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CHAPTER

7 Must a Physicalist be a Microphysicalist?

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Abstract

This chapter challenges the entailment from physicalism to microphysicalism — the view that all facts metaphysically supervene on the microphysical facts. It observes that physicalists can avoid microphysicalism by rejecting physical microscopism. Humean supervenience is a strong version of microphysicalism, and it is false if a non-Humean view of laws is true. But such a view is consistent with physicalism. A weaker form of microphysicalism adds microphysical non-Humean laws to get a broader microphysicalist supervenience base for all facts. On this view, all the laws are metaphysically determined by microphysical laws and microphysical initial conditions. In response, the chapter argues that the existence of emergent Broad-laws, i.e. macroscopic laws that are not metaphysically dependent on microphysical laws and microphysical initial conditions, is consistent with physicalism. It also argues that physicalists can consistently deny that facts about persisting objects, including organic and artefactual objects, metaphysically supervene on microphysical facts.

Keywords: physicalism, microphysicalism, dualism, Humean supervenience, laws of nature, emergence

Subject: Philosophy of Science, Metaphysics, Philosophy of Mind

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1. Introduction

I take myself to be a physicalist. I hold that all facts, including such prima facie non-physical facts as mental and biological facts, metaphysically supervene on the physical facts.

However, I do not have any views about the relationship between macroscopic and microscopic facts. I am neutral on such questions as whether big things are always made of small things.

Recently I have become worried about this combination of views. This is because many other philosophers seem to think of physicalism as some kind of commitment to the primacy of the microscopic. In their view,

physicalism doesn't just say that everything is physical. It also says that everything is *micro*scopically determined.

Here are some representative quotations:

> [Physicalism is] the doctrine that actually (but not necessarily) everything non-microphysical is composed out of microphysical entities and is governed by microphysical laws (Pettit 1994, 253; see also Pettit 1993).
>
> Any thing of any level except the lowest must possess a decomposition into things belonging to the next lower level. In this sense each level, will be as it were a 'common denominator' for the level immediately above it (Oppenheim and Putnam 1958).
>
> The bottom level is usually thought to consist of elementary particles, or whatever our best physics is going to tell us are the basic bits of matter out of which ↳ all material things are composed. As we go up the ladder, we successively encounter atoms, molecules, cells, larger living organisms, and so on. The ordering relation that generates the hierarchical structure is the mereological (part–whole) relation: entities belonging to a given level, except those at the very bottom, have an exhaustive decomposition, without remainder, into entities belonging to the lower levels (Kim 1998).
>
> [Physicalism requires] a *mereological structure*, ordered by the part–whole relation . . . (Schaffer 2003).

p. 127

Perhaps I have been missing something. Despite my lack of interest in the issue, maybe physicalism does entail that everything is microphysically determined.

But there is another possibility. Perhaps there are two separable theses associated with physicalism, and the philosophers just quoted are unjustifiably running them together. This is what I shall argue in this paper. I shall distinguish physicalism per se from a further thesis about microphysical determination, and I shall argue that these two theses are independent. Physicalists don't have to be Microphysicalists.[1]

2. Two Theses

Let me start with what I take to be the basic content of physicalism.

> (P) All facts metaphysically supervene on the physical facts.

For clarity, I shall capitalize this thesis henceforth as 'Physicalism'.

Now consider this further claim about the nature of the physical facts themselves.

> (M) All physical facts metaphysically supervene on the microphysical facts.

I shall call this thesis 'Physical Microscopism'.

On the surface, it certainly looks as if these two theses could be independent. Physicalism is a doctrine about the relationship between prima facie non-physical things and physical things. It says that the mental, biological, meteorological and other prima facie non-physical things—that is, those things that can be directly identified using mental, biological, meteorological and other non-physical vocabulary—are not in fact ontologically distinct from physical things. Physicalism thus tells us how prima facie non-physical realms relate to the physical realm.

Physical Microscopism, by contrast, doesn't say anything about the relationship between the physical and other realms. Rather it is a doctrine about how things ↳ go *within* physics itself. It says that all physical facts are fixed by microphysical facts. It doesn't say anything about prima facie non-physical things.[2]

p. 128

The theses expressed in the quotations above can be viewed as the *conjunction* of Physicalism and Physical Microscopism. Let us define 'Microphysicalism' as the thesis that

> (A) All the facts metaphysically supervene on the microphysical facts.

Microphysicalism so defined is equivalent to the conjunction of (P) and (M).

To verify this equivalence, note first that, if (P) everything supervenes on physical facts and (M) all physical facts supervene on microphysical facts, then (A) everything supervenes on microphysical facts, by the transitivity of supervenience. Conversely, if (A) everything supervenes on microphysical facts, then immediately (M) everything *physical* supervenes on microphysical facts, and also (P) anything prima facie non-physical supervenes on microphysical facts and so a fortiori on physical facts.

The Microphysicalist doctrines quoted above are thus committed to the conjunction of Physicalism and Physical Microscopism.[3] By the same coin, there are philosophers who *deny* both Physicalism and Physical Microscopism. Not only do they defend the traditional dualist view that non-physical realms like the mental are ontologically separate from the physical realm, but they also maintain holist doctrines about the physical realm itself, insisting that certain kinds of physical wholes are metaphysically more than the sum of their microphysical parts. (Thus Crane and Mellor's influential 'There is No Question of Physicalism' (1990) defends a version of this extreme anti-Microphysicalism.)

However, I shall be arguing that it is not mandatory to tie Physicalism to Physical Microscopism in this way. By way of preliminary support for this claim, note that the other two combinations of assertion and denial of Physicalism and Physical Microscopism also make perfectly good initial sense.

Thus there is the possibility of defending Physical Microscopism while rejecting Physicalism. I would have thought that this was Descartes's view, for example. Even though Descartes is a paradigm dualist about the relation between the mental and physical realms, within physics itself he certainly looks like someone who thinks that the microphysical facts at least fix all the *physical* facts. We might also expect some contemporary dualists, such as David Chalmers, similarly to ↳ uphold this combination. There is no obvious reason why their commitment to an ontologically separate mental realm should force them to any kind of holism within physics itself.

p. 129

The other possibility is Physicalism without Physical Microscopism. This is the option that interests me. The Microphysicalist quotations above suggest that once you are a Physicalist, then this will carry Physical Microscopism in its train. But why should this follow? Suppose I am a Physicalist about the mind. I think that the mental level is determined by the physical level. There is nothing more to the mind than the brain. Why should this commit me to any view in particular about the way things go within physics? Why shouldn't I hold that physical wholes transcend what is determined by their microphysical parts? Such a within-physics holism would seem perfectly consistent with my rejection of Cartesian dualism. Can't I still identify mental facts with macrophysical facts, even if I think that those macrophysical facts transcend what is determined by microphysical parts?

This anyway is the possibility that will concern me in the rest of this paper. Can one be a Physicalist without embracing Physical Microscopism? Equivalently, must a Physicalist be a Microphysicalist?

3. Motivations for Microphysicalism

Why might anybody think that Physicalism requires Physical Microscopism? Are the Microphysicalist views expressed in the earlier quotations just an oversight, betraying insufficient thought about the nature of Physicalism? Or is there some more principled reason for linking Physicalism to Physical Microscopism?

I can think of two possible reasons for forging this link. The first is to do with the *meaning of 'physical'*. The second relates to the availability of *arguments for Physicalism*. Let me consider these possible reasons now, as they will allow me to introduce some points that will be useful later. I shall take them in turn.

The difficulties involved in defining 'physical' are well known. As Carl Hempel (1969) pointed out many years ago, Physicalists cannot simply define this term in terms of the categories recognized in contemporary Physics Departments. This is because current physics is a work in progress, so to speak—future discoveries will no doubt add to and subtract from the categories recognized by current physical theory. So a 'Physicalism' that asserts that everything supervenes on currently recognized physical categories will almost certainly prove false. Nor is it much of a solution, Hempel added, to define 'physical' by reference to the categories that will be recognized by *future* Physics Departments—at the ideal end of enquiry, perhaps. To the extent that we currently lack any clear idea of what those categories will be, this would remove any substantial content from Physicalism.

p. 130 In the face of this dilemma, one possible solution is to define 'physical' in terms of 'microphysical'. That is, we might read 'physical' as encompassing only what is microphysically determined. Philip Pettit understands 'physical' in this way. The passage quoted earlier is part of an argument designed to show that 'physical' can be defined as 'composed out of microphysical entities and governed by microphysical laws'. By this proposal, Pettit hopes to counter the view that there is no good way of understanding 'physical' and that 'Physicalism' is therefore an empty doctrine.

Now, if we do define 'physical' as Pettit does, then Physical Microscopism will become a definitional truism. All physical facts will inevitably supervene on microphysical ones, for if they didn't they wouldn't be 'physical'. And therewith the Physicalist claim that everything is physical will automatically collapse into the Microphysicalist thesis that everything is microphysically determined.

However, there are alternatives to Pettit's definition of 'physical' as microphysically determined. These will leave it open whether or not everything physical is microphysically determined, and therewith allow for versions of Physicalism that are not committed to Physical Microscopism.

For a start, there is the option of defining 'physical' negatively, as covering anything that can be directly identified *without* using some distinguished terminology. For example, we might count as 'physical' anything that can be directly identified using non-mental terminology. Or we might define it somewhat more restrictively, as anything that can be directly identified without using mental *or* biological terminology. This is the way of understanding 'physical' that I myself favour. In my book *Thinking about Consciousness* (2002) I argue for an understanding of 'physical' as *inorganically identifiable* . The idea here is that we start with a distinguished inventory of mental and biological terms, and then pick out the physical realm as anything that can be directly identified without using those terms. (Note that the physical realm is here anything that *can* be so identified, not things that can *only* be so identified. Physicalists will of course hold that some parts of that physical realm can *also* be identified using mental or biological terms.)

Some philosophers favour a yet further option, one that takes off from Hempel's dilemma. The idea here is to appeal to the categories represented by current Physics Departments, but to allow some wiggle room for future developments. So we might think of 'physical' as referring to all those categories that bear some *resemblance* to the categories recognized in contemporary Physics Departments. For example, 'physical'

might be understood as equivalent to something like 'displaying mathematically simple and precise behaviour'. I shall call this the 'resemblance' conception of 'physical' in what follows.

I shall not choose between these different understandings of 'physical' in this paper. It will be enough for my purposes to show that they allow various senses in which Physicalism might hold without Microphysicalism. But it will be useful to make one further point about the meaning of 'physical'. Suppose
p. 131 we have ↳ fixed on one of the above definitions of 'physical'. It will be convenient for the purposes of this paper to understand 'physical' recursively, in the sense of including any categories that supervene on the so-defined physical realm, even if they do not themselves fit the base definition. For example, suppose we equate 'physical' with 'inorganically identifiable'. Then it may be that facts about insects supervene on the physical realm so-defined, but that there is no way of stating insect facts using inorganic terminology. (Suppose that insect facts are 'multiply realized' at the inorganic level, in a way that precludes any uniform inorganic specifications of such facts.) Even so, I will take the supervenience of the insect facts on the physical facts to qualify them as 'physical'.

This recursive way of understanding 'physical' would not necessarily be appropriate for all philosophical purposes. For instance, if our focus were on physical *explanation*, it would be confusing to hold that certain facts were physically explainable just because they could be explained in terms of entomological facts that supervene on physical facts, even though there was no question of specifying those entomological facts in physical terms. But our interest here is with ontology, not explanation, and in particular with which categories supervene on the physical facts and which do not. Given this, it will suit my expository needs to count anything in the former category as 'physical'.

I turn now to the other possible reason for equating Physicalism with Microphysicalism, namely, the demands of providing an *argument* for Physicalism. Even if there are ways of understanding 'physicalism' that do not automatically collapse Physicalism into Microphysicalism, it could nevertheless be that the only way of *arguing* for Physicalism argues for Physical Microscopism too.

Thus consider this inductive argument: all facts so far subject to scientific scrutiny have turned out to supervene on the microphysical facts; so all the facts supervene on the microphysical facts. Some philosophers take this to be the primary rationale for embracing Physicalism. (Cf. Rey 2002.) Now, if this kind of inductive argument were the only available argument for Physicalism, then clearly any justification of Physicalism would justify Microphysicalism too. Our rationale for thinking that all facts supervene on the physical facts would essentially depend on the lemma that they all supervene on the microphysical facts. So our rationale for Physicalism would endorse Physical Microscopism along the way.

However, the above inductive argument is not the only possible argument for Physicalism.[4] There are alternatives that are quite free of any assumptions about microphysical goings-on. Thus consider the 'causal argument' that goes: prima facie non-physical facts like mental and biological facts have physical effects; all
p. 132 physical effects have physical causes ('the causal completeness of the physical'); so ↳ those prima facie non-physical facts must supervene on physical facts (or we would have unacceptable overdetermination). This is the argument for Physicalism that I myself favour. As we shall see below, this argument need not commit us to any claim that all the physical facts supervene on the *micro*physical facts. The crucial premise —the causal completeness of the physical—need only claim that all physical effects have *physical* causes, not that they have microphysical causes. And then this argument will only commit us to the conclusion that prima facie non-physical facts must supervene on physical facts, not that they must supervene on microphysical facts. The causal argument will thus remain available even to those Physicalists, like myself, who wish to remain neutral on the issue of Physical Microscopism.[5]

4. Species of Emergence

My aim is to show that we can deny Microphysicalism without denying Physicalism. That is, I want to show that Microphysicalism might fail, not because there are non-physical facts, but rather because some physical facts fail to supervene on the microphysical facts. In such a case, we would have a violation of Physical Microscopism, but not of Physicalism.

I won't be concerned here to make a positive case for any such violations of Physical Microscopism. As I said at the beginning, my first commitment is to Physicalism, not to any views about microphysical determination. So my aim is only to establish conditional claims of the form: even if certain facts are emergent vis-à-vis the microphysical realm, Physicalism can still be true. I shan't defend the antecedents of these conditionals. My interest is not in microphysical emergence as such, but rather in the fact that Physicalists don't always *need* to reject microphysical emergence.

Of course, not all kinds of microphysical emergence are compatible with Physicalism. Cartesian dualism, for example, posits microphysically transcendent facts that would clearly violate Physicalism. This is because Cartesian minds would not only transcend the microphysical realm, but the physical realm too. To support my thesis, I need microphysically emergent facts that would remain genuinely physical.

p. 133 Some of the microphysically emergent facts I consider below will fail to support my thesis. This is because it will prove difficult to avoid the conclusion that they would not count as physical. In the face of these particular species of microphysical emergence, Physicalists cannot of course stand neutral. They must reject any emergent facts that would transcend the physical realm, just as they must reject Cartesian minds. Fortunately, as we shall see, there are good arguments for denying those variants of microphysical emergence that would also transcend the physical realm.

5. Humean Supervenience

Microphysicalists claim that all the facts, including the macrophysical facts, supervene on the microphysical facts. The strength of this claim depends on what gets included in the ‘the microphysical facts’. Austere understandings of the microphysical facts make for strong versions of Microphysicalism. Such strong versions will be comparatively easy to deny. By contrast, the more that gets included in ‘the microphysical facts’, the less easy it will be to show that there are facts that transcend the microphysical facts.

A particularly strong version of Microphysicalism would correspond to David Lewis's doctrine of ‘Humean Supervenience’ (Lewis 1986):

> (HS) All the facts are metaphysically determined by the intrinsic properties of spacetime points plus the spatiotemporal relationships between those points.

This asserts that any world which agrees with the actual world on the ‘Humean mosiac’ of spacetime points and their intrinsic properties will contain all the facts that are present in the actual world. This is an extremely strong doctrine. It countenances no ‘external relations’ between spacetime points except their spatiotemporal relationships. Every other relational fact is fixed by the intrinsic properties of the points and the way these points are arranged in space and time.

Suppose we agree that the intrinsic properties of spacetime points are all physical properties. Humean Supervenience will then amount to a very strong form of Microphysicalism. Because it is so strong, it is easy for it to be false. In particular, it will be false if a non-Humean view of laws is true. The Humean view is that

laws depend on nothing more than the 'constant conjunctions' of particular facts displayed by the actual world. So any view on which laws transcend such facts of constant conjunction will contradict Humean Supervenience. Any such view implies that a world can agree with this world on the Humean mosaic yet differ on the laws.

I take this to illustrate a minimal sense in which one can be a Physicalist while rejecting Microphysicalism.
p. 134 If we equate Microphysicalism with Humean ↳ Supervenience, then anybody who rejects a Humean view of laws will be rejecting Microphysicalism. But nobody, I take it, would want to argue that a non-Humean view of laws amounts to a violation of Physicalism. This would only follow if non-Humean laws must in some sense themselves be non-physical, and there seems no reason to hold this. Certainly many actual Physicalists embrace this kind of non-Humeanism about laws without feeling that it somehow undermines their Physicalism.

Still, I don't suppose that this point will worry any of the philosophers who think that Physicalism requires Microphysicalism. This is because they are unlikely to understand Microphysicalism as making the extreme claims of Humean Supervenience, and in particular as requiring a Humean view of laws. Just as Physicalists in general will say there is nothing non-physical about non-Humean laws, so those who equate Physicalism with Microphysicalism are likely to say that there is nothing non-*Micro*physical about non-Humean laws either. They will thus be happy to add non-Humean laws to Lewis's Microphysicalist supervenience base, and thereby weaken the relevant supervenience doctrine: to fix all the facts, it is not enough just to fix the intrinsic properties and spatiotemporal arrangements of spacetime points—we must also fix the laws that govern the causal interactions between those points. These laws themselves need not supervene on the properties and arrangements of spacetime points.

This doesn't mean that those who want to equate Physicalism with Microphysicalism will place no restrictions at all on the laws present in a given world. They will typically insist that the only basic laws are *microphysical* laws. There may be genuine macroscopic laws, but if so they will be derived from the microscopic laws. As Pettit puts it, '. . . once the microphysical conditions and the microphysical laws have been fixed, then all the crucial features of a world like ours will have been fixed; viz., all the other laws that obtain at the world . . .' (1993, p. 219). From this point of view, while we might have to add non-Humean laws to get an adequate Microphysicalist supervenience base for all facts, it will be enough to add *microphysical* non-Humean laws. There are no further laws that are not determined by microphysical laws plus arrangements of microphysical initial conditions. So now we have another Microphysicalist supervenience thesis, one that places restrictions specifically on laws.

> (L) All the laws are metaphysically determined by microphysical laws and microphysical initial conditions.

6. Broad-Style Emergent Laws

I now want to consider whether a Physicalist can deny (L) and yet remain a Physicalist. That is, would the existence of macroscopic laws that are not dependent on microphysical laws and microphysical initial conditions somehow contradict Physicalism?

p. 135 This will prove a less than straightforward matter. In this section I shall argue that there is no immediate reason why Physicalists should not countenance macroscopic laws that do not depend on microscopic ones. However, the situation is complicated by considerations to do with force fields. I shall consider these complications in the next section.

A first question to address is what exactly qualifies a law as microphysical. We can take a microphysical law to be one that applies inter alia to small physical systems. (We needn't worry about what precisely qualifies a physical system as 'small'—the issues will come out the same wherever we draw this line.)

Note that there is nothing in this definition of a microphysical law to require that it applies *only* to small physical systems. It may be that microphysical laws are formulated in such a way that they apply uniformly to both small and large physical systems.

Thus consider the law of gravitation. This says that, in any isolated physical system made up of bodies B_1, . . ., B_n, each body B_k will be subject to the vector sum of the forces due to the other B_js ($j \neq k$) (namely, Gm_km_j/r^2_{jk}—where m_j is the mass of the other body B_j, r_{jk} is the distance between B_j and B_k, and G the constant of universal gravitation). Now, this law qualifies as a microphysical law because it tells us what would happen in a very small localized system comprising a few tiny particles. But at the same time it is formulated in an entirely general way. So it also tells us what would happen to a large falling body near the surface of the earth, say. We don't need any new principle to tell us what will happen to such a body. We simply apply the same gravitational law that applies to very small systems to the more complex set-up comprising the falling body and the earth.

Now, there seems no principled reason why all basic laws should be microphysical in this sense. Thus consider 'emergent laws' of the kind C. D. Broad (and other 'British Emergentists') envisaged. These are laws that (a) apply to specific large-scale physical initial conditions, (b) don't follow from microphysical laws, and (c) are essential to the appearance of certain physical effects. For example, imagine that, when the molecules constituting animal cells are in the physical context characteristic of a developing embryo, they start behaving in ways that aren't predictable given only the microphysical laws. Or, again, suppose that the molecules comprising neurotransmitters behave in a similarly unpredictable way when they are in the physical environment of a functioning brain.[6]

p. 136 Emergent Broad-laws would thus violate (L). They would give us a kind of macroscopic law that is not metaphysically determined by microphysical laws and initial conditions. There could be two possible worlds that agreed in their microphysical laws and microphysical initial conditions yet differed in their large-scale emergent laws—for example, one might have a law about special molecular movements to be found in developing embryos, while another might lack any such law.

The question now is whether this kind of emergence would threaten Physicalism. Would Broad-style emergence transcend the physical realm and call into being something non-physical? Or would it merely be a violation of Physical Microscopism that transcended the *micro*physical but leaves Physicalism intact?

At first pass, there is no obvious reason why Broad-laws should be viewed as requiring anything non-physical. Broad-laws would mean that certain large-scale complexes enter into laws that don't follow from basic microphysical laws and which make a real difference to the evolution of physical systems. But there would seem no immediate reason not to count both these large-scale complexes and the laws they enter into as *physical*. After all, nothing said so far requires these complexes to be anything more than large-scale arrangements of small physical parts. And nothing said so far requires the emergent laws to do anything except relate these physical initial complexes to physical results. (True, if 'physical' by definition required governance by microphysical laws, as in Pettit's definition of 'physical', then the physical complexes entering into emergent laws would come out as 'non-physical'. But they won't if we adopt either the 'resemblance' or 'inorganically identifiable' conceptions of 'physical', as seems more natural in this context.)

What about the *argumentative rationale* for Physicalism? Would this survive the existence of emergent Broad-laws? Again, there seems no immediate reason why Broad-laws should stop us arguing for Physicalism. Maybe they would if the only argument for Physicalism somehow proceeded via a

demonstration that all physical laws supervene on microphysical ones. However the causal argument for Physicalism sketched above makes no such assumption. Rather it hinges on the causal completeness of the
p. 137 physical realm, which says nothing about ↳ microphysics, but only that every physical effect has a fully sufficient *physical* cause. Broad-laws seem in perfectly good accord with this assumption. True, such laws would mean that some physical effects essentially result from macroscopic physical causes in ways unpredictable on the basis of microphysical laws alone. But for all that, they are still physical effects with sufficient (macro)physical causes. And so the causal argument will still tell us that any mental causes of those physical effects cannot be metaphysically distinct from those (macro)physical causes.

7. Special Fields

Despite the points made in the last section, there are further considerations that complicate the question of whether emergent Broad-laws are consistent with Physicalism.

Modern relativistic physics implies that causal influences exerted over spacetemporal distances must be mediated by the propagation of force fields. Relativity theory precludes any causal influences travelling faster than the speed of light. So there will be temporal gaps between any separated causes and effects. In typical cases this temporal interval will mean a violation of the conservation of energy. The standard solution is to suppose that the causes work locally, not at a distance, by propagating force fields which in turn produce the distant effects. These fields can then be viewed as embodying the relevant energy during the temporal delay between distal causes and effects (Lange 2002, ch. 5).

This argues that any Broad-laws would be associated with the emergence of special fields generated by the specific macroscopic initial conditions appearing in those laws. It is not to be taken for granted that these fields will count as 'physical', even if the macroscopic initial conditions that generate them do. To the extent that they would, Physicalism will remain intact, and the special fields would at worst violate the within-physics supervenience required by Physical Microscopism. But if the extra fields were non-physical, then they would automatically invalidate Physicalism.

To see more clearly what is at issue here, return to the suggestion that organic molecules behave in a distinctive manner in a developing embryo, or that neurotransmitters do the same when in a functioning brain. These behaviours would give us reason to posit 'vital' and 'mental' force fields respectively. And these fields would be genuinely extra to basic physical force fields like gravitation and electromagnetism, given that Broad-style laws give rise to physical effects that cannot be accounted for by more basic force fields.

The question is now whether fields like these would count as 'physical' or not. This turns out to be a rather messy question. I earlier considered three ways of defining 'physical': (a) metaphysically supervenient on
p. 138 the microphysical; (b) inorganically identifiable; and (c) resembling currently recognized physical ↳ categories. At a first approximation, the last of these make special force fields come out as physical, the second argues that at least some are non-physical, while the first delivers no clear verdict.

Let me briefly run through these options. (a) *'Physical' = 'supervenient on the microphysical'*. At first sight it might seem as if special force fields won't be 'physical' on this definition, because they aren't supervenient on the aggregates of microphysical facts that generate them: after all, there are worlds containing those facts that lack the relevant Broad-laws and so the fields. But that doesn't necessarily decide the issue, for special force fields will still standardly supervene on the local values of the fields themselves: fix the field values at all spacetime points and you fix all the field facts. So special force fields will be micro*scopically* determined. But does this mean they are micro*physically* determined? It depends on whether local values of special force fields count as physical or not. And this would seem to require a verdict from some other

criterion of physicality, such as our second and third definitions. (b) *'Physical' = 'inorganically identifiable'*. On this definition, it matters what type of special fields are at issue. If they are mental or vital force fields, then they will presumably count as *non*-physical. Referring to them as 'mental' or 'vital' force fields clearly doesn't give us a way of referring to them directly in inorganic terms. Of course, we could always form new terms to name such fields. But these terms will arguably be 'organic' too, insofar as they refer specifically to entities that are found only in living bodies and never elsewhere. However, not all special fields associated with Broad-laws need be so exclusively attached to organic circumstances. There could be fields that arose specifically in certain complex inorganic chemical molecules, say. These fields would then come out as *physical* on the second definition. (c) *'Physical' = 'resembles current physical categories'*. As I suggested earlier, a natural way to fill this out is to require that putatively physical entities should display 'mathematically simple and precise behaviour'. Any special force fields associated with Broad-style laws would be likely to satisfy this requirement. The principle of the conservation of energy is relevant here. Given this principle, any increases in kinetic energy occasioned by some force field must be compensated by a loss of potential energy with respect to that field, and vice versa. It is hard to see how this requirement could be satisfied if the evolution of any special fields were not governed by some definite mathematical principle that allowed us to define potential energy. To this extent, then, the third definition would count any Broad-style special fields as *physical*.

Overall, then, it looks as if special force fields associated with complex *inorganic* circumstances will come out as 'physical' on any definition, but that vital or mental force fields will only be 'physical' given the resemblance definition of 'physical', and not if 'physical' means inorganically identifiable. No doubt there is more to say on whether special force fields should count as 'physical'. But I do not propose to pursue this issue any further. To the extent that special force fields do qualify as 'physical', the associated Broad-laws
p. 139 will illustrate my thesis that you can deny Microphysicalism without denying Physicalism: such laws will ↳ violate the Microscophysicalist thesis (L), yet will not take us beyond the physical realm. On the other hand, special force fields that count as 'non-physical' will be no good for my thesis, since their associated Broad-laws will not only violate Microphysicalism but Physicalism too.

Of course, this means that Physicalists must resist any force fields of the latter kind. But this presents no great difficulty. Whichever definition of 'physical' is in play, the only force fields that threaten physicalism are vital and mental fields. I take it that there is no good reason to believe in any such fields. Until the end of the nineteenth century, most scientists took vital and mental fields for granted, along with other special fields. But modern research has not supported their view. In particular, twentieth-century physiology has given no indication that there are any processes inside living bodies that cannot be fully accounted for in terms of more familiar physical forces. (Cf. Papineau 2002, appendix.)

8. Persisting Objects

I turn now from laws to another kind of fact that might fail to supervene on the microphysical facts, namely facts about persisting objects, like molecules, stones, brains, beetles and bicycles. These are objects that retain their identity through time: a stone at one time can be identical to a stone at another time. It will turn out that there is plenty of room for Physicalists to deny that facts about persisting objects are microphysically determined without compromising their Physicalism.

As with laws, a strong form of Microphysicalism about persisting objects would assert Humean Supervenience:

> (O) All facts about persisting objects are metaphysically determined by the intrinsic physical properties and spatiotemporal relations of spacetime points.

Some contemporary philosophers endorse this claim. More specifically, they hold that facts about persisting objects depend on nothing but appropriate relations of spatiotemporal continuity among 'time-slices' (and that facts about 'time-slices' depend on nothing but the intrinsic physical properties and spatial relations of spatial points at the time in question). We can think of a time-slice as conveying an instantaneous 'snapshot' of the putative object. The strong Microphysicalist view at issue is thus that a persisting stone, say, is determined by a sequence of stone-type 'snapshots' that over time trace a continuous stone-type 'worm' through space.

However, this strong Microphysicalist view is denied by at least as many contemporary philosophers as uphold it. In support, they standardly invoke Kripke's 'rotating disc' argument.[7] Consider a homogeneous
p. 140 disc made of ↳ completely smooth matter. A sequence of time-slices will reveal where the disc is centred at each moment, but will not reveal whether it is rotating or not. In both cases, the time slices will simply be 'frozen' snapshots of homogeneous matter. So both a rotating disc and a non-rotating disc would display the same sequence of homogeneous time-slices. Yet intuitively there is a difference between these two alternatives. It seems to follow that there are facts about the disc that are not fixed by relations of spatiotemporal continuity among its time-slices.

This then gives us one sense in which Physicalists might fail to be Microphysicalists about persisting objects without compromising their Physicalism.[8] They can deny that persisting objects are sums of time-slices. For it certainly doesn't look as if this denial will somehow automatically undermine their Physicalism. After all, there seems no reason why Physicalists should withhold the term 'physical' from molecules or stones—or discs, for that matter—just because they think that these persisting objects fail to supervene on time-slices. Persisting objects like these would seem to be the paradigm of physical objects, whether or not they supervene on time-slices.

Perhaps there are few Microphysicalist philosophers who wish to uphold a strong Humean Supervenience thesis about persisting objects (just as few wish to uphold a strong Humeanism about laws). Still, the point I have just made also applies to various weaker Microphysicalist supervenience theses about persisting objects. There are in fact a range of possible weaker such Microphysicalisms, differentiated by what they add to time-slices in search of an adequate supervenience base for persisting objects. Thus there are philosophers who hold that the way to stick the time-slices together, so to speak, is to add instantaneous velocities to the supervenience base (Tooley 1988). Others favour the addition of primitive relations of singular causation (Zimmerman 1997).[9] Yet others appeal to 'non-supervenient relations' between the time-slices (Hawley 2001).

p. 141 We need not dissect these strategies in any detail here. The important point for my purposes is simply that there seems plenty of room to dispute these weaker Microphyicalisms too, without thereby contradicting Physicalism. For a start, any supervenience thesis of the above form will be denied by 'three-dimensionalists', that is, those philosophers who deny that persisting objects have time-slices as temporal parts, and so a fortiori will reject any claim that persisting objects are time-slices 'glued together' by such things as instantaneous velocities, singular causation or non-supervenenient relations. And even among 'four-dimensionalists', who do recognize time-slices, none of these suggestions for gluing them together will have majority support. Yet, as before, there seems no reason why somebody denying any of these Microphysicalist theses should be deemed thereby to have compromised their Physicalism. As I said above, things like molecules and stones are paradigms of physical objects. We needn't stop viewing them as such just because we deny one or more theses about how they are constituted out of temporal parts.

9. Brains, Beetles and Bicycles

Maybe molecules and stones are still paradigms of physical objects, even if they fail to supervene on time-slices and relations between them. But what about other kinds of persisting objects, including organic entities like brains and beetles, and artefacts like bicycles? Here it is not so clear that their status as 'physical' will survive their failure to supervene on time-slices plus 'glue'. And, if their physical status doesn't so survive, then this will argue that Physicalism about these entities does require some kind of four-dimensional Microphysicalism about persisting entities after all.

Let us suppose, for the sake of the argument, that three-dimensionalism is true, and that there is no way of 'gluing together' persisting objects out of time-slices. Given this, it is by no means obvious that objects like brains, beetles and bicycles will still qualify as physical.

Recall how we earlier considered three different notions of 'physical': (a) microphysically determined, (b) resembling current physical categories, and (c) inorganically identifiable. Under the hypothesis of three-dimensionalism, brains, beetles and bicycles clearly won't qualify as physical because they are microphysically determined by time-slices and their relations. Nor do they seem likely to qualify because they resemble current physical categories. As to the requirement of inorganic identifiablity, brains and beetles certainly won't satisfy this; moreover, it's not even clear that inanimate artefacts like bicycles will qualify, given that it is arguably essential to such artefacts that they are made by an intelligent designer.

This suggests that Physicalism isn't compatible with three-dimensionalism after all, and that we need some doctrine of supervenience on time-slices and relations to ensure that organic and artefactual persisting objects do not transcend the physical realm.

However, there is a further line of thought that promises to preserve the physical status of such objects even in the face of three-dimensionalism. For such objects might well supervene on their *spatial* parts even if they don't supervene on their temporal parts. And if those spatial parts are physical, then this will restore the physical status of brains, beetles and bicycles after all, even without any four-dimensional supervenience on time-slices.

The thought here is that organic and artefactual objects will surely supervene on facts about atoms, molecules or other small material constituents, whatever view we take about temporal parts. Could you have two identical arrangements of molecules, and one constitute a beetle, or a bicycle, and the other not? It seems unlikely. And we have already argued, in the last section, that the physical status of paradigm physical objects like molecules will not be undermined by their failure to supervene on time-slices. So this argues that beetles, brains and bicycles will retain their status as physical even if four-dimensionalist supervenience fails. All persisting physical objects, big and small, may fail to supervene on temporal parts, but as long as organic and artefactual objects supervene on small spatial parts, and those small spatial parts are physical, then organic and artefactual objects will count as physical too. (Note how the recursive understanding of 'physical', flagged in section 3 above, matters here. Brains, beetles and bicycles may not qualify as physical in their own right, so to speak, but they will qualify derivatively, in virtue of their supervenience on their small spatial parts, plus the physicality of these parts.)

So the thought is that Physicalists can reject Microphysicalist four-dimensionalism and yet maintain their Physicalism by insisting that organic and artefactual persisting objects will still count as physical in virtue of the physicality of the spatial parts that they supervene on. A natural question to ask at this point is *why* there should be such supervenience on spatial parts, if there is a failure of supervenience on temporal parts. Does not my putative three-dimensionalist Physicalist owe us some *argument* for the claim that organic and artefactual persisting objects supervene on their spatial parts? However, such an argument is not hard to find. A version of the standard causal argument for Physicalism makes it very hard to see how organic and

artefactual objects could fail to supervene on their spatial parts without generating an unacceptable species of systematic overdetermination.

To see how this would go, note that causes involving organic and artefactual objects characteristically have physical effects. (They dislodge stones, leave tracks, and so on.) At the same time those physical effects can surely be fully accounted for by causal processes involving only the small spatial parts of those objects. (The
p. 143 impacts of the molecules in those objects will fully account for the dislodging of ↳ the stones and the leaving of tracks.) So, if the organic and artefactual objects were metaphysically distinct from their molecular parts, in the sense of not supervening on them, we would have two ontologically independent causes for the relevant effects, which would be absurd.[10]

So my putative three-dimensionalist Physicalists can offer a good argument in support of their crucial claim that organic and artefactual objects supervene on their small physical parts. At this point, however, we might well wonder why a similar argument won't undermine their three-dimensionalism. If persisting objects can't transcend their spatial parts without generating unacceptable overdetermination, then how come they can transcend their *temporal* parts? Why won't this imply unacceptable overdetermination too, on the grounds that effects of causes involving the persisting object will already have full causes involving the temporal parts of that object?

However, I take it that somebody who is persuaded by the arguments for three-dimensionalism will deny the completeness premise assumed here. After all, they deny that persisting objects have temporal parts, and so a fortiori will not allow that there are already a full set of causes involving such temporal parts. Rather, they will insist that the only particular entities that feature in causes are persisting objects, like molecules and stones, or beetles and bicycles, not any supposed 'time-slices' of those objects. So for them there will be no question of the effects of molecules and stones also being determined by facts involving temporal parts.

These last comments illustrate a general point. I have taken the canonical argument for physicalism to be the causal argument: putatively non-physical causes have physical effects; all physical effects have physical causes; so avoiding (strong) overdetermination requires the putatively non-physical causes to supervene on the physical ones. Now, if we could replace the second premise with a stronger claim that all physical effects in some sense have *microphysical* causes, then obviously the argument would deliver the conclusion that all putatively non-physical causes must supervene on causes which are microphysical in that sense. Correlatively, Physicalists who wish to deny that putatively non-physical causes are microphysical in some
p. 144 given sense must deny that all physical effects have ↳ microphysical causes in the relevant sense. The possibility of three-dimensionalist Physicalists illustrates the general point. It is specifically because they deny the relevant microphysical completeness thesis—that all physical effects have sufficient causes composed of time-slices—that they are able to deny the metaphysical thesis that all physical causes must supervene on time slice facts.

10. A Microphysicalist Fork

It might seem to some readers as if the main point has now been conceded to those who hold that Physicalism implies Microphysicalism. After all, haven't I just agreed that Physicalism requires all facts about persisting objects to supervene on facts about small spatial parts like atoms and molecules? And wasn't this always the most natural reading of the view that Physicalism implies Microphysicalism (at least as it relates to particular facts rather than laws)? Thus recall the wording of the quotes with which I started, which spoke mostly of 'composition' by microphysical entities. Such talk of 'composition' can be read in various ways, but the most obvious way is as implying that the existence and properties of large persisting objects supervene on the existence and properties of their small spatial parts.

Let us briefly take stock of the dialectical situation. I brought in the idea of supervenience on small spatial parts to show how an anti-time-slice three-dimensionalist can uphold the physical status of organic and artefactual objects. The thought was that even three-dimensionalists will have good reason to uphold supervenience on small spatial parts, and that this will preserve the physicality of brains, beetles and bicycles. Without such supervenience, however, three-dimensionalists are in danger of violating Physicalism, for it is not clear, given their three-dimensionalism, what will ensure the physicality of organic and artefactual objects.

Given this, it looks as if Physicalists must at least embrace this final Microphysicalist thesis:

> (C) Facts about persisting objects supervene on the intrinsic physical properties of (and causal and spatial relations between) their spatial parts.

Maybe this thesis itself isn't indisputable. In principle, there is room to argue that facts about bicycles and beetles do in fact transcend facts about their spatial parts. And maybe this won't automatically generate unacceptable overdetermination—perhaps the relevant microphysical causal completeness thesis can be questioned, on the grounds that whole objects like bicycles and beetles do sometimes have physical effects that aren't also caused by their small spatial parts. (Cf. Owens 1992.) But none of this looks any good to Physicalists, for if *they* deny the Microphysicalist (C), then it seems that they will lose their reason for saying that organic and artefactual objects are physical.

p. 145 In short, it looks as if either Physicalists must accept Microphysicalist thesis (C)—or deny it and thereby undermine their Physicalism. Either way, there doesn't seem any room for a Physicalist to avoid this last version of Microphysicalism.

Even so, I am now going to argue that Physicalists can deny (C) consistently with their Physicalism. This is because quantum mechanics gives us strong reason to deny (C), but doesn't therewith undermine the physical status of brains, beetles and bicycles.

11. Quantum Holism

Prepare two electrons in the singlet state and send them off in opposite directions. The left hand electron will have a 50% chance of showing spin-up in the x direction, and 50% chance of showing spin-down. The same is true of the right hand one. They are—let us suppose—a light year apart, and in consequence have no current causal connection. Yet there will be a further fact about this joint system that does not supervene on the facts so far mentioned. The joint state of the two electrons is ‘entangled’. If the left hand electron is spin-up, the right hand one will be spin-down, and vice versa. This is a ‘non-local’ fact about the joint system, in the sense that it cannot be viewed as the sum of local facts about the separated electrons.

This kind of non-locality needs to be distinguished from the non-local *action at a distance* that some interpretations of quantum mechanics posit to explain what happens when measurements are made on distant ‘entangled’ objects. Thus suppose you measure the left-hand electron in the above situation and observe spin-up. You will then know that any measurement on the other electron will display spin-down. Some interpretations of quantum mechanics cannot avoid concluding that the measurement on the left-hand electron instantaneously produces real effects at the location of the right-hand electron. Other interpretations, in particular Everettian interpretations, claim to avoid any such non-local action at a distance. However, the non-locality I am concerned with here is independent of what happens in measurements, and so of these different interpretations of quantum mechanics. Rather it involves the structure of the quantum wave function before any measurements are made. It arises directly from the fact that the wave function for multiple particles can contain information beyond what it implies for any

localized properties of the particles. This species of non-locality is thus unavoidable in any interpretation of quantum mechanics that views the quantum wave function realistically.[11]

p. 146 Non-local entanglement is ubiquitous in the real world. I illustrated it above by considering a system of two separated electrons. But it will also be present in systems comprising basic physical persisting objects, like atoms and molecules. The joint state of the local components of such composite systems will characteristically contain information additional to that implied by the local properties of the components (see e.g. D. Lewis 2004, section I).

This point thus undermines our final Microphysicalist thesis (C). There are facts about persisting objects like atoms and molecules that transcend the intrinsic physical properties of their spatial parts plus the spatial and causal relations between them.

Note, however, that this denial of thesis (C) certainly doesn't look as if it undermines Physicalism. (Cf. Esfeld 1999.) The properties of atoms and molecules may be irredeemably holist because of quantum non-locality, but these properties are surely still physical. We don't want to say that the total spin of a number of electrons doesn't count as 'physical' just because it isn't determined by the local properties of the individual electrons. (I suppose that this would follow if we made satisfaction of Microphysicalist thesis (C) a defining requirement for 'physical'—but this implication surely simply counts against that reading of 'physical'. Certainly the relevant holist properties will come out as 'physical' on the inorganic and resemblance understandings of 'physical'.)

Can a Physicalist really deny the Microphysicalist thesis (C)? The worry in the last section was that brains, beetles and bicycles—not atoms and molecules—might end up as non-physical if they don't supervene on their small physical parts, as ensured by thesis (C). Still, there seems no reason why organic and artefactual objects should end up as non-physical just because their composite atoms and molecules have quantum holist properties. After all, those properties will still be physical (for the reasons I have just given) and facts about brains, beetles and bicycles will still supervene on them (here I revert to the assumption—contrary to the in-principle alternative aired towards the end of the last section—that all the physical effects of organic and artefactual objects will already have complete causes among the physical properties of their atomic and molecular parts).

What if the failure of Microphysicalist thesis (C) is more radical, and the quantum holism extends beyond atoms and molecules to larger entities, perhaps even to brains, beetles and bicycles themselves? That is, what if such larger entities also have properties that cannot be inferred from the local properties of their component atoms and molecules? At this point differing views on the interpretation of quantum mechanics come into play. Some will deny that there are any such macro-holist properties, because of what happens
p. 147 when the wave ↳ function 'collapses'. Others will hold that there are such properties, and will offer some explanation for why they are so difficult to detect. But we can by-pass these issues here. Let us simply suppose, for the sake of the argument, that quantum non-locality does extend beyond atoms and molecules, and that certain larger entities have properties that do not supervene on the local properties of their spatial parts. This still doesn't look as if it is going to undermine Physicalism. Any such large-scale quantum-based non-local properties will still count as physical (given that they will (a) occur in inorganic contexts as well as organic ones, and (b) display mathematically simple and precise behaviour). And facts about organic and artefactual objects will still supervene on physical properties including those non-local quantum properties (given that the physical effects of organic and artefactual objects will have a full set of causes among such physical properties).

So it seems that Physicalists can deny Microphysicalist thesis (C) after all. Quantum non-locality gives us cases which violate thesis (C) but do not take us beyond the realm of the physical. Even if this non-locality sometimes involves objects larger than atoms and molecules, it still won't transcend the physical realm. It

thus turns out that Physicalists can deny even this last minimal version of Microphysicalism without compromising their Physicalism.

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Notes

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1 The distinction between Physicalism and Microphysicalism was originally defended in Hüttemann and Papineau 2005. Here I want to revisit some of the issues raised in that earlier paper.

2 In Hüttemann and Papineau 2005 we talked about 'Levels Physicalism' and 'Part–Whole Physicalism' rather that 'Physicalism' and 'Physical Microscopism'. My rationale for the change of terminology is that it is unhelpful to present Physical Microscopism as a species of physicalism, given that its claims are internal to the physical realm.

3 It is true that the above quotations speak of decomposition into microphysical entities, where I have defined Microphysicalism in terms of supervenience on microphysical facts. I have switched to the latter formulation because it seems to me both more general and more precise. It certainly includes cases where the existence of some macroscopic entity is determined by the existence and arrangement of its microphysical parts, but it also covers other kinds of determination of macroscopic facts by microphysical ones. The specific issue of decomposition into *spatial* parts will be the focus of sections 10 and 11 below.

4 Which is just as well for Physicalism, if you ask me—after all, only a very limited range of facts have been shown actually to supervene on microphysical facts (as opposed to being assumed to so supervene on the basis of a prior commitment to Microphysicalism).

5 In the context of the philosophy of mind, some philosophers defend Physicalism via an 'inference to the best explanation', rather than by appeal to the causal argument. Their thought is that there are many well-established synchronic correlations between mental states and brain states, and that Physicalism is a 'better explanation' of these correlations than dualist epiphenomenalism (Hill 1991, Hill and McLaughlin 1999). To my mind, this starts the argument in the middle rather than at the beginning, by simply assuming the relevant mind-brain correlations. The point to note here is that we wouldn't posit such correlations if we were interactive dualists (for then we wouldn't think dualist mental states needed any help from synchronic neural correlates to produce physical effects). So we need the causal argument, not the proposed inference to a best explanation of correlations, to eliminate interactive dualism.

6 Note how clause (c) is needed to ensure that emergent laws are genuinely independent of microphysical laws. To see why, consider Jerry Fodor's version of non-reductive physicalism, as outlined in his influential 'Special Sciences' (1974). Fodor there posits special laws that (a) apply to specific large-scale physical initial conditions; (b) don't follow from microphysical laws. But Fodor is not denying that his special laws supervene on the microphysical laws plus particular microphysical initial conditions. This is because Fodor does not think that his special macroscopic laws describe any*independent causal influence* governing particular outcomes. In each *particular* case, the generation of physical results can be fully accounted for by the way microphysical laws govern the microscopic parts of the system. True, Fodor supposes that the microprocesses responsible for such outcomes will be *different* in different instances of the special law —that is why his special laws don't follow via a classic Nagelian reduction from microphysical laws. But, even so, there will be *some* microprocess that is responsible for the outcome in each particular case, and so what happens in general will be fixed by microphysicial laws plus the overall distribution of particular microphysical facts. This is where Broad-style emergent laws differ from Fodor's special laws. With genuinely emergent laws, but not with Fodor's laws, we get particular outcomes that wouldn't occur were the evolution of particular systems governed by microphysical laws alone. (Fodor's picture might make one wonder why all his variable realizations should conform to the same macropattern, if they involve such different microprocesses. But that is another issue. See Papineau 1993, ch. 2, Block 1997.)

7 Kripke's argument is given in unpublished lectures. See also Armstrong 1980.

8 In Hüttemann and Papineau (2005) we appealed to a different idea to defend the possibility of Physicalism without Microphysicalism about particular facts. We argued that the macroscopic properties of objects are not *asymmetrically* determined by their microscopic properties, since the macroscopic properties determine the microscopic ones as much as vice versa. Thus consider a system composed of three bodies, of masses m_1, m_2 and m_3 respectively. These individual masses determine that the whole has a mass of m_1+m_2, $+m_3$. But, by the same coin, the mass of the whole plus the mass of the first two bodies determines the mass of the third. (Cf Hüttemann 2004.) I stand by the idea that there is a symmetry of determination here. However, it no longer seems to me that this contradicts Microphysicalism. Why shouldn't Microphysicalists simply concede this kind of object-relative symmetry of determination? They can still explain why it is appropriate to think that macrophysics depends on microphysics, rather than vice versa, by pointing out that a world matching ours in microphysical detail will match it in macrophysical respects too, while the converse is not true—for the obvious reason that our world contains many 'free-floating' microphysical features that aren't properties of objects that also have macrophysical features.

9 Interestingly, it looks as if these singular causal relations need to be prior to laws, not derivative from laws and particular non-causal facts. It won't help to add laws that don't generalize over singular causal relations to the supervenience base, not even non-Humean causal laws: if we don't yet have any particular qualitative differences between the stationary and rotating discs, such laws won't distinguish them. Cf. Zimmerman 1998.

10 Some readers might be wondering, Kim-style, whether even the supervenience of persisting objects on their spatial parts is enough to avoid unacceptable overdetermination, if such supervenience falls short of identity. In the context of the relation between mental and physical properties, Kim (1993) uses this thought to argue in favour of type identity and against non-reductive supervenience. In the present context, however, there seems no question of *identifying* persisting objects with their spatial parts (given that the objects are one and the parts are many). Trenton Merricks concludes from this that the only way to avoid unacceptable overdetermination in this context is to *eliminate* persisting objects in favour of their spatial parts (2001). Myself, I think that these considerations cut the other way, and cast doubt on Kim's initial assumption that supervenience without identity generates unacceptable overdetermination. (Cf. Bynoe forthcoming.) Note that we can still insist that 'strong overdetermination' by two non-supervenient causes is unacceptable (as required for the causal argument for Physicalism) even if we allow 'weak overdetermination' by two supervenient causes. (Cf. Bennett 2003.)

11 Some philosophers take this quantum non-locality to show that 3N-dimensional 'configuration space' (where N is the number of particles in the universe) eclipses ordinary 3-dimensional space as the fundamental framework of reality. (Cf. Albert 1996.) And others argue that this restores a version of Humean Supervenience, on the grounds that all facts supervene on the intrinsic 'local' properties of points in configuration space plus 'spatial' relations between these points (Loewer 1996). However, it is debatable whether quantum mechanics really implies that ordinary 3-dimensional space is superseded by configuration space (P. Lewis 2004).