruse (1998).

plant's growth (i.e., the mature structure) is somehow thought to reach back in time and pull the plant's juvenile form toward itself. The proper response to this challenge is twofold: we may first grant that if teleological causation were conceived along these lines then it would be incoherent. But second, we may simply note that no one who postulates *sui generis* Aristotelian teleology is likely to endorse the view that teleology is correctly understood as efficient causality *of any sort*.¹⁶ That teleological causation appears incoherent when it is modeled on backwards efficient causality is no threat to teleology as such; it is a threat to the claim that we ought to conceive of teleological causation along these rather unpromising lines.¹⁷

Fear of vitalistic commitment (O1f) is a bit more troublesome. The charge that the invocation of teleology is vitalistic and hence proven false would be warranted and correct if (as I argued in chapter one) commitment to *sui generis* teleology committed one to the view that teleology 'floated free' of physical properties either in the sense that it did not depend for its existence on physical properties or in the sense that its action in the world broke physical laws. However, as I argued in chapter one, there exists a perfectly coherent middle path between sophisticated mechanism and vitalism that allows room for the causal efficacy of irreducible properties with novel causal powers so long as those properties depend for their existence on the instantiation of further physical properties and those causal powers do not break any physical laws. Science has not refuted the view that there are such properties; indeed one main goal of this chapter is to bring to the fore the fact that one science (quantum mechanics) seems to provide excellent grounds independent of our narrow concerns with biological teleology for believing that such emergent properties and causal powers exist. There is room, therefore, for *sui generis* teleology in a nonvitalistic conception of the world; a large part of the burden of this chapter is to elucidate just such a view.

¹⁵ For an example of this mistake, see Reichenbach (1957, pp.192-5).

¹⁶ See Woodfield (1976, 34).

¹⁷ Of course, if this model of teleology fails one may rightly ask for some explanation of how teleology *does* work in the world; this chapter is devoted to providing just such an explanation. The narrow point here is that this particular challenge to *sui generis* teleology is misdirected.

I conclude, then, that none of the supposed associations thought to cause trouble for teleology (O1a-f) is fatal to a commitment to Aristotelian teleology. While some versions of the theory may have made such commitments, they are not inevitable counterparts of Aristotelian theses generally, nor in particular of the theory to be offered in this chapter.

6.1.2. The methodological acceptability of Aristotelian teleology.

Problems (O2a-c), the supposed problems facing Aristotelian teleology from the realm of scientific methodology, are no more worrisome than problems under (O1). It is simply not the case that the advancement of science during the modern period has shown teleological explanation to be irrelevant as (O2a) charges. Biologists have never abandoned teleological explanation; it performs explanatory work in their work *qua* biologists, and there is no indication that theoretical biology will give it up in the near future.¹⁸ If my arguments were sound, then the claim that teleology (under any analysis) has been shown by science to be irrelevant must rely on either (what amounts at this point to) a question-begging assumption that teleology is reducible to some other form of causation¹⁹ or a narrow identification of science with physics and chemistry. Neither of these assumptions is justified, however. The persistence, patterns, and apparent explanatory value of our functional attributions in everyday life and science give ample justification to a realist stance on teleology, and these reasons to be realists are not undermined by the failure of reductive accounts of teleology *unless there are independent problems with the supposition that teleology is a sui generis causal factor in the world*. Determining whether or not such independent problems exist is the motivation for this survey and for this chapter, but we need not fear that (O2a) — the claim that teleology has been shown by science to be irrelevant — will undermine *sui generis* teleology for (O2a) is false and, as such, cannot undermine anything.

¹⁸ David Buller says, "In spite of the difficulties associated with teleology, however, biologists continued to use the teleological concept of function in describing the characteristics of organisms, finding the organization of organisms and the operation of their parts *virtually incomprehensible in strictly non-teleological terms*" (1999, 6. Emphasis added). As David Hull puts it, "Teleological systems do seem to force themselves on us" (1974, 120). Andrew Woodfield says, "Although *some* biological function-statements may seem metaphorical, some seem to be literally false (e.g. 'Noses exist in order to support spectacles'), and some seem literally true.... Whatever the correct analysis of these TDs [teleological descriptions] may be, there is a strong presumption that they make at least *some* objective claim on reality" (1976, 32, see also p. 1). See also Nissen (1997, vii), Allen and Bekoff (1995, 244).

The worry that explanation in terms of Aristotelian teleology must be vacuous, (O2b), has no special bearing on the problem of teleology for the same purported problem arises with other forms of causation. The vacuity problem is typically illustrated with the explanation of a pill's power to put one to sleep through mentioning a directedness in the pill toward putting one to sleep. But the existence of this type of vacuous teleological explanation cannot undermine teleological explanation generally since cases of such vacuity arise in the case of efficient causality as well; thus we may claim not that the pill has a *directedness* but simply a *power* to put to sleep.²⁰ This explanation is as vacuous as the first but makes no reference to teleological directedness. We are right in this instance not to find this to be a problem with efficient causal explanation in general, but instead diagnose it as a local failure concerning a particularly lazy invocation of an otherwise useful form of causal explanation.

Just as clearly, however, there are plenty of nonvacuous teleological explanations, as evidenced by biology's continued devotion to seeking and offering such explanations. As we saw in chapter five, biologists find teleological explanation quite powerful. Far from being the vacuous and trivial affairs invoked in the vacuity objection biological functions as invoked by scientists may take a great deal of empirical work to discover and can be quite surprising to their discoverers. Only selective attention on the worst abuses of teleological explanation could convince one that teleology is undermined by the existence of vacuous teleological explanations. There may of course be local failures of teleological explanation of the sort cited in the vacuity objection, but such failures do nothing to undermine teleology generally.

There is a further worry associated with (O2b), however, which needs to be aired. In explaining this supposed problem for teleological explanations, Andrew Woodfield claims that:

The nub of the criticism is that appeals to natural tendencies are nonexplanatory unless there is or could be evidence for them which is independent of their alleged manifestations. (1976, 7)

¹⁹ I argued in chapter five that extant reductivist accounts of biological teleology fail.

²⁰ See Woodfield (1976, 7-8).

Woodfield here places a constraint on genuinely explanatory invocations of teleology. To be genuinely explanatory invocations of teleology must be such that there is or could be evidence for the teleological directedness *independent of its alleged manifestation*. This requirement would imply that many function attributions are not genuinely explanatory. Fortunately, however, the requirement that generations this implication must be rejected, for it is far too strong.

That this is so becomes obvious when we generalize the application of the same requirement to nonteleological cases. Physical explanations could not meet the requirement stated since they cannot be vindicated by evidence independent of the manifestation of physical properties, entities and relations. But surely any requirement that rules out physical explanation in the sciences is too strong. Taking further examples, we neither do, nor should we, require evidence of the existence of the external world independent of the world's alleged manifestations.²¹ Nor should we require evidence for the existence of moral norms independent of their alleged manifestations in intuitions concerning wrongness, rightness, and the like.

The requirement, then, is far too strong; no autonomous (i.e., *sui generis*, nonreductive) area of inquiry could meet the challenge. It is not the case that legitimate explanations of sort *F* must 'back themselves up' with explanations of sort *G* where $F \supset G$, and it will not be the case that such explanations are available for autonomous domains of inquiry – whatever those happen to be. Singling teleological explanation out by placing this requirement on it alone may exhibit a tacit presupposition that teleology must be reducible to some other (independent and independently specifiable) relation between things.²² But in the context of the vacuity problem this reductionist demand is quite simply out of place:

²¹ Descartes (1967) disagreed. He attempted to find grounds for belief in the physical world through invoking intuitions about the nature and existence of God, requiring that we have such independent grounds for our belief before we are justified in claiming to know that there is an external world. Thomas Reid objects that Descartes' demand, taken up unwittingly by the empiricists, is unwarranted (1983). For expositions of Reid's arguments, see Alston (1985) and Wolterstorff (1983).

²² Given the ambiguities in the notion of 'reduction', and corresponding ambiguities in what Woodfield may mean by 'independent' in the statement of his requirement, this point may require revision. If 'reduction' requires only correlation, then it is unobjectionable as I note below. Stronger readings of Woodfield's requirement presuppose stronger forms of reduction, and it is those stronger forms that are objectionable in this context. See my discussion of reduction in the appendix to this chapter. My thanks to Chris Shields for bringing this point to light in comments on an earlier draft.

nonreductive explanations need not be vacuous. Physical explanations are nonvacuous but nonreductive,²³ explanations of modal and ethical terms may be both nonreductive and nonvacuous, and teleological explanations may be both nonreductive and nonvacuous for all the vacuity objection has shown. There is no reason offered here to doubt *sui generis* teleological explanation which is not also a reason to doubt *any* autonomous type of explanation.²⁴

Aristotelian teleology cannot be saddled with explanatory vacuity, therefore, unless we unfairly restrict our attention to the very worst cases of teleological explanation or place unmotivated requirements on teleological explanations, requirements stronger than any purported explanatorily autonomous domain could hope to meet. If we set the requirements for adequate teleological explanations sufficiently high we can, of course, trivially guarantee that no nonreductive account of teleology will meet those standards. The interesting question is whether teleology can pass the reasonable and motivated standards for explanatoriness that are employed elsewhere in everyday life and successful sciences — both formal and physical — and the vacuity objection has supplied us with no grounds to suppose that it cannot.

Nevertheless, the worry concerning the supposed vacuity of *sui generis* teleological explanations is probably only heightened by (O2c), the problem that such explanations seem not to be open to empirical test. This claim is false, however.^{25 26} So long as there exist reliable causal correlations between

²³ As David Chalmers expresses the point, "Physical theories do not derive the existence of these features [i.e., matter, motion, space, and time] from anything more basic, but they still give substantial, detailed accounts of these features and of how they interrelate" (1996, 213).

²⁴ Alvin Plantinga makes this point clearly and convincingly in chapter one of his *Warrant and Proper Function* (1993, see esp. p. 4).

²⁵ Above I cited Allen and Bekoff (1995, 244; 1995, 9) as raising this worry. To be fair to those authors I must make clear at this point that they do not phrase the worry in the terms that I do, nor do they commit themselves to the falsity of what I say in the body text. They do, however, raise a problem for teleological explanation which I believe is fairly represented by (O2c).

²⁶ Bedau addresses this issue convincingly. He illustrates the possibility of such a science with an uncontroversial example — the materialistic study of *physical primes*. 'Physical primes' refers, roughly, to prime numbered groups of objects some distance from each other. The point of the example is that one could study such groups of objects in a materialistic science despite the fact that *being a physical prime* isn't an entirely naturalistic property since it has a mathematical component. He likens this uncontroversial case to the cases of the study of conscious beings (even if consciousness is *sui generis*) and life. He says, "Thus, by analogy, even though biologists study living entities naturalistically, it does not follow that the notion of life is itself purely naturalistic. The naturalistic practice of the

teleological properties and physical phenomena (which they should be, if the two²⁷ forms of causal relation are compatible and are at play in orderly phenomena), teleological explanations will be open to empirical testing through standard scientific methods (both physiological and evolutionary). So long as we are careful not to confuse the correlation between the Darwinian origin of a trait's function and an analysis of its being a function, we are free to employ all the sophisticated tools of modern biology (including nonevolutionary tools from physiology and anatomy) in our investigation of biological functions. Investigation will continue to turn up functions that were unavailable even to tutored common sense before empirical investigation, and further empirical investigation may even overturn the assignment of functions given by tutored common sense and science in particular cases. Thus, there need be no problem concerning the testability of statements involving genuine Aristotelian teleology. If our teleology were strongly vitalistic in the sense that it was claimed to float free of or be independent the interactions of physical objects then the charge of being unopen to empirical test would have real bite. As it stands, so long as teleological directedness is causally enmeshed in and compatible with standard efficient causal relations we have no reason to suppose that they will not be strongly correlated with other salient properties and hence open to standard empirical tests and investigations.

To make this point more clear, note that the worry as it applies to teleology may rest on the assumption, stated by Woodfield (above p. 7), that causal relations are not legitimate unless they can be confirmed to exist independently of their manifestations. That requirement was too strong; it would not rule any causal relations (or any other *sui generis* phenomena) as legitimate. If the requirement of testability raises a skeptical worry such that we need a special *independent* test for the existence of teleological causes, then it too places too strong a requirement on genuine teleological explanation and should be rejected for that reason. If, however, all we have is the weaker non-skeptical demand that

science of life is consistent with the hypothesis that the notion of life contains a non-naturalistic, evaluative component" (Bedau 1992a, 46).

²⁷ There is, of course, no reason to suppose that there are only *two* sorts of *sui generis* types of causal relatedness, efficient and teleological, but nothing hangs on the simplification expressed.

teleological claims be open to scientific test according to the standards and practices of our best scientific theories, then there is no worry that *sui generis* Aristotelian teleology cannot rise to meet the demand.

6.1.3. *Sui generis* teleology and physical ontology.

I have argued that the bulk of the objections to Aristotelian teleology are easily met. We arrive at last, however, at the greatest objection to *sui generis* final causality. What is needed is an account of the possibility of *sui generis* teleological interaction in the causal structure of the world that coheres with the ontology of the physical world as revealed by modern science. The most serious problem is that *sui generis* Aristotelian teleology seems incompatible with the prevailing conception of the ontology of the physical world (O3). According to the standard picture, there is no place for teleology in a world that runs according to physical causes and laws.

The best argument against the supposition that efficient and teleological causation are incompatible is to develop a strong case for their compatibility. Science is often claimed to have shown us that there is no room in the world's physical ontology for teleological causes, but I shall argue that it is not science but certain philosophical presuppositions of science that have generated the apparent incompatibility. Indeed, I argue that the science of quantum mechanics provides evidence that the ontology of the physical world as revealed by science is not only not incompatible with *sui generis* teleology but is in fact downright hospitable to it. It has been the philosophical presuppositions of modern science, not the science itself or any method definitive of science, that has made teleology seem incompatible with science, but the quantum mechanical (and possibly biological and psychological) evidence gives us strong reason to abandon those presuppositions.

In what follows I give a brief sketch of an ontology for the physical world in which *sui generis* teleology may find a natural home, namely, an emergentist ontology.²⁸ I then argue on the basis of contemporary work on the philosophy of quantum mechanics that our best scientific theories indicate that our world instantiates just such an ontology. Thus far from it being the case that modern science has

revealed a physical ontology at odds with the postulation of *sui generis* teleology, if we take our conclusions from science rather than from *a priori* presuppositions concerning the way the world must be causally structured, then we have good reason to suppose that there is room for both science and *sui generis* Aristotelian teleology.²⁹ The chapter proper closes with defenses against common objections to such an ontology.

6.2. Emergentism and teleology's compatibility with contemporary science.

The thesis of this section is that there is nothing incoherent or contradictory about the supposition that the ontology of the physical world includes *sui generis* teleology. Strong forms of emergentist ontologies such as the one I sketch below (and develop in detail in the appendix to this chapter) are intended to elucidate 'middle ways' between strong and unacceptable dualisms and equally strong and unacceptable materialisms.³⁰ Such ontologies are designed to handle the dual tasks of accommodating the results of science, both methodological and substantive, while at the same time resisting the strong methodologically and ontically monist or reductivist tendencies of contemporary science and philosophy of science. The goal of emergentist ontologies is to illustrate that there exist coherent conceptions of the ontology of the physical world that neither challenge nor undermine our best science, but which also accommodate the possibility that the world is ontically more robust than strict reductivist and mechanist conceptions would allow.³¹

²⁸ I have included an appendix to this chapter in which I discuss and defend in more detail the ontological commitments of the ontology invoked here. I refer readers to that discussion for more details concerning emergentist ontology.

²⁹ If Aristotle were telling the narrative, he might say, "When these men and the principles of this kind had had their day, as the latter were found inadequate to generate the nature of things, men were again forced by the truth itself, as we said, to inquire into the next kind of cause" (*Met.* i.3 984b9-11; see also *Met.* i.3 984a18, *PA* i.1 642a19-20, 642a27-8, *Phys.* i.4 188b28-9). Richard Healey (1991) draws our attention to the moral that our philosophical presuppositions about the world need to stay in touch with what our science is telling us about the world in exactly the context I have in mind. Hilary Korblieth (1994, pp.40-2, quoted below) opts for an even stronger commitment to the ontic authority of the sciences. See also Crane (1994, 480) and Rudder Baker (2000, 23).

³⁰ See chapter one's discussion of vitalism for examples of such positions.

³¹ To say that the ontology is coherent is not to say that it has gone unchallenged. See Bedau (1997), Kim (1992; 1993; 1999) and Klee (1984) for challenges to the view. John Searle (1992) supports a weak form of the ontology while challenging a stronger form. Defenders of the ontology include Broad (1918-19; 1925), Lovejoy (1927), Hasker (1982; 1999), Healey (1991), Humphreys (1995; 1996; 1997a; 1997b), O'Connor (1994), Silberstein and McGeever (1999), and Teller (1986).

The notion of property emergence was originally explicated and employed in attempts to develop a *tertium quid* between vitalism and mechanism in biology and also between materialism and substance dualism in the philosophy of mind.³² Emergentists attempt to keep the best of both camps while avoiding their excesses. From the vitalistic and dualist camps, they took the notion that there are properties of physical things that are irreducible to the physical but nevertheless (and least possibly) causally efficacious.³³ From the materialistic and mechanistic camps the emergentists took both a respect for the material continuity of physical things and a firm commitment to the causal dependence of such emergent properties as there may be on physical realization bases. Microphysical explanation and causation have a firm place in emergentist thinking about the physical world despite the fact that they enjoy neither the explanatory nor the causal hegemony they have in traditional monistic and reductionistic conceptions of the world.³⁴

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.³⁵ There are a number of ways of cashing this claim out, and they will lead to various conceptions of emergence that need distinguishing.³⁶ Clearly, however, all doctrines of emergence will be dealing with properties of *complex physical systems* composed of parts, systems which are such that at least some of their parts may exist outside of those complex systems. We may deepen our positive conception of emergentism by bringing to the fore some claims that emergentists deny.

According to Arthur Lovejoy, underlying the opposition to emergentism lies an adherence to a medieval assumption about causality which he calls the 'preformationist assumption'.

³² See especially Broad (1918-19; 1925), Goudge (1967), Lovejoy (1927), and McLaughlin (1992).

³³ I argued in the last chapter that teleology was one such property. See also Plantinga (1993) and Bedau (1992b). In the philosophy of mind there exist arguments for the *sui generis* status of intentionality (see, for example Bealer 1993a; Searle 1980; 1983) and especially qualia (see, for example Bealer 1994; Jackson 1986).

³⁴ See Philip Pettit (1993) for an exposition of the traditional view. I discuss features of Pettit's account below.

³⁵ Emergentism is thus closely associated with holism. Healey (1991) and Teller (1986) draw this connection.

³⁶ The detailed work distinguishing varieties of emergence has been removed to the appendix.

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" (1927, 20).³⁷

The preformationist assumption is a 'medieval' doctrine concerning causality in the sense that it was refuted decisively in the modern era by Hume.

Hume argued that we cannot know *a priori* which things will or can be causally related to which other things; there are no nontrivial *a priori* constraints on what two things may enter into causal relations. 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 micro-entities.³⁸ We cannot know *a priori* that the interactions of strictly physical properties and entities will not causally give rise to the existence of *sui generis* mental properties such as consciousness or *sui generis* teleology, for instance. Further, according to emergentists Hume's insight concerning causality reveals that there is no *a priori* bar on whether these emergent properties may enter into primitive and novel causal relations with other entities whether the causal relations are on the 'same level' (i.e., between two emergent novelties) or 'downward' (i.e., between a cause which is an emergent novelty and an effect at the level of its base properties and entities) or 'upward' (i.e., between a cause which is an emergent novelty at level L1 and an effect which is an emergent novelty that itself emerges only from the ordering of L1 properties into complex wholes).

From this brief overview, we may take the following core commitments of the emergentist's ontology.

1. *Emergentists accept an 'ultimate physical ontology'.* "[Ultimate Physical Ontology] There are basic, nonemergent 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.* Emergentists accept that 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

³⁷ Lovejoy is not alone among emergentists in drawing these connections. See also Goudge (1967) and Popper (1977).

³⁸ Hume's arguments are in his (1975, §IV) and (1990, Book I.iii). As Hume says, we are in a "natural state of ignorance with regard to the powers and influence of all objects" when we consider them *a priori* (1777, §IV.ii.32).

and entities which generate them and upon whose interactions they depend for their instantiation.

3. *The denial of preformationism (2): the affirmation of 'downward' causation.* Emergentists hold that novel emergent properties may enter into novel causal relations; specifically, while novel properties depend for their existence on the interactions of their base properties, they may nevertheless influence the course of lower-level events in ways compatible with their continuing to be instantiated.

These basic positions lead us to a definition of an emergentist ontology strong enough for our purposes in this chapter.

Emergentist ontology: The ontological doctrine that there exist or may exist properties P of a structure X with components $a_1...a_n$ such that, (i) P properties depend causally for their existence on the interactions of $a_1...a_n$ 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 $a_1...a_n$ in their interactions outside of structures of the same type as X ; and (iii) P properties may have novel causal powers; the causal relations P enters into are not wholly identifiable with any of the causal powers and relations of $a_1...a_n$ or their aggregates outside of structures of the same type as X .

A few comments on this ontology are in order.

First, the emergentist ontology respects the findings of modern science. Emergentism does not deny the fact or value of micro explanation in modern science. Emergentism accepts that there exist no natural systems concerning which it will fail to pay dividends to seek a reductive micro-level understanding of the behavior and being of those natural systems. Emergentists do, however, deny the hegemony of mirco-level explanations at least in principle; autonomous 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.

Second, the ontology is controversial; the standard view of what science has revealed about the physical ontology of the world is not an emergentist picture. This point is illustrated amply by the acceptance of the reductionist's project by the overwhelming majority of theorists working on the problem of teleology. As Elliot Sober says, "*Function* is a concept that should not be taken at face value" (2000, 87).³⁹ The assumption at play in such statements and commitments is that since the micro-parts of entities with biological functions are composed display no *sui generis* teleological directedness, the complex wholes made up of those parts must not either. The emergentist's reply to this inference is that

³⁹ See also Buller (1999, 6), Nagel (1979, 291), Godfrey-Smith (1993, 194) and Neander (1991, 127).

Hume's arguments concerning the nonexistence of substantive *a priori* constraints on causality show the inference to be ungrounded.

The emergentist picture goes against the grain of the standard view of the ontology of the physical world in another way. 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)⁴⁰

Contemporary views of the ontology of the physical world not only attempt as a matter of principle to do without entities and properties that cannot be reductively identified with entities and properties at lower physical levels, they also have a bar on the existence emergent causal relations from higher levels back 'down' to lower levels. But again, the emergentist reasserts that Hume has taught us that there is no *a priori* bar on the existence of such causal relations. As a number of emergentists emphasize, the world may quite possibly be more causally 'intertwined' than the neat micro-to-macro exclusively picture maintains.⁴¹

Even opponents of this ontology tend to grant that it is a coherent description of one possible way the world might be.⁴² The importance of this point for our purposes is that *sui generis* teleology may find a natural and scientifically respectable home in an emergentist ontology of roughly the stripe indicated above. On such a picture, *sui generis* teleological directedness is taken to emerge from the causal interactions of micro-entities and states within organisms at and above some level of organic

⁴⁰ See also Mark Bedau (1997, 377), quoted below.

⁴¹ For authors who stress this point see especially Broad (1918-19), Silberstein and McGeever (1999) and Humphreys (1995; 1996; 1997a; 1997b).

⁴² For example, Mark Bedau, who argues that we have no need for such a strong conception of emergence, notes that it is "logically possible" that some such ontology obtain (1997, 377). Robert Klee argues not that the ontology is incoherent, but that we lack any models for understanding its detailed workings and thus ought not accept it (1984, pp. 60-1 see below for a response to this criticism.). Jaegwon Kim also grants that the ontology is coherent; he simply argues that it is incompatible with certain things we know as a matter of contingent fact to be true of the world (see also 1992; see especially 1993; 1999. I respond to Kim's arguments below.).

complexity.⁴³ Further, such directedness may influence the course of events in the world at both the macro- and the micro-levels. The plant's directedness towards flourishing may be causally efficacious in the turning of its leaves towards the sun given that there can be no *a priori* bar on which kinds of things can causally interact with which other kinds of things.⁴⁴ The findings of science do not debar teleology from the world; certain philosophical presuppositions of modern science do. That there is a coherent ontology for the physical world which respects the substantive and methodological findings of contemporary science and has a place for *sui generis* teleology establishes this claim.

Elucidating an ontology that is rich enough to accommodate Aristotelian teleology but not so strong as to fail to respect the findings and methodologies of modern science⁴⁵ does not, of course, establish that the actual world has such an ontology. Nevertheless, the theoretical point has value, for the modern presumption against unreduced teleology is so strong that establishing even this theoretical point is quite significant. In the next section I argue that the ontology outlined here is not a mere theoretical fantasy but describes the ontology of the actual world.

6.3. The ontology of the physical world.

I argued in the last section that certain modern philosophical presuppositions concerning physical ontology generate the seeming incompatibility of teleology and modern science; the results and methodologies of science are compatible with an ontology in which *sui generis* Aristotelian teleology finds a natural home. In this section I argue for the stronger claim that we have strong scientific evidence from quantum mechanics for the actuality of the ontology necessary for the acceptance of *sui generis* teleology.

⁴³ Of course it is possible that teleology could arise causally from complex interactions of inorganic materials, but I will stick to the case with which we are familiar.

⁴⁴ Whether this sort of causal interaction would be utterly 'mysterious' and hence to be avoided, or whether we need some 'model' for how it might work are issues which are taken up below.

⁴⁵ Again, this ontology is treated in depth on its own terms in the appendix to this chapter.

This is a crucial dialectical point in my argument for the acceptability of *sui generis* teleology. There are a number of philosophical⁴⁶ reasons to suppose that the ontology of the natural world is emergentist: the continuing failure of reductivist accounts of teleology combined with biology's thriving as an explanatory discipline that invokes functions argues strongly for a *sui generis* realist conception of teleology and an ontology in which such teleology makes sense. In the philosophy of mind, and in particular with regard to problems of mental causation and freedom of the will the purported irreducibility of certain mental states and properties to physical states and properties along with the robustness and explanatory value of our belief that mental states are causally efficacious constitutes another philosophical argument for the actuality of an ontology where such facts make sense.⁴⁷ Philosophical presuppositions concerning what science has revealed about the nature of the world, however, stand in the way of wide dialectical acceptance of these arguments.

In such a dialectical standoff, then, it is imperative to note that many contemporary philosophers accept a broad thesis of the ontic authority of science; this commitment will prove relevant to the dialectical acceptability of *sui generis* teleology and other purported emergents. Hilary Kornblith expresses the general sentiment well.

The ontic authority of science: In metaphysics, I believe, we should take our cue from the best available scientific theories. As Wilfred Sellars so nicely put it, '... science is the measure of all things, of what is that it is, and of what is not that it is not.' . . .The task of the naturalistic metaphysician, as I see it, is simply to draw out the metaphysical implications of contemporary science. A metaphysics which goes beyond the commitments of science is simply unsupported by the best available evidence. A metaphysics which does not make commitments as rich as those of our best current scientific theories asks us to narrow the scope of our ontology in ways which will not stand scrutiny. (quoted from Kornblith 1994)⁴⁸

⁴⁶ As I note below, the reasons which follow need not be construed as 'philosophical' rather than scientific (i.e., conclusions from the sciences of biology and psychology). There is a *strong* tendency still alive in philosophy and contemporary philosophy of science, however, to venerate physics; in discussions of ontic emergence in psychology and in biology this tendency reveals itself in invocations of the incompleteness of our knowledge in these sciences in response to claims that such sciences may reveal an ontology richer than the ontology presupposed by physics and chemistry alone.

⁴⁷ See William Hasker (1999) for a development and defense of an emergentist solution to the problems of mental causation and freedom of the will.

⁴⁸ See also Tim Crane (1994, 480), Alex Rosenberg (1996), Lynne Rudder Baker (2000, 23), and Richard Healey (1991).

Because of the wide acceptance of the ontic authority thesis by most of emergentism's detractors, this thesis plays a central role in forming a dialectically sound argument for the acceptability of *sui generis* teleology.

Of course, we might suppose that *biology* and *psychology* (not the philosophy of biology or philosophy of psychology) provide arguments for ontic emergence on the basis of the facts referred to above, and that given the ontic authority of science we therefore have reason already to revise the philosophical commitments of our ontology of the physical world. As C.D. Broad noted long ago, however, scientific arguments on the basis of biology and psychology may be dialectically ineffective given the strength with which those presuppositions are held.⁴⁹ Due to the relative complexity and uncertainty pertaining to issues in biology and psychology arguments based on findings in these fields are open to the charge that motives for postulating ontic emergence are artifacts of our relative ignorance of the subject matter rather than a genuine feature of the world.

The strategic best hope for an argument that our world's ontology is an emergentist ontology roughly along the lines indicated above, then, comes from our most established science: physics. Fortunately, there are good arguments that quantum mechanics reveals a world with an emergentist physical ontology. If these arguments prove to be correct, then we have strong dialectical ground to claim that the ontology sketched above is not merely theoretically interesting but describes the ontology of the physical world. In that case, the philosophical presuppositions that generate opposition to *sui generis* teleology require revisioning on the basis of arguments wholly independent of concerns centering on biological teleology. There is strong independent motivation for postulating the ontology teleology requires.

The strongest case to date for the existence of strong ontological emergence comes from the science of quantum mechanics. Although admittedly I lack the expertise to evaluate arguments for the

⁴⁹ Broad (1918-19, 87; 1925, 44); see also Humphreys (1997b, pp.4-5).

existence of emergence from this area, a number of authors⁵⁰ concur that the best interpretations of our best theories point to the existence of instances of ontological emergence along the lines indicated above. Here I will summarize only one of these arguments.

Silberstein and McGeever argue that certain quantum phenomenon⁵¹ – EPR Bohm systems – have only three possible explanations, two of which are to be rejected on empirical grounds, and that the remaining explanation postulates ontic emergence. In one such system, quantum mechanics theorizes that should a single zero-spin particle decay into two spin-half particles moving outwards in opposite directions, then conservation of angular momentum implies that the two particles' angular momentum must always equal that of the original particle (zero), and so their spins must always be opposite.

Silberstein and McGeever argue that it is implausible in the extreme to suppose that the particles could 'agree in advance' about their spin states given all possible future observation conditions and that it is empirically implausible given general relativity to think that the particles could exert nonlocal influence on each other at later times. They conclude that the quantum system of the two particles displays emergent properties; "These systems exhibit correlation properties that cannot be accounted for by local properties and dispositions possessed individually by their parts.... The world cannot be governed solely by local [rather than holistic/emergent] interaction" (1999, 188-9). The idea is that the 'higher level' EPR Bohm system itself, the system that is micro-composed of the two half-spin particles, is a higher-level entity that determines the lower level states of its component parts. Rather than the state of the system as a whole being wholly determined by the intrinsic local features of the half-spin particles that go to compose the system, the system itself is a whole which determines some of the states of its component parts.

⁵⁰ See Humphreys (1995; 1996; 1997a; 1997b), Teller (1986), Stapp (1993), Penrose (1995), Healey (1991), Silberstein and McGeever (1999), and Stairs (1990).

⁵¹ Paul Teller says that cases like these "inundate quantum mechanics" (1986, 76), and that emergent phenomena appear to be "all pervasive" in the field (83).

If such cases present sound interpretations of good scientific theory, then we have strong evidence for the actuality of ontological emergence. If quantum mechanical arguments such as Silberstein and McGeever's are correct, then

The best interpretation of our best science tells us that the properties of things in the world may not be fixed absolutely with respect to some unchanging space-time background, but rather that these properties arise from their interactions with and relationships among the other things in the world. . . . It is perhaps therefore necessary to seek non-reductive explanations... of some phenomena, not merely as a function of ignorance, but because the phenomena in question truly are ontologically emergent. (1999, 199)

The upshot is that not only is an emergentist ontology coherent and logically possible but we have strong evidence that this ontology is instantiated in the actual world.

Given the commitment of dialectical opponents of emergence to the ontic authority of our most developed science (i.e., physics), this argument should exert strong dialectical pressure to revise the presuppositions concerning the ontology of the natural world such that we may accommodate the arrival of new states and systems from the interactions of lower-level component parts and, further, the possibility that these higher-level systems might exert causal influence 'downward', effecting the states of their component parts. There are strong grounds⁵² to suppose that the causal structure of the world is not neatly organized along the lines of the micro-to-macro only model, but is much more 'entangled'.

One important feature exemplified by this example of ontological emergence is the entangled nature of parts and wholes. The kind of emergence found in QM [quantum mechanics] and quantum field theory completely explodes the ontological picture of reality as divided into a 'discrete hierarchy of levels'. . . . It would seem that the world is much more complex and intertwined than the current cartography of scientific disciplines leads us to believe. (Silberstein and McGeever 1999, 189)⁵³

Insofar as we want to reflect in our ontology the commitments of our best science, it appears that we ought to accept that our world's ontology is emergentist in at least some of its respects. This means, of course, that the ontology of our world has room in it for *sui generis* Aristotelian teleology, as I argued in the previous section. We have evidence, then, from our best science that not only is the ontology of the

⁵² Richard Healey estimates the strength of evidence in favor of accepting ontic emergence on the basis of quantum mechanics as follows. (Healey's use of 'holism' in what follows is very similar to the broad conception of emergence I describe above.) Healey says, "the metaphysician should not use controversy about the correct interpretation of quantum mechanics as an excuse for not investigating the implications of holism and nonseparability; for quantum mechanics comes about as close to demonstrating holism and nonseparability as it does to establishing indeterminism" (1991, 394).

⁵³ See also Humphreys, esp. (1995).

physical world as revealed to us by modern science not in conflict with the postulation of *sui generis* Aristotelian teleology but that it in fact has a natural place for teleology.⁵⁴

That there are quantum mechanical cases of strong ontological emergence does not, of course, establish that there is also *sui generis* Aristotelian teleology, but we have already seen that there is strong and persistent biological evidence for real teleology in the world and that reductive explanations of the phenomena fail. Given this state of affairs, it seems reasonable to put forward the hypothesis that we should indeed take teleological phenomena seriously, and we should rethink the main objection to robust interpretations of these phenomena — the objection that *sui generis* Aristotelian teleology is ontologically suspect in the context of the ontology revealed by modern science. It has been assumed that the ontology of science can allow only efficient causality, but the quantum mechanical cases of strong ontic emergence (if successful) show that this ontology needs supplementing in exactly the way required to make sense of the causal influence of *sui generis* Aristotelian teleology. Far from it being the case that modern science stands in the way of an ontology of strong ontological emergence, it would appear that our best, most fundamental and precise science indicates that the ontology emergentism requires is the actual one.

⁵⁴ It is worth noting one possible response to this argument. Philip Pettit has given a definition of physicalism according to which physicalism is committed (since physics itself is supposed to be committed) to there being no irreducible high level properties with irreducible high level causal powers. All the primitive entities, properties and causal relations are micro-physical on this view. However, Pettit does believe that physicalism is consistent with the claim that below a certain size level, "there is no single level of grain at which microphysical laws obtain hegemonically. Thus the fundamental microphysical laws may include some laws at a relatively smaller level of grain, some at a relatively higher" compatible with his definition of physicalism and its commitments (1993, 221n8). Thus, Pettit makes room in physicalism for the expression of novel causal powers at higher levels *so long as all such entanglements and downward causation is isolated within the micro-physical realm*. Thus, Pettit's definition would 'screen off' the results of the quantum mechanical argument given above, preventing them from being applied in 'macro' cases such as teleology or the mind. (Jaegwon Kim likewise attempts to allow the emergence of genuine and causally efficacious novelty — everything the emergentist desires — *only* at the micro-level. See Kim (1998, 116-8).)

The thing to note about this strategy, however, is not its illegitimacy but its arbitrariness. We could postulate that emergentist ontology held only below a certain size level, but the claim must appear *ad hoc* and unprincipled. Indeed, Pettit recognizes as much when he notes that an emergentist challenge to physicalism in his sense would be "much more challenging" than standard objections, and would "go to matters of deeper metaphysics" (217). What these deeper matters are, or how we might evaluate them, are issues Pettit does not address. We are thus left to our own devices in evaluating the plausibility and coherence of an emergentist ontology suitable to teleology. I survey a number of possible objections to the account below.

If the case for emergence among quantum phenomena is sound, then we have strong reason to believe that the automatic and unthinking modern rejection of *sui generis* teleology is an artifact of philosophical presuppositions about the ontic structure of the physical world which simply do not obtain. This is *strong* reason to rethink and re-evaluate the place of *sui generis* teleology in the modern world. Given the failure of reductivist accounts of teleology (argued in chapter five) and the persistence of strong reasons to be realists concerning biological teleology, evidence from physics for the actuality of an ontology in which *sui generis* teleology finds a natural home is a boon indeed.

6.4. Naturalism.

Since the thesis of this chapter — that there is a place in the contemporary scientific worldview for *sui generis* Aristotelian teleology — is, I recognize, heterodox, it is worth pausing to re-emphasize the firm commitment of this position to the findings of modern biological science. Indeed this is one respect in which I follow the reductivist tradition concerning biological teleology completely. The main motive for popular realist but reductivist accounts of biological teleology is the acceptance and centrality of biological teleology in tremendously successful contemporary evolutionary biology.⁵⁵ There are further substantive senses, however, in which this account is firmly naturalistic in its ontology *and* methodology.

The ontological story told here is one which meets the negative ontological constraint on naturalistic accounts that they not be committed to *super*-natural entities or forces, or nonphysical substances such as 'entelechies'.⁵⁶ *Sui generis* teleology is, on the picture sketched above, just the emergent product of causal relations between natural things and it is hence, itself just another natural feature of the actual world. The account also satisfies the strong methodological constraint on naturalistic theories that they endorse only the methods of knowledge acquisition employed in the sciences, for my account is, again, firmly based on the findings of quantum mechanics and the supposition that biologists need to be

⁵⁵ See Buller (1999, 6), Hull (1974, 120), Woodfield (1976, 32, see also p.1), Nissen (1997, vii), Allen and Bekoff (1995, 244), Neander (1991, 127; 1995, 227), Bigelow and Pargetter (1987, 100), Allen, Bekoff, and Lauder (1998, 1-2) and Dretske (1988, 63).

⁵⁶ See McGinn (1991, 87), Katz (1998, 12) and Post (1995).

realists about teleology combined with the fact that reductive accounts of their commitments fail.⁵⁷ To invoke *sui generis* teleology, then, is not to invoke, in David Chalmers' terms, "the forces of darkness" (1996, 128).⁵⁸

6.5. Objections to strong ontological emergence.

The picture I have presented thus far has been extremely optimistic. Not surprisingly, however, ontological emergence of the sort I have been explaining and advocating is not without its critics. The body of this chapter concludes with a consideration of a number of the most common objections to ontic emergence; these objections consist of off-hand dismissals, objections to the 'mystery' of downward determination, objections stemming from the supposed causal closure of the physical world, and finally, the supposed incompatibility between scientific methodology and ontic emergence.

6.5.1. Off-hand dismissals.

[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. (quoted in Humphreys 1996, 63; Lewis 1986b, x)

In a certain style of contemporary philosophy, the bold and dogmatic statement of a particular form of orthodoxy — like the one quoted in the epigraph — has become distressingly common. Charitably interpreted, such bold statements are read as nothing more than strong statements of commitment to a particular view's truth, and taken in this way they constitute no objection or

⁵⁷ For this constraint see Bonjour (1998, 69) and Katz (1998, 12). Of course, that the account satisfies the constraint need not constrain others — nonnaturalists in epistemology — from accepting the result; the account is not the exclusive possession of naturalists in epistemology.

⁵⁸ Chalmers invokes the 'forces of darkness' in defending his property dualism from the charge that fails to be naturalistic. His naturalism is stronger than the version formulated here in the (dubious) sense that it presupposes the ontology of the physical world this chapter seeks to call into question. It is interesting to note that the naturalism with which the view advocated here is compatible is stronger than Lynne Rudder Baker's 'broad naturalism'. On that view, science is not the only arbiter of ontic authority — Rudder Baker argues that we ought to take the ontic commitments of common sense seriously (if critically) as well. While I find this aspect of her 'broad naturalism' congenial, my point here has been to stress that the ontology and methodology required to arrive at *sui generis* teleology naturalistic in quite stringent senses.

impediment to the view presented in this chapter — whatever objections are to be offered must be offered elsewhere than even the gruff and seemingly dogmatic statement of a position.

In practice, however, statements such as these often seem to function as 'argument stoppers'⁵⁹ which mark out territory that will not be questioned by another, and — the gruff realism of the rhetorical tone implies — ought not be questioned by those who wish to deal with the world as it is rather than as they wish it to be.⁶⁰ When used or read in this way, such statements are themselves taken to offer reasons against the views which are rhetorically undermined.⁶¹ Nevertheless, there is no *argument* contained in these denials, however gruff. If there is to be a real discussion of objections to strong ontic emergence, it must move beyond these highly rhetorical and prejudicial opening moves.

6.5.2. Is strong ontic emergence 'too mysterious'?

Although strong emergence is logically possible, it is uncomfortably like magic. . . . such causal powers should be quite unlike anything within our scientific ken. (Bedau 1997, 377)

As I have argued above, the claim that ontological emergence is unlike anything in our scientific ken is false of quantum mechanics, and — more controversially but more to the point for this dissertation — false of biology as well. Nevertheless, the fear may remain that strong ontic emergence is 'uncomfortably like magic.' One response to such fears (sufficient on its own) would be simply to point out that in the face of the reputable scientific evidence in favor of ontic emergence these fears should go the way of our intuitions about absolute space in a post-Einsteinian world. We need better reasons than this to oppose the conclusions and explanatory tools of scientific work in quantum mechanics and

⁵⁹ The phrase is John Mullens (1995, 10). He defines an 'argument stopper' as "a verbal response to argumentation that is intended to, and has the effect of, ending rational debate."

⁶⁰ As William Hasker comments, "such dogmatism is hardly rendered benign by the fact that it is fairly widespread in the philosophy-of-mind community" (1999, x).

⁶¹ Richard Spencer-Smith (1994, 119) and Mark Bedau (1997, 377) employ 'arguments' of this sort as reasons to reject emergence. Each grants the coherence of the view, but either declares it refuted by empirical data which are nowhere cited (Spencer-Smith) or declares it irrelevant (Bedau). Such proclamations can carry no weight in serious debates over the acceptability of emergence; some substantive, publicly available and evaluable reason must be offered if progress is to be made.

biology. Despite the adequacy of this response, it is possible to move the issue further forward before employing it.

In the epigraph Bedau has particularly in mind purported cases of 'downward' or 'macro-to-micro' causation; it is supposed causal relations of this sort which are said to be 'uncomfortably like magic.' The impression that downward causation is somehow illegitimate may be fostered by the idea that we understand upward (micro-to-macro) determination better than the downward variety of determination. Here I quote an extended and informative passage by Robert Klee on this matter.

We find micro-explanation to be a powerful and impressive form of explanation. Micro-explanation is powerful in virtue of the fact that when a level of organization within a system can be explained in terms of lower-levels of organization this must be because the lower-levels (i.e. micro-properties) determine the higher-levels (i.e. the macro-properties). This is why micro-explanation makes sense—the direction of explanation recapitulates the direction of determination. The intuition behind this is that when we have something explained to us we understand it, and a large part of understanding something is knowing how it is determined. What this comes to, among other things, is that a micro-explanation (if it is a good one) provides us with the *effective means or mechanism* by which the higher-level is determined or produced out of the lower levels. . . . How might this notion of a *mechanism, or effective means*, help us to evaluate macro-determinative emergence? Most *mechanisms* of determination that current scientific theories acknowledge indicate that the direction of determination is micro-to-macro. . . . We 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. (Klee 1984, 59-60. Italics added)

This rich passage well reflects the worry that 'downward causation', as I have been calling it, is too vague or mysterious to engage our scientific interests. What is the substance of Klee's charge?

Klee argues that explanation proceeds (in large part) through elucidating determinative or causal relations between things and events. We want not just formal understanding in the sciences, but also an understanding of the causal structure of the world. Micro-explanation satisfies in this regard. We already understand, Klee claims, how the micro determines the macro, whereas with purported cases of macro-determination we have no model of the mechanism by which the determination is supposed to work, and the lack of a model makes the determinative relation look "somewhat mysterious."⁶²

⁶² The accusation that macro-to-micro causation is 'too mysterious' to be countenanced in our ontology has obvious parallels to the standard objection to dualistic interaction. Mental/physical interaction is taken to be 'too mysterious' and in need of some sort of explanation before we can accept it. But, as William Hasker points out, "This argument may well hold the all-time record for overrated objections to major philosophical positions" (1999, 150). Crane and Mellor diagnose the problem with the objection thus, "It is indeed an old thought that mental causation is hard to make sense of, and especially causation linking the mental to the non-mental, because they seem to be so different. But why should that impress anyone who has learned from Hume that causation never 'makes

Note, however, that no model *or* mechanism for understanding micro-causal explanation was offered by Klee. Micro-explanation is accepted without a model; insofar as a model is employed by Klee it consists simply in making explicit various links in the micro-to-macro causal story. The individual upward links, however, are accepted as basic and explanatory *because* they are so well attested as causal determination relations for which no model or mechanism can *in principle* be offered.⁶³ Being a determinative relation accepted in well founded scientific theory itself justifies accepting this sort of determination.⁶⁴

Of course, advocates of 'downward causation' maintain that *it* is a well attested form of determinative relation and that in the absence of principled objections to accepting such relations as genuine, we ought to accept them on the strength of their role in scientific theory. But of course, claiming to find a causal relation 'too mysterious' does not itself constitute a principled objection; if we are to be given reason to reject downward determination opponents must do more work than this.

In sum, Klee places a condition on the legitimacy of macro-to-micro causation that the micro-to-macro case was not required to meet. This condition is illegitimate, however, as Hume has taught us. No empirically discovered causal relation must pass before the bar of *a priori* reason's demand that it be made 'transparent' to the mind before we may accept it into our ontology.⁶⁵ No causal relation, upwards,

sense': that it is always a matter of fact, not of reason? Nothing in either Humean or other modern analyses of causation forces causes to be like their effects; nor does anything in them stop causes and effects being mental" (1990, 192). See also E.J. Lowe (1996, 52), Arthur Lovejoy (1927, 20) and C.J. Ducasse (1961). This response transfers without loss as a response to the mysteriousness objection offered against macro-to-micro causation.

⁶³ C.J. Ducasse says, "[T]he objection that we cannot understand how a mental event could cause a physical one (or vice versa) has no basis other than blindness to the fact that the 'how' of causation is incapable at all of being either mysterious or understood only in cases of *remote* causation, never in cases of *proximate* causation. For the question as to the 'how' of causation of a given event by a given event never has any other sense than *through what intermediary causal steps* does one cause the other." (1961)

⁶⁴ Perhaps there is simply an ambiguity at play here in 'determination'. As the emergentists use the word, macro-to-micro determination is a causal relation; macro events are related as causes to micro events as effects. Often, however, micro-to-macro determination may be thought of not as a causal relation at all, but as a logical or supervenience relation, as when we say that the dots in a dot-matrix picture determine the picture's qualities. This sort of aggregative determination is, perhaps, well understood in a way that the emergentist's downward causal efficacy is not, but if this is what Klee has in mind then he has simply failed to address the emergentist's position. Emergentists do not conceive of downward causation on the model of supervenience, they understand it as an instance of ordinary causal relations between things and events in the world.

⁶⁵ As John Foster says, "why should any explanation be demanded? . . . Why should he [i.e., the dualist in this case] be called on to offer a deeper mode of explanation than that which is available to physical science?" (1991, 160-1)

downwards, or horizontal is anything but opaque to our reasoning. The invocation of mystery by Bedau and Klee is wholly out of place (or, rather, time) in a post-Humean context.

6.5.3. The causal closure of the physical.

One might object to the emergentist ontology elucidated here on the grounds that it involves a violation of the causal closure of the physical. The idea behind causal closure is the supposition that it should be possible to give a complete account of the causal structure of the world in the terms of physical causes. Thus, the causal closure of the physical maintains (roughly) that for any event E that has a cause we can cite a physical cause, P , for its happening, and that citing P explains why E happened. Further, for any event, E , once we have cited all of E 's physical causes, $P_1...P_n$, we have cited all of E 's causes simpliciter; there are no nonphysical causes of E .⁶⁶

Doctrines that embrace strong ontological emergence may appear to violate the principle of the causal closure of the physical, but it is not clear that all versions of such a theory will do so. Thus, if quantum mechanical phenomena exhibit strong ontic emergence then it seems plausible to suppose that both the properties and entities in the emergence base and the properties and entities which emerge from the interactions of the base properties and entities are physical, and their causes and effects are all physical. It would appear, then, that there is no incompatibility between the causal closure of the physical world and ontological emergence.

Nevertheless, while ontic emergence and causal closure may be compatible, it is surely the case that if *sui generis* Aristotelian teleology emerges, there is some reason to believe that the principle of the causal closure of the physical has been violated. Surely teleological causes are not physical causes, and thus cannot be accommodated into our ontology on the supposition that the physical world forms a causally closed system with no 'outside' nonphysical influences.⁶⁷

⁶⁶ Jaegwon Kim says, "One way of stating the principle of physical causal closure is this: If you pick any physical event and trace out its causal ancestry or posterity, that will never take you outside the physical domain. That is, no causal chain will ever cross the boundary between the physical and the nonphysical." (1998, 40).

⁶⁷ Note of course, that on the emergentism presented here teleological causes can only be 'outside' the physical in an extremely weak sense if at all. On this view they are *not* supernatural properties or entities added into the causal matrix from without for free, like supernatural beings or entelechies. Rather, the teleological properties of things in

I have two responses to this worry, developed in the next two sub-sections. First, I question the evidence in favor of causal closure; how strong are our reasons for accepting causal closure? Second, the principle of the causal closure of the physical can be no more substantive than our independent conception of what it is to be physical. There can be no principled objection to purported nonphysical causes unless we have a principled (i.e., not merely stipulative or question begging) distinction between the physical and the nonphysical.

6.5.3.1. Evidence for causal closure.

Evidence cited in favor of the causal closure of the physical consists, generally, in a vague reference to the enormous success of the physical sciences in the modern era and what is claimed to be a sound inductive inference from that success to causal closure. How strong is this argument?

Not terribly. Inductive inferences which extrapolate our experience in one domain *X* into another domain *Y* are only as good as our reasons to believe that domains *X* and *Y* are relevantly similar. Thus, famously, medical science once generalized the results of studies conducted solely on men to women — we are all *human* after all. But this was a hasty, dangerous, and as it turns out ill-founded generalization in many crucial cases. Bearing this sort of general issue concerning inductive inferences in mind, the case for causal closure is extraordinarily weak.

I grant of course that physics and chemistry have been enormously successful using reductive models of micro-to-macro causation invoking only efficient causes. Nevertheless, to suppose that this success transfers straightforwardly into the extremely controversial domains of biology and psychology would be rash. I have argued in the last two chapters that there are no acceptable reductive accounts of biological teleology and that there does exist an ontology that we have strong reason to believe is instantiated in this world within which *sui generis* teleology finds a natural home. But if this is correct, then the widely shared grounds for being realists about teleology themselves weigh against the supposed inference to causal closure: biology appears to require *sui generis* teleology and the success physics and

virtue of which they direct aspects of their behavior are themselves the causal result of interactions among physical things; they are a *part* of nature, not outside of it. See pp. 23-24.

chemistry have enjoyed without it is neither here nor there given the principled differences between the two domains.⁶⁸ My point is the simple one that we cannot suppose at this stage in the argument that reference to causal closure will refute *sui generis* teleology, for the grounds for the inference to causal closure are themselves undermined by the arguments thus far offered in favor of accepting *sui generis* teleology.

It is important at this stage of the argument to keep in mind that this conclusion is not as heterodox as it might seem. On the view presented in this chapter, *sui generis* teleology constitutes a natural part of the physical world and *not* a supernatural or mysterious and independent new entity added into the world 'from without'. *Sui generis* teleology is the causal result of the interactions of physical things as they behave in complex organized systems; their appearance is no more mysterious or unnatural than any effect of any cause given the opacity to reason of causal relations generally. To undermine the grounds for causal closure, then, is not (in at least this instance) to invoke supernatural causal factors independent of or in conflict with physical causes, nor is it to undermine the results of science. In fact the view attempts to fully respect the grounds for being realists about teleology that arise out of reflection on contemporary biology.

6.5.3.2. What system is causally closed when the physical is causally closed?

Thus far I have argued that the inference to causal closure is only as strong as the claim that the success of physics and chemistry transfers without hitch to biology and psychology. The argument of the last two chapters, however, undermines this claim, and causal closure therefore cannot be invoked against *sui generis* teleology at this stage without some substantive objections independent of the claim of causal closure itself. We may see that causal closure fails to provide a principled independent argument against emergent teleology in another way, however, for the principle of the causal closure of the physical is itself only as substantive as the notion of the physical that it invokes.

⁶⁸ Similar arguments for the *sui generis* status of causally efficacious mental properties likewise weigh in against the inference to causal closure.

A *a priori* definitions of the physical are out of vogue;⁶⁹ contemporary definitions of the physical are almost exclusively formulated with reference to the principle of the ontic authority of science. According to the thesis of ontic authority (see above, p. 18), we ought to accept into our ontology whatever completed science requires. Of course, on this view of the physical *sui generis* teleology poses no threat to the causal closure of the physical for I have argued that biology needs *sui generis* teleology. If 'physical' is understood to apply thus without any *a priori* constraints on what science might one day determine to be necessary, then this position is not in conflict with the causal closure of the physical. Again, we require substantive objections to the ontology independent of bare claims concerning causal closure if *sui generis* teleology is to be threatened.

Nevertheless, there is a widely shared intuition that something has gone terribly wrong with any conception of the physical on which *sui generis* teleology or mental properties count as physical properties. Recognizing this, many theorists attempt not to give *a priori* positive descriptions of the physical, but rather to place *a priori* constraints on what is excluded from the physical: if there is *sui generis* teleology, then *it* is a nonphysical property, for instance. Of course, if we simply stipulate the teleological out of the physical in this sense, then once again the principle of the causal closure of the physical cannot be invoked against the emergentist teleology of this chapter, for no such stipulative terminological move may carry substantive weight. If this conception of the physical constitutes our whole grounds for objecting to teleology, we have been given no substantive reason to give it up.

Given this, we might try to define the physical such that it applies primarily to things which are very small (i.e., atoms and smaller, perhaps) and those things which are composed out of small things. Philip Pettit (1993) has formulated a definition of physicalism (the claim that everything that exists is physical) on this model. Pettit claims that his definition gives substantive content to the notion of being physical; it would be false, for instance, if there were *sui generis* teleology. Perhaps if we understand the

⁶⁹ We may think, for example, of definitions of the physical in terms of what possesses extension, has mass, solidity, excludes other objects, etc.

physical in Pettit's way, then, we can generate a substantive case from causal closure against emergent teleology.⁷⁰

This strategy cannot succeed, however, for while Pettit's definition does rule out *sui generis* teleology, it does so (again) by stipulation. The problem for our purposes comes to the fact that Pettit must specify what it is for a thing to be composed out of physical things and still to be physical in his restrictive sense. If Pettit's constraints were too weak, then teleology would count (again) as a physical cause in virtue of its constitution base in the physical. Pettit excludes teleology, then, by stipulating that on his version of physicalism composition relations must be 'noncreative', and by further stipulating that such macro-level laws as might exist all be wholly derivative upon micro-level causal laws — Pettit excludes emergent novelties and emergent causal influence from physicalist ontology *by stipulation*. While this is a perfectly legitimate move to make in defining the physical, it cannot form the basis for a principled objection to emergentist teleology for that sort of teleology is ruled out of the physical (again) merely by definitional stipulation. Such terminological maneuvering may give substance to the thesis of physicalism, but it cannot be invoked as the basis for a principled objection to *sui generis* teleology on the basis of the causal closure of the physical.

6.5.3.3. Section summary.

The principle of causal closure, then, cannot form a principled objection to *sui generis* teleology as conceived here. The inductive inference to causal closure is weak in the absence of independent objections to the grounds for *sui generis* teleology offered in the last two chapters and there does not exist a substantive conception of the physical which could form the ground for a principled objection to positing a *sui generis* teleological cause. Instead, the primary move in excluding teleology from the realm of the physical is to invoke *a priori* constraints on the nature of the physical and to define causal closure on the basis of those *a priori* constraints. But, given Hume's argument that all causal relations are opaque to us we cannot infer on the basis of supposed *a priori* constraints on what can cause what that teleology is not a real causal factor in the structure of the world. If we respect the ontic authority of what science

⁷⁰ Ignoring, of course, the objections of the previous section.

has revealed to us *a posteriori* then there is no objection to accepting *sui generis* teleology as a physical cause. If we impose an *a priori* constraint on what may count as a 'physical' cause then we lose the basis for any substantive objection to postulating *sui generis* teleology.

6.5.4. Methodological worries about emergence.

Perhaps, however there are valid worries from the domain of scientific methodology which require us to forego emergentist explanations. Macro-micro and micro-macro explanations are not on a par not because one is inherently less well understood or legitimate than the other, but because one is suspect on methodological grounds.

Thus, one possible objection to an emergentist view is that it will lead to a complacency about scientific explanation on the part of those who accept the ontology. One of the chief reasons, it will be claimed, for the stunning success of science in the modern period is the fact that scientists have sworn themselves off from 'easy answers' to complex problems about the nature and operation of the physical world and have continually pushed themselves to understand the world strictly in terms of physical causes. An ontology of strong ontological emergence that accepts with equanimity such suspect entities as *sui generis* teleology and/or mental properties can only stand in the way of genuine scientific progress by encouraging lax pseudo-explanations in sciences where genuine (but difficult to discover) micro-explanation has much to tell us.

I believe that there are two proper responses to this objection. The first is simply to reiterate the point made above (see p. 7) that it is simply not the case that allowing emergent properties into ones scientific ontology requires abandoning genuine and systematic scientific inquiry. The assumption that it does can only rest on selective attention to the facts or the unfounded assumption that all emergentist explanation must be vacuous. But invocations of biological teleology are far from vacuous. The history of biological investigation of functions reveals unquestionably that serious investigation is needed for the discovery of numerous biological functions, and none of this work is undermined in either substance or methodology if we recognize teleology as strongly ontologically emergent. Similar remarks may be made about the neurophysiological investigation of the mind and its relation to our first-person experience of

the world. Further examples of good scientific work yielding emergentist results are available if the argument above concerning quantum mechanical examples of strongly emergent phenomena are sound. Indeed, this last example, if defensible in the long run,⁷¹ ought to provide conclusive reason to dismiss this objection as unfounded. Good science, good physics, is compatible with ontic emergence; quantum mechanics and biology prove it.

There simply is then no incompatibility between good science and ontological emergence. To claim that accepting an emergentist ontology must mean the abandonment of serious scientific inquiry is either to ignore these stunningly successful sciences or to assume in a question-begging fashion (in this context) that those sciences investigate and uncover only properties strictly reducible to physical properties and events. To suppose that the methods and successes of these scientific investigations must be abandoned because of the adoption of a particular ontological view of the underlying facts of the matter is utterly unfounded and fails to take seriously the ontological presuppositions of the standard view of scientific method. The presuppositions of emergentist ontology are not stronger nor more extravagant than the presuppositions of the standard view — they are simply different.

Second, the objection appears to assume a doctrine of the unity of scientific method and investigation which is highly questionable at best. Certain scientific disciplines are committed by their subject matter to a continual effort to seek further micro-physical causes for macro-events, and there is no reason for a strong emergentist to suggest any changes in the methodologies of such inquiries. Nevertheless, there is no reason to believe that all genuine science must proceed under the same (microphysical) explanatory constraints, and the doctrine of strong emergence articulates one way in which such explanatory and scientific pluralism makes sense.

In a world where causal interactions between higher and lower levels are 'entangled'⁷² rather than being strictly uni-directional the door is open to a realist causal basis for different methods of investigation. While microphysical investigations have been extraordinarily fruitful and it would be

⁷¹ See again Richard Healey's estimation of the strength of evidence quantum mechanics provides for ontic emergence, quoted above in n. 52.

foolish to suggest that we discontinue seeking them, that rash proposal is not on offer. One of the advantages of the emergentist position is that it honestly seeks to acknowledge the strong basis we have for our beliefs about the fundamental levels of physical reality and our ability to understand macro events through micro causes. The emergentist simply denies that the success of microexplanation either entails or even strongly suggests the falsity of views on which there exists greater ontic and causal heterogeneity in the structure of the world than a simple micro-to-macro reductivist model of science would suggest.

I conclude that the objection that a strong emergentist ontology is suspect on grounds of scientific methodology is either empirically falsified or question-begging. It is empirically false if the objector disavows the evidence of quantum mechanics and biology. It is question-begging if the objector assumes that the explanatory successes of biology and quantum mechanics can only be understood on the reductive micro-to-macro model. We all grant the methodological power of the scientific method in biology and quantum mechanics, but we cannot assume that the correct ontology underling this method can only be the reductivist one traditionally presupposed. Sound scientific practice is not wedded to the idea that the world must be ordered only according to micro-to-macro determination rather than being more heterogeneous.⁷³

6.5.5. Conclusion.

In this chapter I have argued that there exists an ontology of the physical world that enjoys independent scientific and philosophical support and that *sui generis* Aristotelian teleology both makes sense within this ontology and may play a robust role in the causal structure of the world. I have attempted to defend both this conception of teleology and the ontology that underwrites it through positive arguments in favor of adopting such an ontology and through defenses against traditional and contemporary objections both to teleology and to emergentist ontology. I conclude that there is a

⁷² The expression is Silberstein and McGeever's (1999, 189, quoted above).

⁷³ See Broad (1918-19) and Humphreys (1995).

scientifically and philosophically respectable place for *sui generis* Aristotelian teleology in the modern world.⁷⁴

In the next chapter we return to the question of Aristotle on the nature of life. In chapter two I hinted that Aristotle may define life in terms of teleology. In the intervening chapters I have investigated both Aristotelian teleology and the prospects for teleology in contemporary science in a preliminary investigation of the viability of such a conception both as an interpretation of Aristotle and as a contribution to contemporary concerns about the nature of life. Having defended the theses that the scope of Aristotle's teleology presents no problem for an analysis of life in teleological terms, that Aristotle's teleology is a *sui generis* causal factor in the world, and that such a conception of teleology has a place in a modern conception of the world, I now return to the task of elucidating and defending Aristotle's conception of life in teleological terms.

⁷⁴ This conclusion is buttressed further in the appendix which follows. In the appendix I deepen the picture of emergentist ontology necessary to support the claims of this chapter.

Appendix to Chapter Six:
The ontology of emergent properties and laws.

This appendix constitutes an extended defense of my claim that emergentist ontology is coherent. Below, I survey the history of debates concerning emergentism, formalize a definition of emergence strong enough both to do the work required in this chapter and to make clear what the view is — and is not — committed to.

Some terminological confusion is bound to arise given contemporary uses of related terms, and I will attempt to clarify and distinguish my view in what follows. Richard Spencer-Smith points to the fact that 'emergence', as it is invoked in the philosophical literature, can express both a reductionist and an anti-reductionist sense¹ and compares such a situation to there being a linguistic community which uses the same word "as a synonym both for 'black' and for 'white'" (1994, 113).² As a number of authors point out, the term 'emergence' also seems to be used in both epistemological and ontological senses.³ All of these senses need distinguishing and clarifying before we can move on.

6.6. The core sense of emergence.

As with so many concepts, emergence is best introduced through an explanation of what it denies. 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.⁴ There are a number of ways of cashing this claim out, and they will lead to various conceptions of emergence which need distinguishing. Clearly, however,

¹ For deflationary or reductionistic accounts of emergence, see Spencer-Smith (1994), Bedau (1997), Klee (1984), and Newman (1996). Jaegwon Kim joins the reductionists in arguing against the coherence of stronger forms of emergence in a number of important papers; see his (1992; 1993; 1999). For anti-reductionists, see Broad (1918-19; 1925), Lovejoy (1927), Humphreys (1995; 1996; 1997a; 1997b), O'Connor (1994), Silberstein and McGeever (1999), Hasker (1982; 1999), Lowe (1996) and Searle (1992).

² Unfortunately, Spencer-Smith's attempt to disambiguate and find the common ground between these two uses falls flat. On his view, "What entitles us to see the radical and interactional conceptions as aiming at the same kind of phenomenon is the idea of a property emerging at a higher level as a result of the behaviour of the lower level constituents" (1994, 122). This solution to the problem, however, merely equates the common core of the concept of emergence with the use employed by one camp: the reductionists.

³ See, for example, Silberstein and McGeever (1999).

all doctrines of emergence will be dealing with properties of *complex physical systems* composed of parts, systems which are such that at least some of their parts may exist outside of those complex systems.⁵

According to Arthur Lovejoy, underlying the opposition to emergentism lies an adherence to a medieval assumption about causality which he calls 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" (1927, 20).⁶

The preformationist assumption is a 'medieval' doctrine concerning causality in the sense that it was refuted decisively in the modern era by Hume.

Hume argued that we cannot know *a priori* which things will or can be causally related to which other things; there are no nontrivial *a priori* constraints on what two things may enter into causal relations. 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 micro-entities.⁷ We cannot know *a priori* that the interactions of strictly physical properties and entities will not causally give rise to the existence of *sui generis* mental properties such as consciousness or *sui generis* teleology, for instance. Further, according to emergentists Hume's insight concerning causality reveals that there is no *a priori* bar on whether these emergent properties may enter into primitive and novel causal relations with other entities whether the causal relations are on the 'same level' (i.e., between two emergent novelties) or 'downward' (i.e., between a cause which is an emergent novelty and an effect at the level of its base properties and entities) or 'upward' (i.e., between a cause which is an emergent novelty at level L1 and an effect which is an emergent novelty that itself emerges only from the ordering of L1 properties into complex wholes).

⁴ Emergentism is thus closely associated with holism. Healey (1991) and Teller (1986) draw this connection.

⁵ The next two paragraphs borrow introductory material from the discussion in chapter six.

⁶ Lovejoy is not alone among emergentists in drawing these connections. See also Goudge (1967) and Popper (1977).

⁷ Hume's arguments are in his (1777, §IV) and (1990, Book I.iii). As Hume says, we are in a "natural state of ignorance with regard to the powers and influence of all objects" when we consider them *a priori* (1777, §IV.ii.32).

Emergence is also opposed to the thesis ('Humean supervenience') that all the properties of wholes are determined by the local intrinsic properties of micro parts. Emergentists thus reject (what have been variously labeled) materialistic, mechanistic, reductionistic, physicalistic or particularistic conceptions of complex systems. Again, quoting Lovejoy:

*The doctrine of particularism:*⁸ (a) [T]he conception ... of natural events as combinations or rearrangements⁹ of relatively simple, preëxistent entities, of which the total number or quantity remains invariant, and of each of which the qualities and laws of action remain the same through all the combinations into which it may enter. . . . (b) in this second form¹⁰ the preformationist assumption implied a program of reduction or simplification; it. . . means learning to see in the complex nothing but its beggarly elements—the meager qualities and limited repertoire of the simple, merely multiplied a certain number of times. (1927, 20-1)¹¹

In part (a) of this quote Lovejoy explicates the metaphysical view that will form the particularist's core metaphysical thesis; in part (b) he points to a reductive explanatory methodology which naturally accompanies that metaphysical view.¹² Emergence is tied with the denial specifically of the metaphysical view first explained, but will (on realist conceptions of explanation) find natural ties with the denial of a universalistic reductionist methodology as well.

⁸ Lovejoy calls what follows the doctrine of *physicalism*. I have changed the name because 'particularism' is an apt phrase to describe the metaphysical claim indicated in part (a). As we will see below, it is an open question whether or not emergentist doctrines are 'physicalist' or 'materialist', and so these descriptions of the opposition would be inapt. 'Reductionist' may seem to indicate an explanatory tendency (although it also has a central metaphysical sense) and may for that reason be more misleading than 'particularism'.

⁹ A proper understanding of the phrase 'combinations or rearrangements' in this definition is crucial to marking off Lovejoy's intended meaning. Emergentists distinguish between properties of wholes that are 'merely resultant' and those properties that are genuinely ontologically emergent. Lovejoy's indication that the physicalist (or, as I am calling her, the particularist) accepts all natural events as 'combinations or rearrangements' of lower-level entities indicates, for him, that while the particularist need not accept that all properties of wholes are properties of parts, all properties of wholes are 'merely resultant' upon the combinations and rearrangements of those parts. I make this distinction clear below.

¹⁰ The first form of the preformationist assumption was a theological or supernaturalistic version which stated that there must be in the First Cause (i.e., God) of the universe all the perfections of the universe.

¹¹ For a contemporary formulation of the metaphysical (rather than methodological) doctrine expressed here, see David Lewis' conception of 'Humean supervenience' in his (1986b, pp.ix-x). Richard Healey's definition of particularism (1991) is a stronger notion; the weakest forms of ontological emergentism are compatible with Healey's particularism.

¹² This explanatory methodology is well described as 'extreme analytical reductionism' by Mayr (1982, 61). See also Richard Healey's definitions of explanatory reductionism (1991, 398-9).

With this notion of the opposition to emergence, we may define a core conception of metaphysical emergence — following Lovejoy — as the denial of the particularist's metaphysical thesis.

Quoting again:

The core sense of emergence: [The general notion of emergence] may be taken loosely to signify any augmentative or transmutative event, any process in which there appear effects that, in some one or more of several ways yet to be specified, fail to conform to the maxim that 'there cannot be in the consequence anything more than, or different in nature from, that which was in the antecedent'. (1927, 20-1, 22)^{13 14}

This general notion of emergence can get cashed out in a number of different ways.

6.7. Epistemological emergence.

As originally formulated¹⁵ emergence was often explained by claiming that emergent properties were 'not deducible' from complete knowledge of base properties in structures unlike those in which the alleged emergent properties were found. Largely as a result of this formulation of the doctrine of emergence, there has arisen a history of treating doctrines of emergence as making epistemological claims about our epistemic limitations rather than principled ontological claims. Here is the definition of 'epistemological emergence' given by Silberstein and McGeever:

A property of an object or system is epistemologically emergent if the property is reducible to or determined by the intrinsic properties of the ultimate constituents of the object or system, while at the same time it is very difficult for us¹⁶ to explain, predict or derive the property on the basis of the ultimate constituents. (1999, 186, see also 182)

The idea behind so called 'epistemological emergence' is that from the fact that we cannot deduce the existence of the emergent property from its base properties it does not follow that it *cannot* be so deduced by a being (perhaps God) with superior knowledge or capacities. That we cannot discover the deduction

¹³ Jaegwon Kim says, "At the core of these ideas was the thought that as systems acquire increasingly higher degrees of organization complexity they begin to exhibit novel properties that in some sense transcend the properties of their constituent parts, and behave in ways that cannot be predicted on the basis of the laws governing simpler systems." (1999, 3)

¹⁴ I provide a more formal definition of this core sense of emergence below, see p. 58.

¹⁵ See especially C.D. Broad (1925).

¹⁶ Mark Bedau makes more precise what it means for it to be 'very difficult for us' to explain such events in his endorsement of a weak (epistemological) form of emergentism in his (1997).

does not entail that the deduction does not exist or even that it cannot be found. Nevertheless, Silberstein and McGeever's definition is ambiguous in at least three ways.

First, it needs to be made clear that an epistemological emergentist *denies* the stronger claims of the ontological emergentist and wants to deflate those ontological claims. According to the epistemological emergentist, our inability to reduce or explain emergent properties in terms of their basal conditions indicates a failure in *us* and *not* a failure of reducibility or explicability in principle. Second, there is a sense in which ontological emergentists are emphatic *not* to deny that emergent properties are 'determined by' their basal conditions; claims of ontological emergence are even compatible with the claim that the behavior of wholes with emergent properties is *wholly* determined by the laws governing the behavior of the elements in the basal conditions. This phrase is therefore both insufficient to distinguish ontological from epistemological emergence and gives the misleading impression that 'upward determination' is something ontological emergentists wish to deny. This is simply false. Finally, there are multiple notions of reduction at play in the philosophical literature, and on some of them ontological emergentists will accept that emergent properties are reducible while on other (stronger) notions they will deny this claim. In our finished definition of epistemological emergence, then, we must indicate that there is some suitably strong sense in which emergent properties are not reducible.

We may therefore offer the following definition of the doctrine of epistemological emergence.

Epistemological emergence: The doctrine that the claims of metaphysical particularism are true, combined with the claim that there exist (or may exist) complex systems for which it is very difficult — perhaps even impossible — for us to discover how the properties of those systems can simply be rearrangements or recombinations of lower-level properties and entities.

This definition captures the core claims of the epistemological emergentist: the positive claim that the particularist's metaphysics is correct, and the negative claim that for merely epistemological reasons we may not be able to see *that* it is correct in particular instances.

While I introduced this section by noting that doctrines of epistemological emergence can find historical roots in Broad's claims that emergent properties are not 'predictable' or 'deducible' from base conditions, I believe that there are legitimate historical grounds to take such doctrines not to reflect the spirit of emergentism as originally formulated in the works of Broad, Lovejoy and Morgan, and I believe

that much terminological confusion would be avoided in philosophical discussion if such a doctrine were not labeled a doctrine of 'emergence' at all.¹⁷ Genuine doctrines of emergence have always been linked to ontological claims about the existence of fundamentally novel kinds of entities and powers in the world,¹⁸ and it can only breed unnecessary confusion to label a deflationary physicalistic view a doctrine of 'emergence' at all.¹⁹ The doctrine of emergence advocated in this chapter is a stronger, ontological version of the doctrine that is more faithful to the intent — if not some understandings of the words — of its originators.

6.8. Ontological emergence.

According to the weakest version of the ontological doctrine of emergence, physical systems give rise to *novel* properties because of the causal powers of the subcomponents of those systems as they express themselves in complex systems. Views committed to emergent novelty are neutral over whether or not these novel properties have novel causal powers. Stronger versions claim that the properties have new causal powers, and even stronger versions may claim that these novel causal powers give rise to regularities in the behavior of systems which may be captured in laws. Weaker versions, however, are compatible with an 'epiphenomenalism' about emergent properties on which genuinely emergent properties exist but do no work in the causal structure of the world.

Clearly if we are to understand these doctrines of emergence we need to understand both what emergentists claim in saying that novel properties arise, and how novel properties could have causal influence. I take these issues up in turn before pulling together the results of our investigation of emergence.

¹⁷ For an example of such a doctrine, see Bedau (1997).

¹⁸ Kim (1999) is particularly clear on this very point.

¹⁹ Nothing in this chapter rests on the truth of this claim about the historical origins and proper use of the term 'emergence'. I raise it here only to explain (not to justify or defend) my restriction of uses of the term to doctrines of ontological emergence.

6.8.1. Novelty.

The novelty of emergent properties is directly related to Lovejoy's claim that emergent properties confute the preformationist assumption (which he associates with reductionistic physicalism) that 'there is no more in the effect than in the cause'. Emergent properties add to the ontological richness of the world. Taking the idea that emergentism is defined by the view that a whole is more than the sum of its parts, we may suppose that we can understand emergent novelty along these lines.

Additivity: A property F is an additive property if it is a property of a complex system S composed of parts and properties $P_1...P_n$ and none of $P_1...P_n$ has F .²⁰

Thus, my weighing 205 lbs. is additive: it is a property of a complex physical system composed of parts none of which weigh 205 lbs. Likewise, I am 6' tall despite the fact that none of my component parts has a length of 6'. My height and weight, then, are paradigm additive properties.

Additivity is not strong enough to capture the ontological emergentist's intended notion of novelty however. These paradigm properties are fully explicable in the strongest reductivist sense: my being 205 lbs. is my being composed of parts the sum of whose weights is identical to 205 lbs. My height and weight are not identical to the length or weight of my parts, but they are identical to the lengths and weights taken aggregatively. There is a clear sense, then, in which these properties of mine are nothing new, ontologically speaking, in the inventory of the world; they are not *genuine* novelties but merely 'resultant' properties. Our task is to distinguish between two types of additive properties: those that are merely resultant and those which are genuine novelties.

This task brings us to foundational and hotly disputed issues in metaphysics. Since novel properties in the emergentist's sense are properties of complex physical systems which arise from and are dependent upon the actions and interactions of component parts and properties, we need a distinction

²⁰ My use of the term 'additive' has historical links to early emergentists' explications of what it was for a property to be 'merely resultant' rather than truly emergent. As numerous commentators have pointed out, however, it is unclear that *additivity* can adequately explain the emergentist's notion of a merely resultant property. I have therefore here defined a property as 'additive' not in terms of its being the 'sum' of properties of parts (although the examples I have chosen are particularly well suited to this) but as a general explication of the motto that wholes are 'more than the sum of their parts' — something is added when we bring the parts together. This general notion is refined below in my definition of novelty, which in turn yields an adequate definition of a property which is merely resultant. In my terms, both novel and merely resultant properties are types of additive properties.

(roughly) between the properties and relations which characterize components *in themselves* and those that characterize the system as a whole. Let us therefore intuitively explain the 'basal conditions' of a complex whole which may (or may not) give rise to novel properties following Richard Healey.

*Basal conditions:*²¹ The basal conditions of a complex thing "include just the qualitative, intrinsic properties and relations of the parts, i.e., the properties and relations that these bear in and of themselves, without regard to any other objects, and irrespective of any further consequences of their bearing these properties for the properties of any wholes they might compose." (1991, 401)

As Healey notes, it is surprisingly difficult to give precise formulation to this characterization of the 'intrinsic' properties and relations of parts — those they bear 'in and of themselves'.²² Nevertheless, our preanalytic understanding of the notion is strong and fundamental enough to warrant our employing it.

With this notion of basal conditions in hand, then, we may define a genuinely novel property as follows.

Novelty: A property P of a complex physical entity E of type T , where entities of type T possess basal conditions B composed of parts, properties and relations $b_1...b_n$, is *novel* if and only if (i) P depends causally for its existence on the interactions of $b_1...b_n$,²³ and (ii) P is *irreducibly different in kind* from the kinds of properties and relations had by the component parts $b_1...b_n$ of the basal conditions B as they appear independent of their composing entities of type T .²⁴

This definition requires a good deal of unpacking.

The complex description leading up to the definition of novelty indicates (roughly) that emergent properties are properties of complex physical systems which may fall into types identified by the types of

²¹ Healey does not call this an explication of basal conditions but of the 'supervenience basis' of a complex thing. His terminology has the potential to mislead, however, since he desires to remain neutral concerning the question of whether all properties of systems with 'supervenience bases' as explained here actually supervene on this base. I have therefore employed the more general term, basal conditions.

²² On this problem, see David Lewis (1983; 1986a).

²³ This qualification is added to Spencer-Smith's definition of novelty. Spencer-Smith defines novelty as follows: "a property P is *novel* in x if x has P , and there are no determinates P' of the same determinable as P , such that any constituents of x have P' ." (1994, 117). Spencer-Smith notes that such a definition allows that *being a word of English* is a novel property of the letters 'n', 'u', and 't', but that these are not the *types* of things which were meant to be emergent properties. Restricting the class of novel properties to those which arise through the causal interactions of sub-components of the systems to which they belong is intended to eliminate this problem.

²⁴ cf. Jaegwon Kim's explication of the notion of novelty: "[The Irreducibility of Emergents] Emergent properties are 'novel' in that they are not reductively explainable in terms of the conditions out of which they emerge" (Kim 1992, 124). Kim's definition is ambiguous in that one might have stronger or weaker conceptions of reductive explanation in mind. On weak conceptions ontological emergentists will accept reductive explanations; on stronger versions they may reject it.

interactions sub-components of the systems enter into. All emergent properties and entities, then, are dependent for their existence on the uniform lawlike natural behavior of the component parts of systems of that type.²⁵

The first clause of this definition states that novel properties in the sense we have in mind are related to their constituent properties through contingent causal relations rather than through necessary logical ties.²⁶ Ontological doctrines of emergence as applied in particular instances are intended to express *a posteriori* empirical discoveries about the causal structure of the world rather than logical, analytical, or strongly metaphysical claims about necessary relations between properties or predicates.²⁷

The basic idea of the second clause is easy enough to understand by pointing to examples, but requires the most unpacking. There are a number of salient examples of debates in philosophy between pluralists about the kinds of things there are in the world and monists who reject ontic plurality. On realistic conceptions of properties, relations and propositions these entities are irreducibly different in kind from physical objects: the former belong to the category of *abstract objects* whereas the latter belong to the category of *concrete objects*, and neither kind can be reduced to the other. Conceptualists reject the appearance of ontic diversity here, reducing properties, relations and propositions to conceptions in the mind (which may be claimed to be further reducible to physical properties and relations). On dualistic conceptions of the mind, mental properties (i.e., qualia and/or intentionality) are irreducibly different in kind from brains or brain states. Reductivist physicalists attempt to reduce the *prima facie* ontic plurality displayed by mental and physical phenomena to a monistic physicalistic ontology. Idealists reduce the

²⁵ In fact emergentists need not be committed to the existence of such lawlike uniformities among basal conditions for emergent properties — they may accept a widely heterogeneous dependency relations between different individual basal conditions and emergent properties which cannot be formulated into lawlike regularities. Despite this possibility, however, the chances seem so remote that emergentists would choose to endorse this as a claim about the actual world that I have formulated the definition as it appears.

²⁶ See Searle (1992) for an expression of this aspect of emergence in the philosophy of mind.

²⁷ As Lovejoy says, "both assertors and deniers of any such hypotheses must address themselves to the analysis of definite empirical data. The assertor must... point out some type of observable entity, even, or quality — call it *E* —... which does not appear adequately describable in the same terms as would describe any entity, even, etc., which we can with probability suppose to have existed in [its constituents outside of structures of the type it currently belongs to]. The denier must attempt to show that everything in *E* is describable in the same terms as some class of entities, events, or qualities in *Ph.A.* [the emergence base]" (Lovejoy 1927, 29).

appearance of ontic plurality to a monistic mentalistic ontology. In the last chapter I argued that teleology was an irreducibly different kind of causal tie than any physical property indicated by contemporary reductivists. Each of these examples illustrates the robust character of widely shared intuitions concerning important ontological differences in kind.

Despite the fact that we have a strong working conception of the distinction between reductivistic and antireductionist theories the issue of when one thing is reduced to another is a vexed one. Given the plurality of different conceptions of reduction which readers may have in mind as they understand this central notion in the emergentist's arsenal, it is imperative that we disambiguate senses of reducibility and clarify in exactly what sense emergentists claim that novel properties are irreducible to basal conditions. The emergentist's claim is distinctive and well defined, but as we will see there are widely shared conceptions of reduction according to which emergentists will be the first to affirm that even properties that are novel in the intended sense are reducible. Much hangs, therefore, on disambiguating and keeping in mind the precise sort of irreducibility emergentists intend.

We are interested here in metaphysical or ontological claims concerning reduction rather than linguistic or explanatory reductions. The core claim of an ontological reduction is the claim that the *prima facie* ontic commitment to *sui generis* entities of type *F* expressed in one type of expression, *E1*, reveals itself upon analysis to commit one to nothing more ontologically than the type *G* ontic commitments of expressions of type *E2*; expressions of type *E2* are perspicuous in revealing ontic commitments whereas *E1* claims mislead about the fundamental ontic inventory of the world.²⁸ Thus, for example, a reductive physicalist claims that mentalistic expressions such as 'I believe *F*' or 'I see an orange after-image' which might seem, *prima facie*, to commit one to a *sui generis* mentalistic ontology of beliefs and after-images in fact express no ontic commitment to anything beyond purely physical entities and properties (or predicates). Idealists believe that expressions such as 'There is a table here now' when properly

²⁸ Thus, Paul Teller (1995), says that reduction is "the replacement of one expression by a second expression that differs from the first in *prima facie* reference" (679). For further preanalytic characterizations of ontological reductionism, see Kim (1999, 15) and Klee (1997, 83).

understood express no commitment to the existence of physical things such as tables but in fact reveal commitment only to ideas.

We may on the basis of this understanding of reduction define a generic notion of reducibility as follows. Supposing that expressions of type *E1* commit one, *prima facie*, to entities of type *F*, where *F* things are *prima facie* distinct in kind from entities of type *G*, then:

Generic reduction (roughly): *F* properties, relations and entities are reduced to *G* properties, relations and entities iff, for each entity *F* there are properties or entities $G_1...G_n$ such that *x*'s being *F* just is *x*'s having $G_1...G_n$ in relation *R*; or, *x*'s being *F* is nothing ontologically over and above *x*'s having $G_1...G_n$ in relation *R*; or, being *F* need not figure as an independent existent in a complete ontological inventory of the world.

This generic notion of reduction admits of a plurality of understandings depending on how one understands what it is for one thing to 'just be' or 'be nothing over and above' another. These distinct understandings form distinctive conceptions of reduction.

As I mentioned above, it is crucial that we distinguish these forms of reduction because the sense in which the emergentist is committed to novel (i.e., roughly *irreducible*) properties hangs entirely on this. In fact, on all but the strongest conceptions of reduction it turns out that the emergentist's conception of ontological novelty is compatible with reductionism. Here I list a number of conceptions of reduction, roughly in ascending order of contemporary use, all of which are compatible with the emergentist's claim that there exist genuinely novel properties in at least some complex physical systems.

Reduction by coextension: Properties or entities of type *F* are reduced to properties or entities of type *G* iff, for each property or entity *F* there are *G* properties or entities $G_1...G_n$ such that *x* is *F* if and only if *x* has $G_1...G_n$.

Reduction by necessary coextension: Properties or entities of type *F* are reduced to properties or entities of type *G* iff, for each property or entity *F* there are *G* properties or entities $G_1...G_n$ such that, necessarily, *x* is *F* if and only if *x* has $G_1...G_n$.

Nagelian theory reduction: Properties and entities of type *F*, whose behavior is described by theory *T1* are reduced to properties and entities of type *G*, whose behavior is described by theory *T2* iff, for each property or entity *F* (a) there exists a bridge law such that *x* is *F* if (and possibly only if) *x* has $G_1...G_n$ and (b) the laws relating *F* properties and entities expressed in *T1* are derivable from the laws relating *G* properties and entities expressed in *T2* plus the bridge laws formed in (a).²⁹

²⁹ This formulation of a reductive thesis is derived from Nagel (1961, chapter 11).

Compositional reduction: Properties or entities of type F are reduced to properties or entities of type G iff, for each F property or entity there are physical properties and entities $G_1...G_n$ such that x has F if and only if x is composed of $G_1...G_n$.³⁰

*Metaphysical version of Kemeny-Oppenheim reduction:*³¹ Properties or entities of type F are reduced to properties or entities of type G iff, for each property or entity F there is a theory T of the behavior of G properties and entities $G_1...G_n$ such that T describes the microcausal mechanism for the implementation of F in entities such as x .³²

I will discuss these notions as applied to emergent novelty in turn.

Reduction by coextension and necessary coextension are infrequently employed in discussions of ontological reduction, and have found their natural home in discussions of mathematics, logic, and language. The notions are frequently thought to be too weak to effect true reductions; it seems that there is a clear sense in which even cross-world correlation between entities does not entail that one entity 'just is' the other in any robust sense. $1+1=2$ and $2+2=4$ make quite distinct claims despite the fact that they are true of the same set of possible worlds (all of them). Kidney bearing and heart bearing animals may be coextensive across nomologically possible worlds, but it is even clearer in this case that being a creature with a kidney is something different from being a creature with a heart. Likewise, emergentists may acknowledge and even emphasize that novel emergent properties are coextensive with basal conditions across nomologically possible worlds without giving up the claim that the purported novel properties constitute a distinct ontic type from the basal conditions and properties.

Emergent novelty is similarly compatible with Nagel's account of theory reduction. As Jaegwon Kim (1992, 125-6; 1998, 25-7 and 95-7; 1999, 12) observes, emergentists need not deny that Nagelian

³⁰ As metaphysically weak as this notion appears, it seems to be a notion of reduction with wide acceptance. Thus, Paul Teller says, "In most and quite possibly all cases of putative theory reduction by strict identities, we have instead a relation of *physical realization*, constitution, or instantiation, nicely illustrated by the property of being a calculator. . . . [Which can be realized] by indefinitely many ... physical arrangements. Perhaps many who have used 'reduction', particularly in the sciences, have intended the term in this sense of physical realization rather than one of strict identity" (1995, 680). This is consistent with Mayr's notion of constitutive reduction, see (1982, 60).

³¹ Kemeny and Oppenheim introduce an epistemological account of reduction in their (1956). The account is roughly along the following lines:

Kemeny-Oppenheim explanatory reduction: Properties or entities of type F are reduced to properties or entities of type G iff, for each property or entity F there are G properties or entities $G_1...G_n$ such that if x is F then x 's possession of $G_1...G_n$ explains x 's being F .

³² This metaphysical version of Kemeny-Oppenheim reduction derives from reflection on Kim's metaphysical explanation of the realization relation in response to an explanatory definition of that relation in his (1993).

bridge laws between basal conditions and emergent novelties exist,³³ and neither (for that matter) must Cartesian dualists.³⁴ Bridge laws express correlations between properties or entities, but just as coextension is too weak to give us reduction so the existence of bridge laws from one domain to another is too weak to indicate that purported emergent novelties are nothing ontically over and above the properties and entities with which they are correlated. Correlation will not yield meaningful reduction, but of course if Nagelian reduction is what a philosopher has in mind by 'reduction' then the emergentist need not deny and may positively affirm that (in this sense, as in others) emergent novelties in her sense *are* reducible to basal conditions.

It is apparent from the literature that compositional reduction is an extremely popular notion of reduction³⁵ even though the correct understanding of composition is (as with so many issues at this level of metaphysical scrutiny) a vexed issue in itself.³⁶ Intuitively, if *CB* composes *E* at *t* then the identity conditions of *E* are distinct from those of *CB*. *E* may survive the loss at *t+Δt* of certain parts of *CB* while *CB* will not survive that loss. Further, if *E* is composed of *CB*, then *CB* is not composed of *E*, although if *E* is composed of *CB* and *CB* is composed of *CB'*, then *E* is composed of *CB'*. This is to say that our intuitive notion of composition is the notion of a relation which is asymmetric and transitive, and less strong than identity understood in terms of Leibniz' law.³⁷

But this is enough to see that emergentists can accept and even affirm the claim that emergent novelties (in their sense) are compositionally reduced to their basal conditions. Indeed, much of the

³³ Kim says, "If, however, all that reduction had to accomplish were this sort of nomological derivation, the emergentists would not necessarily have resisted the idea of reducing consciousness to neurobiological processes, or biological phenomena to physicochemical phenomena. . . . The emergentist could cheerfully admit all this [i.e., all that is required for Nagelian reduction], but at the same time deny that a mere logical exercise of this sort, *based on brute and unexplained correlations between emergent and basal properties*, affords us an understanding of the nature of the emergents." (1992, 125-6).

³⁴ To point this out is not, of course, to equate the doctrines or commitments of emergentists and Cartesian dualists. I mean simply to point out how little about one's ontology follows from accepting a Nagelian reduction — if Nagelian reduction is compatible with Cartesian dualism, then it appears a rather weak and benign form of reduction.

³⁵ See, for example Teller (1995, 680), Mayr (1982, 60-1), and Dobzhansky, Ayala, Stebbins, and Valentine (1977, 488-9).

³⁶ On this issue see Wiggins (1980), Lowe (1989) and Doepke (1982).

motivation for emergentism as a 'middle way' between physicalism and other dualisms such as the 'pre-established harmony' theory³⁸ is to capture a strong sense in which emergent novelties are dependent upon the existence of complex physical objects, and the affirmation of compositional reducibility plays an important role in emphasizing this aspect of the emergentist's position. Still, given that composition is weaker than identity clear sense can be made of the emergentist's claim that the purported emergent novelty is nevertheless ontically distinct from its basal conditions.

The metaphysical version of Kemeny-Oppenheim reduction is an enrichment of compositional reduction to the effect that we have not effectively compositionally reduced one kind of entity to another until we have a well-confirmed microcausal theory of base entities that explains their composition of the higher level properties. Thus, on this conception we have not properly reduced water to H₂O until we have a theory explaining the microcausal means by which groups of H₂O molecules give rise to the properties of water (its wetness, its boiling point, etc.).

Again, however, emergentists need not fear and may positively endorse the search for this type of a reductive account of emergent novelties. They may affirm the existence of causal correlations between basal conditions and emergent properties strong enough to support the formulation of laws and theories that microcausally explain the emergence of emergent novelties.³⁹ Nevertheless, there remains clear sense to the emergentist's claim that having a well confirmed explanatory theory of how *Xs* give rise to *Ys* does not entail that *Ys* are 'nothing over and above' *Xs*. *Ys* may still constitute a genuine — and in a sense still to be defined an *irreducible* — addition to the ontology of the world conceived only in terms of the *Xs*.

We come finally to the sense in which emergentists are committed to the claim that emergent novelties are irreducibly different in kind from their basal conditions.

³⁷ See Lowe (1989, 81).

³⁸ The pre-established harmony theory is defined by the thesis that mind and body are distinct substances or have distinct types of properties, but that these distinct kinds do not causally interact. Instead, they are like two perfect timepieces set to march in step at one initial moment and marching on in harmony for eternity. Leibniz held a view of this sort.

³⁹ This fact is widely noted in the literature on emergentism. See Kim (1999, 8).

Reduction by property identity: Properties or entities of type F are reduced to properties or entities of type G iff, for each property or entity F there are physical properties or entities $G_1...G_n$ in relation R such that being F (for xs) is identical to being $G_1...G_n$ in relation R (for xs).

That this is the 'proper' sense of reduction — the inevitable limit on all reductivist theories — makes sense because we have finally arrived at the strict sense (identity) in which one thing can *just be* another as required by the preanalytic or generic notion of reduction. Temperature (in ideal gases) has in this sense been reduced to and is thus identical to the mean kinetic energy of constituent molecules. Likewise, temperature (in a vacuum) is the blackbody distribution of the vacuum's transient radiation.⁴⁰

Jaegwon Kim (1999) offers one analysis of necessary and sufficient conditions for obtaining this type of strong reduction. According to Kim, it is necessary and sufficient (as a first 'philosophical' step, the rest of the work coming in the construction of scientific theories, see p. 18) to effect a reduction by property identity that the property to be reduced be given a functionalized definition in terms of causal/nomic relations between basal conditions.⁴¹ If E is to be reduced to B , then

E must be functionalized — that is, E must be construed, or reconstrued, as a property defined by its causal/nomic relations to other properties, specifically properties in the reduction base B . (10)

Once being E has been identified with a set of causal/nomic relations between entities and properties in the reduction base B , further scientific work along the lines indicated in the metaphysical version of Kemeney-Oppenheim reduction is necessary to explain how it is that B gives rise to E . Nevertheless, on Kim's account the viability of the reductive analysis stands or falls on the property identification made at the functionalization stage.⁴²

A candidate emergent property qualifies as a genuine emergent novelty if and only if it is not identical in kind to a kind of property which can be had by the component parts of the system from which it emerges in isolation from structures that type. Clearly emergentists will have 'knock down'

⁴⁰ These examples are from Churchland (1988, 41-2). See also Teller (1995).

⁴¹ This idea has obvious affinities to other conceptions of reduction. Nagel's bridge laws and definitions play a similar role in his account of theory reduction. When we understand coextensiveness claims as claims about sameness of meaning, we can see that reductivist claims concerning the coextension are also closely tied with the step Kim explains here.

⁴² Kim also discusses this notion of reduction in his (1998): see especially pp. 24-5 and 98. David Chalmers invokes the same claims for what he calls 'explanatory reduction' in his (1996): see esp. pp.43-5 and 51.

arguments against the possibility of such reduction in only extremely rare cases.⁴³ More frequently emergentists will argue for the novel status of properties on the basis of systematic patterns of failure in historical attempts to give reductive analyses and by reference to distinctive properties of the purported emergent (such as normativity, intentionality, or first-person availability) which seem to drive our preanalytic intuition that properties of type *F* are distinct in kind from properties of type *G*.

I argued for the *sui generis* irreducible status of teleology using this method in chapter five. That investigation relied on arguments concerning the categorial properties of teleology and brought to light features such as teleology's normativity which appear to resist satisfactory reductive analysis. Such arguments for the *sui generis* irreducible status of purported emergent novelties cannot rule out or address future reductive analyses, but they can make the claim of irreducible novelty plausible and intelligible. This section's analysis of the notion of irreducibility invoked by the emergentist shows, further, that the notion of irreducibility involved is perfectly understandable and well motivated in light of other, weaker, notions of reducibility.

With this understanding of reduction, we may reformulate our definition of novelty, specifying the sort of reduction emergentist's deny of genuinely emergent properties. The definition which results from our discussion of forms of reduction will also yield a definition of being a merely resultant property. Our foray, then, has clarified the distinction ontological emergentists draw between those additive properties which are merely resultant and those which are genuinely emergent.

*Novelty**: A property *P* of a complex physical entity *E* of type *T*, where entities of type *T* possess basal conditions *B* composed of parts, properties and relations $b_1...b_n$, is *novel* if and only if (i) *P* depends causally for its existence on the interactions of $b_1...b_n$, and (ii) *P* is *irreducibly different in kind* from the kinds of properties and relations had by the component parts $b_1...b_n$ of the basal conditions *B* as they appear independent of their composing entities of type *T*; that is, (ii') *P* cannot be reductively identified with any of the kinds of properties and relations had by the component parts $b_1...b_n$ of the basal conditions *B* as they appear independent of their composing entities of type *T*.

Mere resultants: A property *P* of a complex physical entity *E* of type *T*, where entities of type *T* possess basal conditions *B* composed of parts, properties and relations $b_1...b_n$ is *merely resultant* if and only if it is additive but not novel.

⁴³ George Bealer's argument for *ante rem* universals in (1993b) may be one such case. Of course, even 'knock down' arguments such as this one have presuppositions which may be denied by committed opponents.

These definitions make clear sense of the emergentist's claim that there is a distinction between those additive properties such as weight and height which are merely resultant and those properties which are genuine additions to the ontology of the world as it would be restricting our view to the ontology sufficient to account for entities of the same type as those in the basal conditions outside of entities of some complex types. My weight is reductively identifiable with (and not merely composed of, or realistically explicable in terms of, or associated by bridge laws with) properties of my parts, and therefore while my weight is an *additive* property (it is not possessed by any of my parts), it is *merely resultant*. A plausible candidate for an intuitive property of me which is additive and novel is the mental property of *seeing red*. If certain arguments for the irreducibility of qualia in the philosophy of mind are correct, then we have here a property which is, by the analysis given, an emergent novelty. This example will be acceptable to those who consider themselves property dualists or nonreductive physicalists in the philosophy of mind, and intelligible even to opponents.

So much for ontology. Methodologically, we discover differences between *kinds* of properties through engaging in analysis that will — typically — involve investigating superordination, subordination, exclusion and inclusion relationships between the concepts we use and their corresponding properties. I have no theory of categories to guide us in determining in every case when we have properties of irreducibly different kinds and when we do not. Nevertheless, categorial and identity intuitions about properties are quite robust; to pick one particularly clear example physicalists, dualists and idealists alike are *emphatic* and consistent in the view that if mental properties turn out not to be reducible or eliminable, then physicalism is either false or vacuous.⁴⁴ This firm bar of the irreducibly mental from physical ontology displays the sort of categorial intuition I have in mind to discover as we seek reductive analyses for purported emergent novelties. Again at a highly theoretical level, Gettier examples are used widely

⁴⁴ The doctrine is false if (as seems right) *sui generis* mental properties are not physical properties, vacuous if we simply expand our conception of the physical to embrace *sui generis* mental properties. One need not read far in the literature on physicalism to find the negative constraint on possible physicalist theories. For a theoretical discussion, see Crane and Mellor (1990).

and widely taken to show that knowledge is not identical to justified true belief.⁴⁵ Further examples are legion in philosophy.

In chapter five I appealed to intuitions about such relations in claiming that *ideas* are of such a kind/category that they cannot sleep; *numbers* are of such a kind that they cannot be tall; *teleology* is of such a kind that it cannot be a historical property; etc. By contrast, triangles and squares are of the same kind, they are both determinates of a determinable, *geometrical object*; red and blue are of the same kind, *color*; mass and extension are of the same kind, *physical properties*; etc. In typical cases such judgements of sameness and difference in kind will not be supported by categorial theory but instead by a rich web of interconnected intuitions concerning subsumption, superordination, exclusion and inclusion relations between the concepts used to pick out the entities in question.

Obviously we will only be able to determine whether putative novel properties are genuinely novel in the intended sense through investigation of particular cases. Still, I have gestured in the preceding paragraphs toward a typical and traditional method that such investigations employ and gave an extended example of such methods at work in chapter five. Allegedly emergent properties will be novel if and only if they turn out after analysis to be irreducibly different in kind from the kind of properties belonging (independently) to their emergence base, or equivalently, if and only if they turn out to be identical to no property or range of properties of the type found in the emergence base.

Our second task, to which we now turn, is developing an understanding of how it is that emergent properties can have genuine causal influence.

6.8.2. Emergent causal influence.

Weak versions of ontological emergence require only that properties that are novel in the sense described above emerge from the interactions of entities at lower ontological 'levels' in certain circumstances. Such versions of emergence are compatible with an epiphenomenalism about emergent properties such that emergent properties have no causal influence in the proceedings of the world. However, these versions of ontological emergence will be too weak for the purposes of chapter six; the

⁴⁵ This example is employed to much the same effect by Bealer (1992; 1999).

goal of that chapter was to gain an understanding of how *sui generis* Aristotelian final causality can be causally efficacious in the physical world. We cannot, therefore, rely on weak versions of ontological emergence that are consistent with epiphenomenalism, but must seek a stronger version of ontological emergence such that physical structures may have novel properties with emergent causal powers.

There exist a number of models for understanding the emergence of 'downward causal influence'. Let us say that a level of types of properties and relations *L1* is a 'higher' level of properties and relations than a level *L2* just in case properties and relations in *L1* are had by entities composed of properties and relations at level *L2*.⁴⁶ The claim to be understood, then, is that at least in some cases novel and genuinely emergent properties — properties existing at a higher level than their basal conditions — exert a causal influence on the course of events at the level of their compositional parts.⁴⁷

48

Timothy O'Connor takes the metaphor of 'downward' causation very seriously in his discussion of the issue. Here is his description of the process.

[The phrase 'novel causal influence'] is intended to capture a very strong sense in which an emergent's causal influence is irreducible to that of the micro-properties on which it supervenes: it bears its influence in a direct 'downward' fashion, in contrast to the operation of a simple structural macro-property, whose causal influence occurs *via* the activity of the microproperties that constitute it. Of course, if we take emergents to be a species of supervenient properties, as I have suggested, then the continuing instantiation of the emergent property is completely dependent upon some set of properties or disjunctive ranges of properties in the object's microstructure. Nonetheless, it exerts a causal influence on the micro-level pattern of events that is not reducible to the *immediate* causal potentialities of the subvening properties. (1994, 97-8. Emphasis in the original)

⁴⁶ See Humphreys (1995, 108).

⁴⁷ Emergent properties may presumably also exert 'same level' and 'upward' determinative influence, but neither of these causal relations is controversial; the only substantive question involved is the question of the possibility of downward causal influence.

⁴⁸ According to Paul Humphreys, whose primary concern is not to argue that particular properties such as consciousness or teleology are emergent and have downward causality but rather that such causal influence is coherent, one coherent form of downward causal influence would be exerted if entities at higher levels were physical (not logical) *fusions* of lower level entities and processes. In his view, physical processes may cause properties which previously existed independently to become fused, losing their independent identity and forming a new, higher-level entity in which the component parts lose their independent identity. In such a situation, the higher-level entity would be composed of entities that no longer maintain an independent existence and the higher-level entity would have causal powers all its own that would not be reducible to the causal influence of its component parts. (See especially Humphreys (1996, 59-62) and (1997b, §5); see also Silberstein and McGeever (1999, 189).) While this model for understanding downward causal influence may show the notion to be coherent, it does not appear readily applicable in the context of a modern scientific ontology to the case I am interested in — the emergence and downward causal influence of *sui generis* teleology — and so I will move on to other models.

On this view, higher order emergent properties exert causal influence which is all their own by changing micro-level relations in their emergence base. These changes are not causally explicable in terms of the causal story applicable to the base properties and entities in isolation from their membership in systems of the type of which they are currently members.⁴⁹ Nevertheless, as O'Connor's account makes clear, the emergent properties all along retain their causal dependence upon their emergent base. We could think of a horse (emergence base) and its rider (emergent downward causal influence) as a rough analogy. Although the rider depends for her remaining upright on the actions of the horse, the rider is also able to effect the course of events at the level of the horse.

William Hasker takes issue with this sort of picture of downward causation. On his view, O'Connor's type of account takes the metaphorical 'downward' of 'downward causation' too literally, and the notion must be replaced by a more moderate conception of emergent causation. In Hasker's view,

to say that the higher levels causally affect the lower levels can only mean that, because of the specific sort of organization and integration involved, the *behavior of the fundamental elements* is different than it would be if those elements continued to be governed by the old, non-emergent laws. (1982, 184. See also pp. 185 and 175-6)⁵⁰

It is less than clear, however, on what basis Hasker objects to the view O'Connor holds. Hasker clearly believes that the view is in danger of giving the wrong impression that downward influence will be exerted without change in lower level laws or behaviors, thus encouraging the view that the two sorts of causal powers are involved in competition such that they must 'push each other around' (the metaphor is Sperry's, see Hasker 1982, 184). While it seems appropriate to warn against viewing the relations in this way, I do not see that O'Connor's view is committed to the competitive view in any way.

I prefer, therefore, to retain O'Connor's description of the action of downward causal influence, which is at least compatible with Hasker's. In downward causation, emergent properties with novel

⁴⁹ This, at any rate, is how I understand O'Connor's claim that emergent causal influence is not mediated 'via' the influence of lower level properties and entities, and that it is not the 'immediate' causal properties of those lower level entities that explain the emergent's causal powers. Epistemic emergents (to continue to employ the term) have causal powers that *are* explicable via the immediate causal powers of microcomponents; these explanations are simply unavailable to us given our cognitive limitations.

⁵⁰ Cf. Jürgen Schröder's definition of downward causation: "Downward causation is the influence the relatedness of the parts of a system has on the behaviour of the parts. It is not the influence of a macro-property itself, but of that which gives rise to the macro-property, *viz.*, the new relatedness of the parts" (1998).

powers exert a causal influence over the course of events in an emergence base which is not explicable in terms of the laws governing those base entities and properties in other contexts. I prefer this way of speaking of downward causation over Hasker's for the simple reason that it emphasizes the causal role of the higher-level property rather than the causal interactions and powers of the emergence base.⁵¹ On a correct understanding, both sorts of causal influences are at play, but it is, after all, the causal powers of the emergent properties which constitute our focus.

It may be objected, of course, that all we have described in a case of purported downward causation is a situation such that

the physical particles or structures involved [in the complex structure] must have possessed beforehand what we may call the 'disposition' or 'possibility' or 'potentiality' or 'capacity' for producing the new properties [and their causal powers], under appropriate conditions. (Popper and Eccles 1977, 23)

As C.D. Broad expresses the point, we may surely say that the emergence base had the *latent* potential for these powers (1918-19, 114). The point of the objection is to question whether the causal power in question is best described as the exertion of a genuinely novel power by a higher level property; it is not to question the coherence of there being new forms causal dependencies which come into play only in certain types of highly complex physical systems.

Broad's response to this objection is the appropriate one.

There is no objection to this mode of expression so long as we remember that it *is* purely verbal, and that it does not alter the fact that some part of the behaviour of the second order complex could be neither deduced nor suspected from a knowledge of the behaviour of its parts in other surroundings. (1918-19, 114)

Ignoring the misleading epistemological verbal trappings of Broad's response,⁵² the response reminds us that emergent causal influence is a result of *two* factors. There can be no objection to claiming that emergent properties in the sense intended are 'latent' in the emergent base so long as we bear in mind that the emergent properties are of an irreducibly distinct kind from the properties possessed by the

⁵¹ This conception of downward causal influence also seems faithful to the notion developed historically by Broad; see his (1918-19; 1925).

⁵² On this point see above, p. 40 ff.

physical base in other circumstances — the properties which are causally responsible are *novel* in the sense explained in the previous sub-section.

Noting that emergent powers were 'latent' in the base, then, is a purely verbal move which establishes no substantive reductionistic theses, and it is harmless *unless* it makes us forget that the new causal powers are supposed to be had by properties of a genuinely novel ontological sort. Indeed, so long as we avoid this mistake, speaking of emergent causal powers as powers which are latent in an emergent base is positively welcome in that it highlights a portion of the emergentist's claims which may be overshadowed in discussions of novelty and downward causation. It is a fundamental claim of emergentists, recall, that emergent properties and their powers are causally dependent upon the interactions of base properties and entities, and talk of the 'latent powers' of these base properties and entities highlights exactly this aspect of the emergentist's position.

6.9. Conclusion, summary, and definitions.

In the preceding sections I have developed an ontology for the physical world in which *sui generis* Aristotelian teleology may find a home. On the ontological view I have explained, there is room for *sui generis* Aristotelian teleology in a scientifically acceptable view of the world so long as our ontology allows for emergent properties with novel causal powers. To explain this view, I have distinguished the following notions, the last three of which appear here for the first time.

The core sense of emergence: A property P of a structure X with components $a_1...a_n$ is emergent if and only if (i) P depends causally for its existence on the interactions of $a_1...a_n$ in X and (ii) P augments the ontology of the world — P is not 'contained in' the properties of $a_1...a_n$ in their interactions outside of structures of the same type as X .

Metaphysical particularism: [T]he conception ... of natural events as combinations or rearrangements of relatively simple, preëxistent entities, of which the total number or quantity remains invariant, and of each of which the qualities and laws of action remain the same through all the combinations into which it may enter. (Lovejoy 1927, 20-1)

Epistemological emergence: The doctrine that the claims of metaphysical particularism are true, combined with the claim that there exist (or may exist) complex systems for which it is very difficult — perhaps even impossible — for us to discover how the properties of those systems result from the rearrangement or recombination of lower-level properties and entities.

Basal conditions: The basal conditions of a complex thing "include just the qualitative, intrinsic properties and relations of the parts, i.e., the properties and relations that these bear in and of themselves, without regard to any other objects, and irrespective of any further consequences of their bearing these properties for the properties of any wholes they might compose." (Healey 1991, 401)

Additivity: A property F is an additive property if it is a property of a complex system S composed of parts and properties $P_1...P_m$ and none of $P_1...P_n$ has F .

*Novelty**: A property P of a complex physical entity E of type T , where entities of type T possess basal conditions B composed of parts, properties and relations $b_1...b_n$, is *novel* if and only if (i) P depends causally for its existence on the interactions of $b_1...b_n$, and (ii) P is *irreducibly different in kind* from the kinds of properties and relations had by the component parts $b_1...b_n$ of the basal conditions B as they appear independent of their composing entities of type T ; that is, (ii') P cannot be reductively identified with any of the kinds of properties and relations had by the component parts $b_1...b_n$ of the basal conditions B as they appear independent of their composing entities of type T .

Mere resultants: A property P of a complex physical entity E of type T , where entities of type T possess basal conditions B composed of parts, properties and relations $b_1...b_n$, is *merely resultant* if and only if it is additive but not novel.

Weak ontological emergence: A property P of a structure X with components $a_1...a_n$ is *weakly ontologically emergent* if, and only if P is novel*.

Strong ontological emergence: A property P of a structure X with components $a_1...a_n$ is *strongly ontologically emergent* if and only if (i) P is novel* and (ii) P has causal powers which are absent from $a_1...a_n$ and their interactions independently of entities of the same type as X .

Nomic strong ontological emergence: A property P of a structure X with components $a_1...a_n$ has *strong nomic ontological emergence* if and only if (i) P is novel*; (ii) P has causal powers which are absent from $a_1...a_n$ and their interactions independently of entities of the same type as X ; and (iii) P 's causal powers are formulable into laws of nature.

On the view I hold, *sui generis* Aristotelian teleology needs to be as strong as, but no stronger than, *strong ontological emergence* to have an explicable and scientifically acceptable role in the causal structure of the physical world.

I have argued that there is a perfectly general ontological framework — the framework of emergent properties — in which *sui generis* Aristotelian teleology can find a natural home even in the modern world. Unreduced *sui generis* Aristotelian teleology may be a scientifically respectable part of our ontology of the physical world so long as it is a *strongly ontologically emergent property* in our world.

Bibliography

- Allen, C., and M. Beckoff. 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*. The MIT Press. pp. 571-87. Also reprinted in Buller, David J., ed. 1999. *Function, Selection, and Design*. Albany: State University of New York Press. pp. 243-56.
- Allen, C., and M. Bekoff. 1995. Function, Natural Design, and Animal Behavior. In *Perspectives in Ethology 11: 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: The MIT Press. pp. 1-26.
- Alston, William P. 1985. Thomas Reid on Epistemic Principles. *History of Philosophy Quarterly* 2 (4):435-452.
- 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. University of Notre Dame Press, Notre Dame, IN: pp. 163-196.
- Bealer, George. 1993a. Materialism and the Logical Structure of Intentionality. In *Objections to Physicalism*, edited by H. Robinson. New York: Oxford University Press. pp. 101-126.
- Bealer, George. 1993b. Universals. *The Journal of Philosophy* XC (1):5-32.
- Bealer, George. 1994. Mental Properties. *The Journal of Philosophy*:185-208.
- Bealer, George. 1999. The A Priori. In *The Blackwell Guide to Epistemology*, edited by j. Greco and E. Sosa. Oxford: Blackwell Publishers. pp. 243-70.
- Bedau, M. 1992a. 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.
- Bedau, M. 1992b. 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*. The MIT Press. pp. 261-91.
- Bedau, M. 1997. Weak Emergence. *Philosophical Perspectives* 11.
- 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*. The MIT Press. pp. 241-60.
- BonJour, Laurence. 1998. *In Defence 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.
- Broad, C. D. 1925. *The Mind and its Place in Nature, International Library of Psychology, Philosophy and Scientific Method*. London: Routledge & Kegan Paul.
- Buller, David J. 1999. Introduction: Natural Teleology. In *Function, Selection, and Design*, edited by D. J. Buller. Albany: State University of New York Press. pp. 1-28.
- Campbell, D. 1974. Evolutionary Epistemology. In *The Philosophy of Karl Popper*, edited by P. A. Schilpp. LaSalle, Ill.: Open Court Publishing. pp. .
- Chalmers, David J. 1996. *The Conscious Mind: in Search of a Fundamental Theory*. Oxford: Oxford University Press.
- Charles, David. 1988. Aristotle on Hypothetical Necessity and Irreducibility. *Pacific Philosophical Quarterly* 69:1-53.

- Churchland, Paul M. 1988. *Matter and Consciousness*. Revised Edition ed. Cambridge: A Bradford Book: The MIT Press.
- Crane, Tim. 1994. Physicalism (2): Against Physicalism. In *A Companion to the Philosophy of Mind*, edited by S. Guttenplan. Oxford: Basil Blackwell. pp. 479-84.
- Crane, T., and D.H. Mellor. 1990. There is No Question of Physicalism. *Mind* 99:185-206.
- Descartes. 1967. *The Philosophical Works of Descartes*. Edited by E. S. Haldane and G. R. T. Ross. 2 vols. London: Cambridge University press.
- Dobzhansky, Theodosius, Francisco J. Ayala, G. Ledyard Stebbins, and James W. Valentine. 1977. *Evolution*. San Francisco: W.H. Freeman and Company.
- Doepke, Frederick C. 1982. Spatially Coinciding Objects. *Ratio* XXIV (1):45-60.
- Dretske, Fred. 1988. *Explaining Behavior: Reasons in a World of Causes*. Cambridge, MA: The MIT Press.
- Ducasse, C.J. 1961. In Defense of Dualism. In *Dimensions of Mind*, edited by S. Hook. New York: Collier Books. pp. .
- Falk, Arthur E. 1981. Purpose, Feedback, and Evolution. *Philosophy of Science* 48:198-217.
- Foster, John. 1991. *The Immaterial Self: a Defense of the Cartesian Dualist Conception of the Mind*. New York: Routledge.
- 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: State University of New York Press. pp. 185-97.
- Goudge, T.A. 1967. Emergent Evolutionism. In *The Encyclopedia of Philosophy*, edited by P. Edwards. New York: Macmillan Publishing Co., Inc. & The Free Press. pp. 474-7.
- Hasker, William. 1982. Emergentism. *Religious Studiens* 18:473-88.
- Hasker, William. 1999. *The Emergent Self*. Ithaca, NY: Cornell University Press.
- Healey, Richard A. 1991. Holism and Nonseparability. *Journal of Philosophy* 88:393-421.
- Hull, David. 1974. *Philosophy of Biological Science*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.
- Hull, David L., and Michael Ruse, eds. 1998. *The Philosophy of Biology*. Oxford: Oxford University Press.
- Hume, David. 1777. An Enquiry Concerning Human Understanding. In *Classics of Western Philosophy*, edited by E. Steinberg. Indianapolis: Hackett Publishing Company. pp. .
- 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.
- Hume, David. 1990. *A Treatise of Human Nature*. Edited by L. A. S.-B. a. P. H. Nidditch. second 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.
- Humphreys, Paul W. 1996. Aspects of Emergence. *Philosophical Topics* 24:53-70.
- Humphreys, Paul W. 1997a. Emergence, Not Supervenience. *Philosophy of Science* 64 (4):s337-s345.
- Humphreys, Paul W. 1997b. How Properties Emerge. *Philosophy of Science* 64:1-17.
- Jackson, Frank. 1986. What Mary Didn't Know. *The Journal of Philosophy* LXXXIII (5):291-5.
- Jacobs, Jonathan. 1986. Teleology and Reduction in Biology. *Biology and Philosophy* 1:389-99.

- Katz, Jerrold J. 1998. *Realistic Rationalism*. Cambridge, MA: The MIT Press.
- Kemeny, J., and P. Oppenheim. 1956. On Reduction. *Philosophical Studies* 7:6-19.
- 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.
- Kim, Jaegwon. 1993. The Non-Reductivist's Troubles with Mental Causation. In *Mental Causation*, edited by J. Heil and A. Mele. Oxford: Clarendon Press. pp. 189-210. Reprinted in Kim, Jaegwon. 1993. *Supervenience and Mind*. Cambridge: Cambridge University Press. pp.336-57.
- Kim, Jaegwon. 1998. *Mind in a Physical World: An Essay on the Mind-Body Problem and Mental Causation*. Cambridge, MA: The MIT Press.
- Kim, Jaegwon. 1999. Making Sense of Emergence. *Philosophical Studies* 95:3-36.
- Klee, Robert. 1984. Micro-Determinism and Concepts of Emergence. *Philosophy of Science* 51:44-63.
- Klee, Robert. 1997. *Introduction to the Philosophy of Science: Cutting Nature at its Seams*. New York: Oxford University Press.
- 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. 1983. Extrinsic Properties. *Philosophical Studies* 44:197-200.
- Lewis, David. 1986a. *On the Plurality of Worlds*. Oxford: Blackwell.
- Lewis, David. 1986b. *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, and Co. pp. 20-33. reprinted in P. Weeiner (ed.), *Readings in the Philosophy of Science* (New York; Charles Scribner's Sons, 1953), pp.585-96.
- Lowe, E.J. 1989. *Kinds of Being: A Study of Individuation, Identity and the Logic of Sortal Terms*. Oxford: Basil Blackwell.
- Lowe, Ernest J. 1996. *Subjects of Experience*. New York: Cambridge University Press.
- Mayr, Ernst. 1982. *The Growth of Biological Thought: Diversity, Evolution, and Inheritance*. Cambridge, Mass: Harvard University Press.
- Mayr, Ernst. 1988. The Multiple Meanings of Teleological. In *Toward a New Philosophy of Biology : Observations of an Evolutionist*. Cambridge, Mass.: 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.
- Mullen, John D. 1995. *Hard Thinking: The Reintroduction of Logic into Everyday Life*. Lanham: Rowman & Littlefield Publishers, Inc.
- Nagel, Ernest. 1961. *The Structure of Science*. New York: Harcourt.
- Nagel, Ernest. 1979. Teleology Revisited. In *Teleology Revisited and Other Essays in the Philosophy and History of Science*, edited by E. Nagel. New York: Columbia University Press. pp. 275-316.
- Neander, Karen. 1991. The Teleological Notion of 'Function'. *Australasian Journal of Philosophy* 69:454-68. Reprinted in Buller, David J., ed. 1999. *Function, Selection, and Design*. Albany: State University of New York Press. pp. 123-41.

- Neander, Karen. 1995. Misrepresenting and Malfunctioning. *Philosophical Studies* 79:109-41. Reprinted (in part) in Buller, David J., ed. 1999. *Function, Selection, and Design*. Albany: State University of New York Press. pp. 221-31.
- Newman, David V. 1996. Emergence and Strange Attractors. *Philosophy of Science* 63:245-61.
- Nissen, Lowell. 1997. *Teleological Language in the Life Sciences*. New York: Rowman & Littlefield Publishers, Inc.
- O'Connor, T. 1994. Emergent Properties. *American Philosophical Quarterly* 31:91-104.
- Penrose, R. 1995. *Shadows of the Mind*. Oxford: Oxford University Press.
- Pettit, Philip. 1993. A Definition of Physicalism. *Analysis* 53:213-23.
- Plantinga, Alvin. 1993. *Warrant and Proper Function*. New York: Oxford University Press.
- Popper, Karl R., and John C. Eccles. 1977. *The Self and its Brain*. Berlin, New York: Springer International.
- Post, John. 1995. Naturalism. In *The Cambridge Dictionary of Philosophy*, edited by R. Audi. Cambridge: Cambridge University Press. pp. 517-8.
- Reichenbach, Hans. 1957. *The Rise of Scientific Philosophy*. Berkeley and Los Angeles: University of California Press.
- Reid, Thomas, ed. 1983. *Thomas Reid's Inquiry and Essays*. Edited by R. E. Beanblossom and K. Lehrer. Indianapolis: Hacktt Publishing Company, Inc.
- Rosenberg, Alex. 1996. A Field Guide to Recent Species of Naturalism. *The British Journal of the Philosophy of Science* 47:1-29.
- Rudder Baker, Lynne. 2000. *Persons and Bodies: A Constitution View*. Cambridge: Cambridge University Press.
- Schröder, Jürgen. 1998. Emergence: Non-Deducibility or Downwards Causation? *The Philosophical Quarterly* 48 (193):433-52.
- Searle, John R. 1980. Minds, Brains, and Programs. *The Behavioral and Brain Sciences* iii (3):417-24.
- Searle, John R. 1983. *Intentionality: An Essay in the Philosophy of Mind*. Cambridge: Cambridge University Press.
- Searle, John R. 1992. *The Rediscovery of the Mind*. Cambridge, Mass: The MIT Press/ A Bradford Book.
- 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. Boulder, CO: Westview Press.
- Spencer-Smith, Richard. 1994. Reductionism and Emergent Properties. *Proceedings of the Aristotelian Society* 95:113-29.
- Stairs, A. 1990. Quantum Mechanics, Mind and Self. In *Essays on Personal Identity*, edited by C. Taylor. Harvard: 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.
- Teller, Paul. 1995. Reduction. In *The Cambridge Dictionary of Philosophy*, edited by R. Audi. Cambridge: Cambridge University Press. pp. 679-80.
- Wiggins, David. 1980. *Sameness and Substance*. Cambridge, MA: Harvard University Press.

Wolterstorff, Nicholas. 1983. Thomas Reid on Rationality. In *Rationality in the Calvinian Tradition*, edited by J. V. H. Hart, and N. Wolterstorff. Lanham, Md.: University Press of America. pp. 43-69.

Woodfield, Andrew. 1976. *Teleology*. Cambridge ; New York: Cambridge University Press.