There are no abstract objects

CIAN DORR

September 13, 2005

1 The thesis

Suppose you start out inclined towards the hard-headed view that *the world of material objects is the whole of reality*. You elaborate: 'Everything there is is a material object: the sort of thing you could bump into; the sort of thing for which it would be sensible to ask how much it weighs, what shape it is, how fast it is moving, and how far it is from other material objects. There is nothing else.' You develop some practice defending your thesis from the expected objections, from believers in ghosts, God, immaterial souls, Absolute Space, and so on.

None of this practice will do you much good the first time you are confronted with the following objection:

> What about *numbers* and *properties*? These are obviously not material objects. It would be crazy to think that you might bump into the number two, or the property of having many legs. One would have to be confused to wonder how much these items weigh, or how far away they are. But obviously there are numbers and properties. Surely even you don't deny that there are four prime numbers between one and ten, or that spiders and insects share many important anatomical properties.[1] But these well-known truths evidently imply that there are numbers, and that there are properties. So your thesis is false. Not everything is a material object.

---

[1] The latter example is due to van Inwagen (2004).

This disconcertingly simple objection is probably quite unlike anything you expected to have to deal with when you first announced your thesis. It is confusing precisely because it is so very simple: if the argument did lead you to give up your initial materialist beliefs, the fact that you ever held those beliefs in the first place should seem profoundly puzzling. How on earth could you have failed to notice the inconsistency between your belief that spiders and insects share many important anatomical properties and your belief that everything is a material object? Seeing this, you will quite naturally wonder whether your disagreement with the objector might not be merely verbal. You may want to begin your reply by making distinctions: 'Of course there is *in a sense* such a thing as the number two; but in another important sense it is still true that material objects are all there are.'

While I have no particular interest in defending the view that the world of material objects is the whole of reality, I think that this reply is right on target. Sentences like

(1)   There are four prime numbers between one and ten.

(2)   Spiders and insects share many important anatomical properties.

(3)   There are numbers.

(4)   There are properties.

(5)   Everything is a material object.

admit of (at least) two systematically different kinds of uses, which I will label "fundamental" and "superficial". Ordinary uses of sentences like (1) and (2) are superficial, and entirely appropriate. When we use these sentences superficially, we assert boring, well-known truths, just as we would have if we had said that spiders and insects both have exoskeletons, or that there are no square prime numbers. On the other hand, anyone who seriously uttered (5) would very likely be using this sentence in the fundamental way. They would be making a claim about "the ultimate furniture of reality": the claim that *in the final analysis*, everything is a material object. This claim is perfectly consistent with the truths that would be expressed by ordinary, superficial uses of sentences like

(1) and (2). The appearance of conflict arises from the fact that each of the above sentences can be used in both ways, although the two uses are not always equally natural. (3) and (4) can be used superficially, in which case they would express truths even easier to know than the ones expressed by superficial uses of (1) and (2). Even (5) could in principle have superficial uses, which would express something obviously false. Conversely, (3) and (4), and even (1) and (2), can in principle be used in the fundamental way, in which case they would express claims that are far from obvious, and inconsistent with the claim expressed by fundamental uses of (5). Thus, the arguments from (1) to (3), from (2) to (4), and from (3) or (4) to the negation of (5) are valid in the sense that the conclusions follow from the premises *provided they are used in the same way*.

I hope this all seems too obvious to need arguing for as opposed to pointing out. How strange it would be to think that ordinary people, including those who never give a thought to questions of metaphysics, hold a wide range of beliefs that are incompatible with the thesis that fundamentally speaking, everything is a material object, and express these beliefs whenever they use sentences like (1) and (2)! But if an argument is wanted, I can offer the following. In ordinary life, we treat arguments such as these as trivially valid:

(6)   (a)   There is a planet that is distinct from some planet.

        (b)   So, the number of planets is greater than one.

(7)   (a)   The Earth is round.

        (b)   So, the Earth has the property of being round.

Indeed, it is easy to hear the conclusions of these arguments as nothing more than stylistic variants, or "pleonastic equivalents" (Schiffer 2003), of the premises. Surely this can't be an outright mistake. But, taken in the fundamental sense, (6b) and (7b), just like (1) and (2), express substantive metaphysical claims—claims that would be false if there were, fundamentally speaking, only material objects. These controversial claims certainly do not follow analytically—just as a matter of meaning—from (6a) or (7a)! Whether we take (6a) and (7a) themselves as fundamental or as

superficial, there is manifestly nothing in their meaning that could stop them from being true if the world of material objects were the whole of reality.[2]

I conclude that (6b) and (7b) are standardly used non-fundamentally, to express something consistent with the claim that there are, in the fundamental sense, no numbers or properties. But if this is granted for (6b) and (7b), it must also be granted for (1) and (2). Clearly we don't take any more of a metaphysical risk in uttering the latter sentences than we do in uttering the former: in whatever sense our utterances of (1) and (2) commit us to the existence of numbers and properties, our utterances of (6b) and (7b) do the same.

Have I said enough by now to enable me to state my thesis without being misunderstood? Let's give it a try. *There are no numbers. There are no properties.* When I utter these sentences, I mean to be using them in the fundamental way. I mean, if you like, that numbers and properties are not part of the ultimate furniture of reality. I mean that there are, in the final analysis, no such things.

Of course I hold similar views about many of the other putative entities that generally get classified as "abstract". But I don't want to be drawn into a pointless debate about how to define that technical term, so I won't attempt to state any more general thesis from which these claims about numbers and properties could be derived.[3] I will, however, add two more claims at the same level of generality. Just as there are no numbers or properties, there are no relations (like *being heavier than* or *betweenness*), or sets (like the set of people who have read this paper, or the null set). I will provisionally use 'nominalism' for the conjunction of these four claims, but will try to say nothing involving this term that would not also be true of various stronger theses of a similar kind.

---

[2]Similarly, our ordinary use of number-talk commits us to treating the argument 'Either there are no planets, or there is a planet; therefore, either the number of planets is zero, or the number of planets is at least one' as valid. Since the premise of this argument is analytically true (true just in virtue of meaning), the conclusion must be too, on its ordinary use. But it cannot be analytic when taken in the fundamental sense: fundamentally speaking, it is not an analytic truth that there are numbers, since it is not an analytic truth that there is anything at all. As Hume and Kant maintained in criticising the standard a priori arguments for the existence of God, denials of existence—when taken in the fundamental sense—can never be self-contradictory.

[3]On defining 'abstract', see Lewis 1986: 82–86, Burgess and Rosen 1997: 13–25 and section 1 of Chris Swoyer's companion paper (this volume).

'So are sentences like (1), (2), (3) and (4) true or false, according to you?' Well, just as these sentences admit of divergent fundamental and superficial uses, so too do sentences like

(1*) 'There are four prime numbers between one and ten' is true.

(2*) 'Spiders and insects share many important anatomical properties' is true.

(3*) 'There are numbers' is true.

(4*) 'There are properties' is true.

and their negations. Perhaps fundamental uses of (1*) and (2*) and their negations are a bit less unnatural than fundamental uses of (1) and (2). If you heard someone utter (1*) or (2*), you would naturally wonder why they didn't just assert (1) or (2); one reasonable hypothesis is that they did so as a signal that they were speaking fundamentally. But one wouldn't want to rely on hearers to come up with this hypothesis on their own.[4]

'Yes, but which of the above sentences are *literally* true?' Well, I'm certainly not play-acting, or speaking metaphorically, or exaggerating, or being sarcastic, when in the course of doing philosophy I say things like 'there are no properties', or when in the course of doing other things I say things like 'spiders and insects share many important anatomical properties'. So if 'literally' is used in the ordinary way to rule out these kinds of verbal manoeuvres, I'll happily say in the

---

[4]There is a complication here, which arises when we consider a sentence like

(*) 'There are no numbers' is true.

Surely, if there are (fundamentally speaking) no numbers, sets, properties or relations, there also aren't (fundamentally speaking) any sentences (i.e. sentence types). If so, it is hard to see how (*) could be true in the fundamental sense, given that the term in quotation marks purports to refer to a sentence. And there is certainly *a* superficial use of (*) on which it expresses a falsehood, just as (4*) expresses a truth. Nevertheless, it seems clear that there's some way of using (*) on which I should find it acceptable, given my thesis. (For more details see the discussion in Yablo 2001 of 'The number of numbers is zero'.) Indeed, when I make claims about sentences, theories, claims, beliefs, views, hypotheses, and so forth in the course of this paper, I will often be talking in this way: still superficial, but closer to the fundamental than most ordinary uses of this sort of language.

first kind of context that there are literally no properties, and in the second that spiders and insects literally share many important properties. However, 'literal' has come among linguists and philosophers of language to have an extended use, on which it is supposed to stand for some category of deep explanatory importance: the domain of semantics rather than pragmatics. A way of using language might turn out to be non-literal in this sense if turned out, at some deep explanatory level, to involve the same kinds of capacities or mechanisms that are involved in metaphor, exaggeration, sarcasm, etc. It has occasionally been suggested that what I have been calling the "superficial" uses of sentences like (1)–(5) are nonliteral in this sense.[5] But I have no interest in arguing for this surprising empirical claim. Indeed, I wouldn't mind if the *fundamental* use of sentences like (1)–(5) turned out to be nonliteral in this sense. Why should it matter, provided I can get my meaning across?

Since I think that the claims expressed by the fundamental uses of sentences like 'there are numbers' and 'there are properties' are of great and enduring philosophical interest, I am naturally disposed to assume that philosophers who utter these sentences mean to be asserting these interesting claims, rather than the trivialities expressed by these sentences on a superficial interpretation. But in some cases, there is other evidence that makes the assumption quite problematic. I am thinking especially of those philosophers who produce these sentences as the conclusions of arguments such as the following:

(6)　(a)　There is a planet that is distinct from some planet.

　　(b)　So, the number of planets is greater than one.

　　(c)　So, there are numbers.

(7)　(a)　The Earth is round.

　　(b)　So, the Earth has the property of being round.

---

[5]Stanley (2001) and Burgess and Rosen (2005) argue on empirical grounds against this claim, which they attribute to Yablo (2000)—although Yablo's response to Stanley (Yablo 2001) suggests that he may not in fact accept it.

(c) So, there are properties.[6]

As I argued above, these arguments are only valid on a superficial reading. The fact that someone puts forth such an argument as valid is thus weighty evidence in favour of an interpretation on which that person is speaking superficially. On the other hand, why would any philosopher court misunderstanding in this way?

In some cases I suppose the right explanation is that, by failing to keep clear on the distinction between the two uses, they have ended up believing that there are numbers or properties in the fundamental sense on the basis of fallacious arguments. But in the more interesting cases, the explanation is, rather, that the philosophers in question *see no alternative* to the superficial way of using sentences like 'there are numbers'. They simply have no idea what the allegedly distinct "fundamental" uses of these sentences are supposed to be. (Or at least, they have convinced themselves that they have no such idea.) Here's how I imagine them responding to my thesis:

> Look, I'd like to interpret you charitably as not expressing that claim—the one *I* would express using the words 'there are no numbers'—which we agree is a trivial analytic falsehood. But I just don't see what else you could have in mind. The only alternative interpretations of your utterance I can think of are ones on which you're expressing some trivial analytic *truth* (e.g. that numbers are not concrete), or some empirical claim to which your arguments are plainly irrelevant (e.g. that it would be in our interest to adopt a practice in which 'there are no numbers' was used to express a truth—cf. Carnap 1950). I'm in an position like the one you would be in if you were faced with someone who maintained that the objects we normally refer to as "chairs", although they do exist, are not really, strictly speaking, in the fundamental sense, chairs. You can't see what could make it appropriate to dignify any variant on our ordinary use

---

[6]"Something from nothing" arguments along these lines have been defended by, among others, Alston (1963), Wright (1983), and Schiffer (2003). Many other arguments against nominalism seem to embed arguments of this kind at crucial points. For example, Russell (1912: chapter 10) gives a celebrated argument for the existence of relations, which depends on the premise that one thing cannot resemble another thing without bearing the relation of resemblance to it.

of the word 'chair' as especially "strict" or "philosophical" or "fundamental". I'm in

just the same position with regard to the ordinary use of 'there are'—the one on which

'there are numbers' is used to express a trivial truth.

I would be delighted to be able to argue people out of this position of principled incomprehension, by finding a distinguishing characteristic of the "fundamental" use of i¿s like 'there are' that even they would have to recognise. My hope is that this could be done by taking my claim that arguments like (6a)–(6b) and (7a)–(7b) are not valid when understood in the fundamental sense, and the related claim (note 2) that claims of existence are never analytically true in the fundamental sense, as partly definitive of the relevant use of 'in the fundamental sense'. But I won't attempt here to develop this into a workable characterisation.[7]

For now, let me simply point out that the two anti-nominalist arguments I will spend most of this paper discussing (sections 3 and 4) purport to show that abstract objects do essential explanatory work of some sort. If these arguments succeed, any way of using language on which 'there are no abstract objects' was used to express a truth (while 'abstract object' continued to mean what it actually means) would be severely explanatorily impoverished. Even those who can make no sense of the claim that such a way of using language is "more fundamental" than our ordinary way of using language might want to resist this claim. They might think that the fact that 'there are abstract objects' is true in ordinary English is just a fact about how we happen to talk, rather than something forced on us by our interest in speaking a language that is not explanatorily impoverished.[8] Those who hold this view have a common interest with me in finding responses to the anti-nominalist arguments I will be discussing.

---

[7]I make this attempt in Dorr (2005).

[8]This is probably the best way to make sense of the idea that the existence of abstract objects "is just a matter of linguistic convention". On its more straightforward interpretations, this slogan is deeply problematic. On one interpretation, it conflicts with the apparently obvious fact that if numbers exist, they would still have existed even if there had never been any human beings. On another interpretation, it is trivial, since every true sentence is true partly in virtue of meaning what it does, and every sentence means what it does partly in virtue of linguistic convention. On a third interpretation, it requires us to make sense of the notoriously difficult idea of a sentence being true *wholly* in virtue of our conventions.

2 Paraphrase

The superficial way of talking about numbers, properties, relations and sets is very useful. But it would be wrong to think of it as giving us access to a domain of independent fact from which we would otherwise be completely cut off. Rather, sentences get to be true or false taken superficially in virtue of what there is in the fundamental sense, and what it is like. Thus, each English sentence must have a "paraphrase": a sentence that, when taken in the fundamental sense, says how things would have to be for the original sentence to be true in the superficial sense.[9]

For some sentences, appropriate paraphrases are ready to hand. For example, we could take (6a) ('There is a planet that is distinct from some planet') as the paraphrase of (6b) ('The number of planets is greater than one').[10] But there is no obvious way to generalise this assignment beyond these easy cases. If it turned out that no system of paraphrases capturing the apparent logical relations among superficial uses of English sentences was possible, that would undermine my case for the existence of non-equivalent fundamental and superficial interpretations of abstract-object sentences.[11] There would then be no choice but to reject at least one of the premises to which I appealed in arguing for that claim—for example, that we are not making a mistake when we treat arguments like (6a)–(6b) and (7a)–(7b) as valid.[12] If we wanted to continue to be nominalists, we

---

[9]The idea of "paraphrase" as a method for reducing one's "ontological commitments" is introduced in Quine 1948. But a warning is in order: given Quine's verificationism and his rejection of the notions of sameness and difference in meaning (Quine 1951), any apparent similarities between the project Quine calls "ontology" and my project of investigating what there is in the fundamental sense are probably quite misleading.

[10]These paraphrases will work only if the kind of superficial use of (6b) we are trying to capture is one on which it can be true only if planets exist in the fundamental sense. In my view, ordinary uses of sentences like (6b) and (6a) do not require planets to exist in the fundamental sense—they are consistent with the claim that fundamentally speaking, there are no composite objects at all (see Dorr 2002 and Dorr 2005). But in the context of the present discussion, we can harmlessly ignore divergences between the fundamental and superficial ways of talking that have nothing to do with abstract objects.

[11]For arguments that an adequate system of nominalistic paraphrases of sentences about abstract objects is impossible, see Pap 1959-60, Jackson 1977, and van Inwagen 1977, 2004.

[12]Two qualifications. First, we must distinguish the question whether an adequate system of paraphrases is possible in principle from the question whether we are in a position to *provide* such paraphrases. One can understand two languages without being in a position to translate

would have to do so in the knowledge that we were disagreeing with something almost everyone has believed. And when we ourselves continued to talk in the usual way about numbers, properties, relations and sets (as we inevitably would), we would find it hard to explain what we were doing if not expressing beliefs flatly inconsistent with our official doctrine.

Fortunately, the challenge to provide the required system of paraphrases can be met rather easily. We can simply take the paraphrase of any sentence S to be 'If there were abstract objects, it would be the case that S'.[13] Or, if one would prefer the paraphrases to be more explicit and less context-dependent, one could aim to fill in the following schematic analysis:

> If it were the case that [axioms of number-theory] and [axioms of set theory] and [axioms of property and relation theory] and [axioms for other sorts of abstract objects], and the concrete world were just as it actually is, then it would be the case that S.[14]

One objection to this sort of proposal stems from the widely-accepted thesis that counterfactual conditionals with metaphysically impossible antecedents are all vacuously true (Stalnaker 1968, Lewis 1973). Since nominalism seems like the sort of thing that should be metaphysically necessary if true, this thesis would be bad news for my proposal. Fortunately, the thesis is false (see Nolan 1997). Here are some manifestly false counterfactuals whose antecedents seem to be metaphysically impossible:

(8a) If I were a dolphin, I would have arms and legs.

---

between them—for example, a bilingual speaker of English and French might understand 'elm' and 'orme' without knowing that they refer to the same kind of tree—and this could be our situation as bilingual speakers of "fundamental English" and "superficial English". Second: it would be enough for the paraphrases to be stateable in a version of English supplemented with arbitrarily powerful devices of infinitary conjunction, disjunction and quantification. It could well be among the benefits of the superficial way of talking that it gives us a finite way of expressing what would otherwise require infinitary resources.

[13]For other attempts to paraphrase problematic sentences by embedding them in the scope of some sort of modal operator, see, e.g., Putnam 1967, van Fraassen 1980, Rosen 1990, and Yablo 2000.

[14]It is a good question how a nominalist should understand the clause '... and the concrete world were just as it actually is'. In section 4 I will consider a question that raises many of the same issues, namely how a nominalist should understand the notion of duplication, or exact intrinsic similarity.

(8b) If it were necessary that there are donkeys, it would be impossible for there to be cows.

(8c) If there were unicorns, none of them would have horns.[15]

In fact, we seem to be just as good at finding sensible things to say about what would be the case if some impossibility were true as we are at understanding what is the case according to impossible fictions.[16]

3 Abstract objects in scientific explanations

If this reply to the "paraphrase challenge" succeeds, the picture from section 1 stands. There are plenty of short and valid arguments from obvious truths to the conclusion that there are numbers and properties in a superficial sense; but such arguments are irrelevant to the question whether there are any such things in the fundamental sense. It seems clear to me that in that case, Ockham's Razor applies: the burden of proof lies with those who maintain that there are, in the fundamental sense, numbers, properties, relations or sets. Unless they can show us that their view brings some important explanatory benefit that cannot be had more cheaply, we should be pretty confident that there are no such things. We should regard it as far more likely that all the things that there are material objects, or spirits, or portions of spacetime, or quantum particles...—objects that are causally or spatiotemporally or mentally or physically interrelated as no number, property, relation or set could ever be.[17]

_____

[15]Kripke (1972: 156) argues influentially for the claim that it is metaphysically impossible that there should be unicorns.

[16]For those who still think that the fact that nominalism is necessary if true poses a problem, the literature on nominalism contains several proposals (e.g. Chihara 1990, Hellman 1989) that aim to get around this supposed problem by finding some metaphysically possible "surrogates" to play the role the impossible axioms about abstract objects play in my paraphrases. I see no problem of principle with these approaches, although they have the practical disadvantage that they can be used to write down paraphrases only for sentences in which all the predicates that apply to abstract objects are ones we already know how to analyse in terms of the predicates that appear in the axioms.

[17]Even if there happen to be some "uninvolved" things that have no positive features inconsistent with being a number, etc., it might still be the case that none of them are numbers. Some philosophers (e.g. Lewis 1993) have argued that the meaning of words like 'number' is very un-

The disjunctive character of this claim makes it hard to say anything further at this level of generality to justify it. If further justification is demanded, the nominalist's best strategy may involve arguing for some more specific, positive thesis about what reality is like, fundamentally speaking—something strong enough to have explanatory power in its own right, and from which nominalism could be derived as a corollary. But I won't try to do this here. Instead, I will spend the remainder of the paper considering two of the ways in which anti-nominalists have attempted to put abstract objects to work in explanations. I agree with Chris Swoyer (this volume) that if it could be shown that the thesis that abstract objects exist (fundamentally speaking) is required by some good explanation of something that couldn't otherwise be explained, or explained so well, that would provide at least some reason to believe it. I will argue, however, that the explanatory benefits abstract objects may seem to bring are in fact illusory.

In this section, I will consider whether the reality of abstract entities might be required for good *scientific* explanations—explanations that answer 'why' questions in the way in which Newton's laws answer the question why the planets move in elliptical orbits. In section 4, I will turn to the question whether the reality of abstract entities might be required for good *philosophical*, or *constitutive* explanations—explanations that answer 'why' questions in the way in which the claim that a certain object is a four-sided figure with equal sides and angles answers the question why it

demanding, so that the existence of *sufficiently many* uninvolved objects is all that is required for some of them to count as "numbers". The idea is that provided that there are enough uninvolved objects, names like '0', '1', '2'... will refer indeterminately to all of them, so that there is no fact of the matter as regards which of them is 0, which is 1, etc. I see no sound motivation for such a *prima facie* surprising proposal. If we were determined to interpret ordinary number-talk as fundamental, there would indeed be pressure to interpret 'number' as undemandingly as possible so as to make it as easy as possible for 'there are numbers' to be true. But I have already argued against such an interpretation: to do justice to our ordinary use, 'there are numbers' needs to be interpreted as *analytic*, and it is plainly not analytic that there are infinitely many uninvolved objects. On a more natural interpretation of 'number', the mere existence of infinitely many uninvolved objects would not be enough for 'there are numbers' to be true in the fundamental sense: certain of these objects would, in addition, have to be structured in the distinctive way captured by the axioms of number theory. Understood in this way, it is clear that even if for some reason we were confident that there were lots of uninvolved objects, we should still, in the absence of positive argument, give little credence to the hypothesis that any of these objects are numbers.

is a square.[18]

The idea that belief in certain abstract entities is justified by their role in good scientific explanations is called the 'indispensability argument', and generally attributed to Quine (1948) and Putnam (1972). At first sight, the case looks strong, especially in the case of mathematics. Why would modern science be so full of theories that logically entail 'there are numbers', if everything these theories purport to explain could be explained equally well without positing mathematical entities? But on second thought, it seems quite easy to weaken any ordinary scientific theory so as to make it logically consistent with 'there are no numbers', without affecting the theory's predictions about the concrete world. We already saw one way of doing this in section 2: when T is an ordinary scientific theory incorporating certain mathematical axioms,

T^* If it were the case that [mathematical axioms] and the concrete world were just as it
         actually is, it would be the case that T

has exactly the same consequences for the concrete world as T itself. So the proponent of the indispensability argument owes us an argument that T^* provides a worse explanation for these facts about the concrete world than T does. Why would one think this?

Some anti-nominalists appeal at this point to the standards actually accepted by practising scientists. They point out that one would get short shrift if one were to submit something of the form of T^* to a journal like the *Physical Review* (Burgess and Rosen 1997: 210). Philosophers, they suggest, should defer to the wider scientific community in forming their opinions about what makes for a good explanation. But if I am right that most uses of abstract-object talk, even in the sciences, are superficial uses, this sort of direct appeal to authority is useless in an argument for the existence of mathematical entities in the fundamental sense.[19] True, scientists never pause to consider theories looking like T^*, but that's because the theories they are interested in are *already*

---

[18]I don't mean these labels to suggest that either of these kinds of explanation is the exclusive province of philosophers or scientists.

[19]I don't mean to suggest that Burgess and Rosen intend to be arguing for that conclusion. It is clear from their most recent paper (2005) that to the extent that they have any quarrel with what I call 'nominalism', it is because they think that not enough has been done to explain what it means to ask whether things of a certain kind exist in the fundamental sense.

of this form, under the surface. Thus, any guidance scientists can give us in our attempt to assess the explanatory goodness of theories like T^* must be indirect: it must depend on some analogy between this case and other cases where scientific practice clearly does take a stand on what is required for a good explanation.

It is not hard to see how such an argument by analogy might go. Putnam (1972) is naturally interpreted as giving an argument of this kind; let me present my own version. If we are "scientific realists" who accept science as a way of finding out about the world, including the unobservable portions of the world, we will presumably think that we have good reason to believe that there are subatomic particles.[20] We will think this even though we recognise that, for any theory T that talks about unobservable entities of some kind, it is possible to find a weaker theory that shares all T's consequences about the observable world without entailing anything at all about those unobservable entities. For example:

$T^\dagger$ All the facts about the positions and motions of atoms are consistent with the hypothesis that T.[21]

(In other words: as far as the positions and motions of atoms are concerned, it is just *as if T* were true.) How can we be justified in believing that there are subatomic particles, rather than cautiously limiting ourselves to beliefs of the form of $T^\dagger$? The standard answer makes use of the notion of explanation. Although $T^\dagger$ has exactly the same observable consequences as T, it does not constitute a good explanation of these consequences. For $T^\dagger$ is the sort of theory which if true, would itself "cry out" for further explanation. It is extremely unlikely, a priori, that atoms should just happen to move around in exactly the ways predicted by T without this fact having any deeper explanation. T itself is the most obvious possible explanation. There may of course be other explanations inconsistent with T, including some we have not yet thought of. But it would be very surprising if someone were to discover a theory that would, if true, provide a good explanation of

---

[20]At least in a superficial sense. The claim that subatomic particles exist in the fundamental sense seems much riskier—it is ruled out, for example, by the appealingly simple hypothesis that fundamentally speaking, there are only spacetime points.

[21]Cf. Field 1988: 260.

$T^\dagger$ without entailing the existence of subatomic particles.

Now, T^* and $T^\dagger$ are similar in some salient respects. There is an obvious sense in which both are "parasitic" theories. Once the original theory T has been written down, it requires no additional effort to formulate the weaker theories T^* and $T^\dagger$; one simply prefaces T with the appropriate complex modal operator, 'If [mathematical axioms] and the concrete world were just as it actually is, it would be the case that...' or 'The facts about the positions and motions of atoms are consistent with the hypothesis that...'. On the basis of this similarity, one might conclude that T^* and $T^\dagger$ must also be similar in respect of being bad as explanations—i.e. in being extremely unlikely to be true without having any deeper explanation.[22]

Once it has been made explicit, this argument by analogy may seem too tenuous to be worth worrying about. T^* and $T^\dagger$ are dissimilar in all sorts of ways. Why should we rest so much on the ways in which they are similar? But on the other hand, what else are we to go on, besides such analogies, in assessing the merits of T^*? It is hard to think of any other way of deciding the status of T^* that would not beg the question by appealing to some premise that only nominalists or anti-nominalists find plausible. For example, many nominalists have seen epistemological significance in the fact that abstract objects, if they existed, would be causally inert (Benacerraf 1973). The number two is not the sort of thing that could, say, move a pointer on some properly-designed

---

[22]As far as I know, the most explicit presentation of an argument by analogy along these lines in the literature is Field's (1988: 260–261). However, Field's argument deals in the first instance, not with theories like T^*, but with theories of the form 'All the facts about concrete objects are consistent with the hypothesis that T', which are far more immediately analogous to $T^\dagger$. He conjectures that his conclusions about these theories generalise, so that every device by which one might "modalize away" the mathematical content of a theory is immediately analogous to some device by which one might "modalize away" its commitment to subatomic particles. But this conjecture seems to be false: there just isn't any way for an eliminativist about subatomic particles to directly mimic the procedure used by the nominalist in formulating T^*. For what would take the place of the mathematical axioms in the antecedent of the conditional? The obvious candidate would be some claim to the effect that an atom is located at a point iff that point is the centre of mass of some subatomic particles bound together in such-and-such ways. But this won't work. Given any world of atoms, there will be many different worlds where subatomic particles are added in such a way as to make true such a claim while leaving the distribution of atoms unchanged; T will be true at at most a few of these worlds. And it is hard to see what, other than the truth of T, could justify the claim that some of the T-worlds are closer to actuality than any non-T world.

number-detector. Appealing to this fact, a nominalist might attempt to argue that T^* must be at least as good as an explanation of observed facts about the concrete realm as T itself, since T adds to T^* only in entailing the existence of causally inert entities like numbers. But anti-nominalists are not going to be persuaded by such an argument: they will simply deny that there is any connection between causation and explanatory goodness of the kind the argument needs.[23]

Of course, such argumentative deadlocks are the norm across philosophy. But there is something very attractive about the idea that we should try to make progress in philosophy by learning from the disciplines in which progress is most manifest, namely the sciences. More specifically, the proposal is this: in the quest for a theory of explanatory inference, we should take as our starting point the large and impressive body of case-by-case epistemological judgements shared by all scientific realists. We then decide what we ought to believe about controversial philosophical questions in accordance with whichever epistemological theory does the best job of accounting for and systematising these data.[24] In this methodological context, at least, the argument by analogy for the badness of T^* is strong enough to be worth taking seriously.

Even if we were to concede that T^* was a bad theory, the debate would by no means be over. Nominalists could still look for alternatives to standard mathematics-laden scientific theories that explain the same data, but don't entail that there are numbers, and are not similar to theories like $T^\dagger$ in any way that would let an argument by analogy get off the ground. This is the strategy favoured by Hartry Field. In his book *Science Without Numbers* (1980), Field works out an elegant and clearly non-parasitic version of Newtonian gravitational theory, which entails the existence of nothing besides particles, spacetime points, and spacetime regions. He shows that, in conjunction with appropriate mathematical axioms and definitions of mixed mathematico-physical predicates,

---

[23]And they are right that if there is any connection here, it is not a very straightforward one. Since we have reason to believe that the world is not about to end, some theories T that entail that it is not about to end must be explanatorily better, in the relevant sense, than any theory of the form 'Up to now, everything has been just as if T'—despite the fact that, since they are located in the future, the additional entities posited by T play no role in causing the observations that constitute our evidence for T.

[24]This is my favourite candidate to be the referent of the coveted label 'naturalism' (Burgess and Rosen 1997: 33).

this theory entails the "platonistic" theory it is meant to replace.[25] However, Field's programme has yet to be carried out for theories like general relativity and quantum mechanics. At this stage, it is simply too early to say whether it is possible to find nominalistic theories of these matters that are as free as Field's theory is from any taint of similarity to bad theories like $T^\dagger$.[26] So there is a strong motivation for those who think that we can, even now, reasonably believe nominalism—as opposed to merely adopting it as a working hypothesis—to resist the indispensability argument at an earlier stage, by maintaining that T^* is a perfectly good theory as it stands, in spite of the analogies between it and $T^\dagger$.

It is not hard to come up with differences between T^* and $T^\dagger$ that look like they *might* be epistemologically significant. For example, there is the aforementioned fact that the additional strength of T over T^* derives entirely from the postulation of entities that are causally inert. But if we adhere to the "naturalistic" methodology for resolving such questions, we have to do more than merely point to one of these differences and claim it to be relevant. We will need to argue for its relevance by appealing to epistemological judgements common to all scientific realists, nominalists and anti-nominalists alike.

Here's what *I* think is the relevant difference. While both T^* and $T^\dagger$ result from the application of some complex modal operator to the original theory T, the operators in question are of different logical kinds. The one in $T^\dagger$—'The facts about the positions and motions of atoms are consistent with the hypothesis that...'—is, in essence, a *possibility*-operator. In the often helpful idiom of possible worlds, $T^\dagger$ can be thought of as saying that there is *some T*-world where the facts about the positions and motions of atoms are just as they actually are. By contrast, the operator in T^*— 'if such-and-such mathematical axioms were true, it would be the case that...'—has the logical properties of a *necessity*-operator. In possible-worlds terms, it says in effect that *every* world where

---

[25]The result I have just mentioned holds only for the versions of Field's theory that use logical resources stronger than first-order logic. For debate about whether a commitment to the superiority of theories using first-order logic might revive the indispensability argument, see Shapiro 1983 and Field 1985.

[26]And even if the programme were fully successful in basic physics, there would be a difficult further question about the role of mathematics in "higher-level" sciences like statistical mechanics and population ecology.

the mathematical axioms are true that is like the actual world in concrete respects is a T-world.[27]

Now to the argument that this is an epistemologically important difference. Surely, if science can tell us about the unobservable at all, one thing it has told us is this: matter is not all alike, but comes in different kinds. Two bits of matter that are alike in respect of shape, size and motion can still fail to be exactly alike—can fail to be duplicates. For example, they might fail to be duplicates by having different quantities or distributions of mass or charge, or by being composed of different kinds of elementary particles.

We have good reason to believe this in spite of the fact that for any theory T that entails that matter comes in different kinds, we can find a weaker theory that makes the same predictions as T about the distribution of matter in space and time, without ruling out the hypothesis that matter is all alike.[28] One way to formulate such a theory is to emulate $T^{\dagger}$, by saying something like 'The facts about the distribution of matter in space and time are consistent with the hypothesis that T.' But provided that T already contains a little mathematics—enough to entail the existence of sets of particles—there is no need to use the modal notion of consistency: we can achieve the same effect using existential quantifiers. Suppose for the sake of concreteness that T gets to entail that matter is not all alike by virtue of entailing that elementary particles come in different kinds: electrons, photons, quarks, neutrinos.... To formulate a new theory T^{-} consistent with the claim that matter is all alike, we will need to introduce some new variables $v_1, v_2, v_3, v_4...$, corresponding to T's one-place predicates 'electron', 'photon', 'quark', 'neutrino'.... We then proceed in two steps. First, for each one-place atomic formula, like 'x is an electron' or 'x is a photon', in T, we substitute the two-place formula '$x \in v_i$', where v_i is the variable corresponding to the predicate in the original formula. Second, we insert existential quantifiers at the beginning of the resulting formula, to bind all the new variables. The resulting theory T^{-} says in effect that there is *some* way to assign sets of

---

[27]Note that if the mathematical axioms are necessarily false, we will need to think of the "worlds" in question as metaphysically impossible worlds.

[28]I take it that the hypothesis that matter is all alike is (a priori) consistent with any consistent hypothesis about the distribution of matter in space and time. If we cannot rule out a priori the hypothesis that there is some matter shaped in a certain way, then we cannot rule out a priori the hypothesis that some homogeneous matter is shaped in that way.

particles to be the extensions of the predicates 'electron', 'photon', 'quark', 'neutrino'... in such a way that T becomes true. This is clearly consistent with the hypothesis that all matter is alike, while having all the same consequences as T as regards the distribution of particles across space and time.[29]

Since the existence of observationally adequate theories like T^- in fact does nothing to undermine our reason to believe that matter comes in different kinds, T^- must be a much worse theory than T. There is a general pattern here. If we want to weaken a theory so as to eliminate its commitment to some sort of hidden structure, we can very often do so by replacing the vocabulary purporting to characterise this structure with variables of an appropriate sort, bound by initial existential quantifiers.[30] So we can draw a general moral: since commitment to hidden structures often plays an essential part in good explanations, such existential quantification must be a source of theoretical badness. When we replace a constant with a variable bound by an initial existential quantifier, the resulting theory will typically be considerably worse than the one we started out with.

---

[29]Provided that the original theory T posits points and regions of flat spacetime, we can use an extension of this method to eliminate its commitment to subatomic particles altogether. To begin with we must supplement T by adding "bridge laws" to make explicit the ways in which the facts about the positions and motions of atoms depend on the facts about subatomic particles. Next, we reconstrue all talk of subatomic particles as talk of regions of spacetime: instead of saying that a particle is *present at* a certain spacetime point, we say that the point is a *part* of the region that is the particle. Finally, as before, we replace predicates like 'electron' that purport to pick out different kinds of spacetime regions with variables ranging over sets of spacetime regions, and add initial existential quantifiers to bind these variables. The resulting theory will have the same consequences as the original theory as regards the spatiotemporal distribution of atoms, but will be consistent with the hypothesis that the only concrete things there are, fundamentally speaking, are atoms moving around in a spacetime manifold that is otherwise completely homogeneous. But this hypothesis entails that there aren't any subatomic particles, even in a superficial sense. Perhaps subatomic particles could exist, superficially speaking, in a world where there were only spacetime points and atoms, fundamentally speaking. But this could happen only in virtue of some asymmetries in the intrinsic character of the spacetime, such as electromagnetic fields, or variable curvature.

[30]Indeed, once we have enough mathematics on board, we can always use existential quantifiers instead of possibility-operators like the one in $T^\dagger$. Instead of saying that the facts about the positions and motions of atoms are consistent with T, we can say that there is some model of T that accurately represents the facts about the positions and motions of atoms.

But *universal* quantification doesn't seem to be a source of badness in the same sort of way. Indeed, when it is possible to weaken a theory by replacing one of its constants with a variable bound by an initial (restricted) universal quantifier, the result of doing so is often considerably better than the original theory. Consider for example physical theories formulated in co-ordinate terms. When we assign 'x', 'y' and 'z' co-ordinates to particles, we certainly don't mean to suggest that there is a single distinguished, physically privileged co-ordinate system, concerning which it would make sense to wonder how far are we are from the nearest axis. Rather, we are implicitly claiming that such-and-such equations hold in every admissible co-ordinate system. Similarly, when a theory uses numbers to measure mass or charge, it is often understood that the choice of a scale is arbitrary, so that what's really being said is that the theory holds true for any admissible assignment of numbers.[31] All this seems quite unproblematic. We would make these theories worse, not better, if we eliminated the implicit universal quantification by positing a metaphysically special One True Co-ordinate System or Privileged Unit of Charge.

Now, the bad theories $T^\dagger$ and T^- seem to be bad in the very same way. So our explanation of the badness of $T^\dagger$ should appeal to some factor common to $T^\dagger$ and T^-. What could this factor be? If T doesn't contain any existential quantifiers of the problematic kind, neither does $T^\dagger$. But it does contain the possibility-operator 'The facts about the positions and motions of atoms are consistent with the hypothesis that...'. And there is a notable logical affinity between possibility-operators and existential quantifiers, one that we exploit when we express claims about possibility in terms of possible worlds. (One need not endorse the unpopular opinion that 'possibly' *means* 'in some possible world' to see this.) Since this is the clearest point of similarity between $T^\dagger$ and T^- that does not also hold between $T^\dagger$ and the unproblematic theories involving universal quantification over co-ordinate systems and the like, we can plausibly conclude that it is the basis for the epistemological similarity between the theories. Applying a possibility-operator to a theory, just like changing one of its constants to a variable bound by an initial existential quantifier, generally leaves one

---

[31]Gauge theories—which, as standardly interpreted, describe equations that are supposed to be satisfied by every assignment of numbers (or vectors, or whatever) to spacetime points that fits in the right way with the underlying facts—provide an even more dramatic example. See Belot 1998.

with a much worse theory—a theory that, if true, would cry out for further explanation. If so, the example of $T^{\dagger}$ gives us no reason to think that applying a necessity-operator to a theory, as we do when we move from T to T^{*}, need do anything to make it worse. As far as the explanatory status of T^{*} is concerned, the analogy that turns out to be most important is not the one between T^{*} and the bad theory $T^{\dagger}$, but the one between T^{*} and the good theories with initial universal quantifiers ranging over co-ordinate systems.

These are, I admit, dialectical baby steps. It's all very well to point out suggestive analogies and disanalogies; the ultimate test for which analogies matter must come when we actually attempt to formulate general epistemological principles and see if we can get them to fit with our intuitions about particular cases. I hope to take some steps in this direction in future work. But I hope that I have already said enough to shift the burden of proof back to those who maintain that belief in the reality of abstract objects can be justified by their role in scientific explanations.

4 Abstract objects in philosophical explanations

Much of philosophy is concerned with questions of the form 'What is it to be F?', or 'What is it for something to R something else?'—requests for analyses, or real definitions. Believers in abstract objects have frequently invoked them in their answers to such questions. They have given analyses on which apparently innocuous claims such as the following turn out to be implicitly about abstract objects:

(9) (a) Necessarily, all dogs are dogs.

(b) Some people believe that penguins eat fish.

(c) If I had missed the bus this morning I would have been late for class.

For example, (9a) is often held to be analysed as 'the proposition that all dogs are dogs is necessary' (Bealer 1993); (9b) as 'some people believe the proposition that penguins eat fish' (Schiffer 2003: chapter 1); (9c) as 'the closest worlds where I miss the bus are worlds in which I am late for class' (Stalnaker 1968, Lewis 1973).

Faced with analyses of this sort, nominalists have three options. First, they can accept the analyses, and conclude that the sentences in question are not true, taken in the fundamental sense. Second, they can suggest alternative analyses. Or, third, they can maintain that the relevant notions are primitive and unanalysable.

Taking the second option need not always mean a lot of hard philosophical work. A lazy nominalist can simply take an analysis mentioning abstract objects, and insert something like 'if there were abstract objects, it would be the case that...' at the beginning.

The hardest cases for nominalism are those where the first of these options, and the lazy version of the second option, can be ruled out. For example, if we want to use counterfactuals in paraphrasing ordinary abstract-object talk, as suggested in section 2, we obviously can't hold that sentences involving the counterfactual conditional are never true in the fundamental sense. And it would be circular to analyse 'If it were the case that *P*, it would be the case that *Q*' in general as 'If there were abstract objects, the closest possible worlds in which *P* would be worlds in which *Q*.' So we are left with a choice between taking counterfactual conditionals primitive and maintaining they can be analysed without bringing in abstract objects.

Despite its importance, I won't have anything more to say here about the difficult task of providing an nominalistically acceptable account of counterfactuals.[32] Instead, I will consider another hard case, that of *basic physical predicates*. What is it for something to be an electron, for example? Some anti-nominalists, such as David Armstrong (1978a,b), answer as follows:

(10) To be an electron is to instantiate the property *electronhood*.

Surely the first option—accept the analysis, and concede that there aren't, fundamentally speaking, any electrons—is not a real option here. (Not that it is so obvious that there are electrons, fundamentally speaking—but if there aren't, it is not because there are no properties!) Likewise, the lazy version of the second option—claiming that to be an electron is to be something which would instantiate *electronhood* if there were abstract objects—is deeply unattractive. Surely if this

---

[32]The view I favour is one on which the analyses of counterfactuals will typically be statable only in a language that allows for infinitely long sentences.

counterfactual is true of an object, it is true because it is an electron, and not the other way round. So we are left with the choice of taking 'electron' as primitive, or finding some analysis quite different in character from (10).

For too long, analyses like (10) were considered only in the context of the claim that all instances of the following schemata are true, no matter what predicates we substitute for '*F*' and '*R*':

(11) To be *F* is to instantiate the property, *F-ness*.

(12) For *x* to *R* *y* is for *x* to bear the relation, *R-ing*, to *y*.

But there are at least two good reasons to reject this sweeping attempt to provide real definitions for all predicates at once.

First, there is Bradley's regress (Bradley 1897: chapter 2). If we accept the following instance of (12)

(13) For *x* to instantiate *y* is for *x* to bear the relation, *instantiation*, to *y*

we have taken the first step in a vicious infinite regress. We take the next step when we accept the corresponding analysis of the predicate on the right-hand side of (13):

(14) For *x* to bear *z* to *y* is for *x*, *y* and *z* to stand in the relation, *bearing*.

And so on. This can't go on forever: analyses must come to an end somewhere.

Second, many predicates already have real definitions not in the form of (11) or (12). For example, we seem to have learned by doing science that

(15) To be a helium atom is to be an atom whose nucleus contains exactly two protons.

Putting this together with the relevant instance of (11)

(16) To be a helium atom is to instantiate the property, *being a helium atom*

we can presumably conclude that

(17) To instantiate the property, *being a helium atom*, is to be an atom whose nucleus contains exactly two protons.

I can see how (17) might be true if we were thinking of the property *being a helium atom* as existing only in a superficial sense, so that truths that appear on the surface to involve it turn out, on deeper analysis, to be truths of a different sort. But how could it be true if the property is a fully real thing, existing in the fundamental sense? I can't see how an account of what it is for an object to instantiate a certain real entity could fail to mention that entity at all, any more than an account of what it is for a region of space to contain a certain real particle could fail to mention that particle at all.[33]

So much the worse for (11) and (12) in full generality. But, as Armstrong forcefully argues, it would be a mistake to dismiss the idea that *some* instances of these schemata are true. According to Armstrong, (11) holds only for an elite minority of predicates, which it is up to physics to identify.[34] It is a good question what, if anything, a nominalist should put in place of these analyses.

One might reasonably object that the question what it is to be an electron is one we should not expect to be able to answer from the armchair. Physicists discovered that to be a helium atom is to be an atom whose nucleus contains exactly two protons, and that to be a proton is to be a complex of quarks of certain kinds bound together in certain ways; it would be foolish for metaphysicians to rule out the possibility of some similar discovery about what it is to be an electron.[35] But there is still a challenge: the analysis of "physical" predicates like 'helium atom', 'proton' and 'electron' in terms of other such predicates cannot go on forever. Eventually (since there can't be infinitely regressive or circular real definitions) there must be a *basic* physical predicate that doesn't have a real definition involving other physical predicates—either because it has no definition at all, or

---

[33]Cf. Fine 2001.

[34]Armstrong also holds that the properties that feature in the analyses of these elite predicates are the only properties there are, fundamentally speaking. But even a believer in "abundant" properties could agree with Armstrong that only a few of these properties feature in true instances of (11).

[35] I should note that Armstrong believes in 'structural' properties—e.g. a property *being a helium atom* that is necessarily instantiated by any atom whose nucleus contains exactly two protons. And he seems to endorse (11) for the predicates corresponding to such properties. Thus, unlike me, he apparently sees no difficulty in accepting both (15) and (16).

because it has a definition that doesn't involve any physical predicates, e.g. a definition of the form of (11). The real challenge for the nominalist is to say something about what happens then. From now on I'll assume for ease of exposition that 'electron' is such a basic physical predicate.

So, why would one think it better to accept (10) rather than taking 'electron' as primitive, or analysing it in some other way? The appeal of (10) becomes apparent only when we turn to another class of predicates for which analyses in terms of abstract objects are often proposed, namely predicates having to do with resemblance. A good example to focus on is the notion of duplication, or perfect intrinsic resemblance.[36] Suppose that the believer in properties analyses this as follows:

(18) For x to be a duplicate of y is for x and y to instantiate exactly the same things.[37]

Putting this together with (10), we can account for the necessity of the following claim:

(D) Whenever x is an electron and y is a duplicate of x, y is an electron.

For, when we replace the predicates 'electron' and 'duplicate' with their proposed analyses, (D) reduces to an elementary logical truth:

(D*) Whenever x instantiates *electronhood* and y and x instantiate exactly the same things,

y instantiates *electronhood*.

This is a significant explanatory achievement. It is not obvious what nominalists should put in its place.

---

[36]Armstrong tends to focus instead on predicates like 'exactly resembles in some respect' (proposed analysis: 'has some property in common with'), and 'is a natural class' (proposed analysis: 'has as members all and only the things that instantiate some property'). But it is not clear that a nominalist should regard these predicates as precise enough to admit of any easily-stated analysis.

[37]If one rejects Armstrong-style "structural" properties (see note 35), and accepts the existence in the fundamental sense of composite objects (contrary to the position defended in my 2002 and 2005), one will require a more complicated analysis of 'duplicate' than this. The problem with (18) is that composite objects can fail to be duplicates by having parts that fail to be duplicates, even though they themselves may not instantiate any real properties. Here is an alternative analysis that avoids this problem: for x and y to be duplicates is for there to be a one-to-one correspondence (bijection) between the parts of x and the parts of y, such that corresponding parts instantiate the same properties and stand in the same relations (cf. Lewis 1986: 61–62),

There are three basic options, short of simply denying the necessity of (D).[38] First, we could maintain that the necessity of (D) follows from an analysis of 'duplicate' in which the predicate 'electron' occurs, presumably along with other predicates. Second, we could maintain that it follows from an analysis of 'electron', either alone or in conjunction with some analysis of 'duplicate'. Or, third, we could maintain that the necessity of (D) cannot be explained in terms of the real definitions of its constituent predicates. I will consider each of these strategies in turn.

(i)   The physical strategy

Although there have been few explicit defences of the first strategy, I suspect that it is in fact quite popular.[39] The idea is straightforward: just as we looked to science to provide us with real definitions of predicates like 'water' and 'helium atom', so we must ultimately look to science to provide us with real definitions of "duplicate" and other predicates of the same general, structural sort. What might such an analysis look like? Bracketing complications raised by duplication amongst complex objects, all we need is a simple conjunction of biconditionals, one for each monadic basic physical predicate:

(19)   For x to be a duplicate of y is for it to be the case that x is an electron iff y is an electron,

and x is a quark iff y is a quark, and....[40]

---

[38]One might refuse to accept that (D) is necessary on the grounds that it might not even be true. If things get to be electrons in virtue of how they stand to other things—e.g. in virtue of being *lower in charge* than other particles (Lewis 1986: 76)—there is nothing to stop a non-electron from being a duplicate of an electron. The easiest way to respond to this worry is to weaken (D) by replacing the notion of duplication with that of *qualitative indiscernibility* (Lewis 1986: 63)— exact resemblance in extrinsic as well as intrinsic respects, of the sort that can occur only if the whole world is perfectly symmetric.

[39]Devitt (1980), Field (1992), van Cleve (1994) and Melia (2005) all defend views that might be interpreted as versions of the physical strategy.

[40]As with the analysis of duplication in terms of instantiation (note 37), we will need a more complicated analysis to handle duplication among complex objects. Here is one way we might do it:

> For x to be a duplicate of y is for there to be a bijection f from the parts of x to the parts of y, such that for all parts $z_1, z_2, z_3 \ldots$ of x: z_1 is an electron iff $f(z_1)$ is an electron, $\ldots$ and z_1 is more massive than z_2 iff $f(z_1)$ is more massive than $f(z_2)$, $\ldots$ and z_1 is

Since this obviously suffices to entail the necessity of (D), it leaves the nominalist free to take 'electron' as primitive.

The main problem I see for the physical strategy is its inability to accommodate what I will call the *Alien Properties Intuition* (cf. Lewis 1983: 158ff.). Roughly speaking, this is the intuition that that there might be alien properties, not identical to or constructed from any actual properties.[41] Of course, nominalists can't accept that way of putting it: but we can still think that when believers in properties talk about situations containing alien properties, they are talking about genuine possibilities, even if they are misdescribing them. Typically, these possibilities will contain things that fail to be duplicates even though they are indiscernible as far as the basic predicates of actual-world physics are concerned:

(20) Possibly, there are two simple things x and y that are not duplicates, although x is an electron iff y is an electron, and x is a quark iff y is a quark, and...

One special case concerns the possibility that nothing falls under any of the basic predicates of actual-world physics. The proponent of the physical strategy is committed to the claim that if this were the case, the world would be *completely homogeneous*. Any two simple things would be duplicates, and indeed qualitatively indiscernible. But this seems wrong. Intuitively, there could be all kinds of interesting goings-on at possible worlds where nothing falls under any of the basic predicates of actual-world physics: they could be every bit as richly varied in their own ways as the actual world is in its.[42]

---

between z_2 and z_3 iff $f(z_1)$ is between $f(z_2)$ and $f(z_3)$, and.... Here the quantified formula has one conjunct for each basic physical predicate. Of course, this will not be acceptable as it stands to a nominalist, given the use of quantification over functions. But we have already seen, in section 2, how such quantification can be paraphrased in such a way as to be acceptable to the nominalist.

[41]Ironically, Armstrong (1989a) once argued for the claim that alien properties are impossible. But he later changed his mind about this (1997: section 10.4).

[42]Notice that some of the modal intuitions that conflict with an analysis like (19) can be stated without using physical predicates like 'electron' at all. For example, an analysis using exactly seventeen basic physical predicates will entail, counterintuitively, that it is impossible for there to be $2^{17} + 1$ simple objects none of which is a duplicate of any of the others. This may be important. Several philosophers (e.g. Bealer 1987, Chalmers 1996) have attempted to draw a

If this is right, it shows that 'duplicate' is just not the sort of predicate that could have an analysis in physical terms. Arguments of the same sort will apply to other predicates with a similarly "structural" or "topic-neutral" character. That's a lot to rest on intuitions about such remote possibilities. Although I feel the pull of the Alien Properties Intuition quite strongly, I'm not sure that its force would be strong enough to make me reject nominalism, if it turned out that the only way to continue being a nominalist was to give it up. But let's press on and consider the other options.

(ii)   The structural strategy

The second option for the nominalist is to explain the necessity of (D) as following from a real definition of 'electron', perhaps in conjunction with a real definition of 'duplicate'.

What might the analysis of a basic physical predicate like 'electron' look like? In the first half of the twentieth century, it was widely believed that physical predicates could be analysed in terms of "observational" predicates: to be an electron is to be something disposed to make white tracks of a certain shape in cloud chambers of a certain design, etc. This sort of view is now deservedly unpopular, for reasons I won't go into. But even if something like this were true, it wouldn't really help us, since observational predicates like 'white' raise the same essential problem for the nominalist as basic physical predicates like 'electron'. Just as any duplicate of an electron must be an electron, so any duplicate of a white object must be white.[43] And as far as the explanation of this necessity is concerned, the analogue of the physical strategy—an analysis of 'duplicate' in terms of observational predicates like 'white'—looks even more problematic than the corresponding explanation of (D). The fact that two objects cannot be distinguished by our observational predicates doesn't entail that they are duplicates.

---

principled distinction between words like 'water' which can give rise to the phenomenon of the necessary a posteriori, and other words which cannot. But there is any such distinction to be drawn, it would seem that all the words in the sentence 'it is not the case that there are $2^{17} + 1$ simple objects none of which is a duplicate of any of the others' belong to the latter category. If so, the proposition expressed by this sentence could be necessary only if it were knowable a priori, as it clearly is not.

[43]Or at least, anything qualitatively indiscernible from a white thing: see note 38.

How could we analyse 'electron' without merely postponing the problem in this way? We might, for example, be Resemblance Nominalists, and attempt—somehow or other—to analyse 'electron' (along with everything else) entirely in terms of *resemblance*. That need not mean that the only nonlogical predicate we can use in our analysis is 'x resembles y': most Resemblance Nominalists have allowed themselves more flexible primitives to work with. For example, Price (1953) seems to treat claims of the form 'x_1 resembles x_2 at least as much as y_1 resembles y_2' as primitive. It is not hard to see how one might go about analysing 'duplicate' in terms of predicates like these. One could say for example that for x to be a duplicate of y is for x to resemble exactly the same things as y, or for x to resemble y at least as much as y resembles itself. While we might object to these analyses on other grounds, at least there is no conflict with the Alien Properties Intuition.

There are various other notions with the same abstract, structural character as resemblance—notions which would not look out of place in an analysis of 'duplicate', and hence could occur in an analysis of 'electron' without merely postponing our problem. For example, Natural Class Nominalists take as primitive the notion of a "natural" class—informally speaking, a class of things that all resemble one another in some one respect and resemble nothing else in that respect.[44] Taken at face value, this predicate is of no use to a nominalist in my sense, who denies that there really are any classes (sets). But this is one of those cases where a claim about classes can be regarded as a misleading way of saying something properly expressed using plurals. That is, instead of saying that the class of electrons (singular) *is* natural, we should really say that the electrons (plural) *are*, collectively, natural.[45] Again, it is not hard to see how this notion might feature in a plausible analysis of 'duplicate'. For example, we could say that for x to be a duplicate of y is for it to be the case that whenever some things are natural, x is one of them iff y is.

Mereological predicates like 'part of' seem to belong in the same "structural" category.[46] Other

---

[44]For discussions of this view see Lewis 1983 and Armstrong 1989b.

[45]For arguments, independent of nominalism, against the view that that plural claims of this kind can be analysed in terms of sets, see Boolos 1984 and Oliver and Smiley 2001.

[46]Although it is controversial whether anything that exists in the fundamental sense has any parts—see Dorr 2005.

cases are harder to adjudicate. Perhaps certain causal vocabulary should be allowed. Some (e.g. Campbell 1991) even put *spatiotemporal* predicates in this category—though from my point of view, the inclusion of 'before' or 'between' in a definition of duplication looks only slightly less problematic than the inclusion of 'electron' or 'quark'. But we don't really need to decide these questions: the hard part is seeing how 'electron' could have a definition in terms of *any* of these materials.

It has generally been assumed in discussions of Resemblance Nominalism that the analyses of most ordinary predicates will involve reference to certain "paradigm" particulars. For example, adapting a suggestion of Price's (1953), one might propose the following analysis for 'electron':

(21) To be an electron is to resemble each of e_1, e_2, ... e_n at least as much as any two of them resemble one another.

There are various possible complications: for example, one might want to have 'anti-paradigms' which one must *fail* to resemble to be an electron.[47]

One initially offputting fact about analyses like (21) is the arbitrariness of the choice of paradigms. It is not plausible that we are simply ignorant of the identity of the paradigm electrons. But this doesn't seem like a serious problem, since it is open to the proponent of the strategy to claim that there is no determinate fact of the matter as regards the identity of the paradigms: in a sense, 'electron' is vague, though we may know a priori that it has no actual borderline cases.[48]

A second objection to analyses like (21) makes use of the notion of intrinsicness: Whether something is an electron is a matter of what that thing is like intrinsically. Whether something resembles the paradigm electrons is not. Hence, it can't be the case that to be an electron just is to resemble the paradigm electrons.[49]

How should a proponent of the structural strategy understand the notion of intrinsicness that features in this argument? On the one hand, an intrinsic characterisation of something is supposed

---

[47]For discussion of some of these complications see Rodriguez-Pereyra 2002: 131–141.

[48]Alternatively, we could allow all electrons to play the role of paradigms: this is the approach favoured by Rodriguez-Pereyra (2002).

[49]Armstrong (1978a: 50–51) makes essentially this objection.

to be one that neither explicitly nor implicitly refers to, or quantifies over, anything apart from the thing in question and its parts (and the properties and relations they instantiate, and the sets they are members of—but these are things a nominalist doesn't believe in.) On this demanding conception, adopting the structural strategy requires one to say that only a very few predicates, like 'resembles itself' or 'has exactly seven duplicate parts', characterise things intrinsically. Clearly, if 'electron' has an analysis in "structural" terms, it will not count as intrinsic in this demanding sense. On the other hand, it is also supposed to be necessary that any two things that have exactly the same intrinsic features are duplicates. But this clearly won't be the case if we adopt the demanding conception. If any form of the structural strategy is correct, it is pretty likely that *any* two simple things are alike in all the respects that count as intrinsic on the demanding conception, whether or not they are duplicates. Given these conflicting desiderata, perhaps the best thing to say is that 'intrinsic' is ambiguous between the demanding sense and some more liberal, but more metaphysically arbitrary, sense on which basic physical predicates do count as characterising things intrinsically. But whatever we end up saying, we must concede that the structural strategy will be unacceptable to those who think they have a firm grip on a notion of intrinsicness satisfying both desiderata.

There is a third problem for the strategy of mentioning particular objects in the definition of 'electron', which seems to me by far the most serious. Namely: any workable analysis of this sort will entail that it is necessary that at least some of those objects exist, if there are any electrons (Armstrong 1978a: 51–53; van Cleve 1994: 579). This is seriously implausible. Surely there could still have been electrons even if *no* actual particulars had existed. Let's call this the *Alien Particulars Intuition*. If we accept it, the idea of using paradigms in the analysis of basic physical predicates must be given up.[50]

---

[50]One might attempt to escape this argument by using a "cross-world" notion of resemblance, saying something like

(21*) To be an electron is to resemble each of e_1, e_2... *as they actually are* at least as much as they actually resemble one another.

This is unproblematic for modal realists like Lewis (1986) and Rodriguez-Pereyra (2002). But any defence of nominalism that relied on modal realism would be widely, and in my view correctly, regarded as a *reductio*. For a non-modal-realist, "cross-world" similarity can hardly be primitive.

The Alien Particulars Intuition rules out just about any structural analysis of 'electron' involving reference to particular objects. That leaves us with *purely general* structural analyses: analyses according to which the facts about the structure of the world are already sufficient to fix which things are electrons, irrespective of which particular objects occupy the positions in the structure.

While this approach is consistent with the Alien Particulars Intuition, it has its own difficulties with modal intuition. Many philosophers (e.g. Lewis 1986, Armstrong 1989a) accept what I will call the *Humean Intuitions*: they think that there are few, if any, interesting structural conditions something must satisfy in order to fall under a basic physical predicate. Instead of obeying the actual laws of nature, electrons could be distributed in some very different way. For example, there could be exactly seven electrons, evenly spaced in a straight line and motionless in otherwise empty space. Likewise, there could be exactly seven *non*-electrons, evenly spaced in a straight line and motionless in otherwise empty space. But if both of these situations are possible, it cannot be the case that whether something is an electron depends only on its place in the structure of resemblances, natural classes, or whatever: these kinds of structural facts are exactly the same at the world with seven electrons and at the world with seven non-electrons. Similar examples could be multiplied *ad nauseam*.

But the Humean Intuitions are by no means uncontroversial. Several philosophers have endorsed, for reasons that don't on their face have much to do with nominalism, the "dispositional essentialist" view that it is necessary that the objects falling under a basic physical predicate like 'electron' should play a certain characteristic role in the laws of nature.[51] On this sort of view, many of the truths that would traditionally be classified as laws of nature—"nomological necessities"— will in fact be metaphysically necessary. For example, it might be necessary that if there are any

---

One could attempt to analyse it in terms of objects playing similar structural roles at their respective worlds: such an analysis would face the same difficulties as the purely general structural analyses I will be considering in the main text. Ideas along these lines have been considered under the heading of "counterpart theory for properties": see Hazen 1996, Heller 1998, Black 2000 and Hawthorne 2001.

[51]Defenders of dispositional essentialism include Shoemaker (1980, 1998), Swoyer (1982) and Ellis and Lierse (1994). Hawthorne 2001 is an excellent survey of the arguments. For opposition, see Sidelle 2002.

electrons, they repel one another and attract any protons there might be.[52]

If we want to maintain that basic physical predicates have structural definitions, can we at least avoid having to classify as metaphysically necessary any truths we would not otherwise have any reason to classify even as nomologically necessary? Unfortunately the answer seems to be 'no', at least if we hold onto our assumption that 'electron' is a basic physical predicate.[53] The problem is that electrons and positrons play symmetric roles in current physical theories. If one reinterprets 'electron' as standing for positrons, and 'positron' as standing for electrons, and makes certain other substitutions of a similar nature, the theory will still be true on the new interpretation. This means that for a purely general structural definition of 'electron' to avoid incorrectly classifying positrons as electrons, it will have to appeal to some distinguishing characteristic of the electrons that a Humean would not even regard as nomologically necessary. For example, if there are in fact many more electrons than positrons, we might say that to be an electron is to be a member of the *largest* natural class playing such-and-such nomological role. If the predominance of electrons over positrons is a merely local phenomenon, we will have to rely on more subtle differences—e.g. the fact that electrons outnumber positrons in the region of space that surrounds a planet that is appropriately similar in structural respects to the planet Earth as it actually is.[54] Clearly it would be unrealistic to expect precision here. If the laws of nature alone don't suffice to do the job of distinguishing electrons from positrons, we're going to have settle for considerable vagueness as regards just how much of the actual "electron role" some things would have to play to count as electrons.

This is certainly a bit unsettling. But I am inclined to think that if we can reconcile ourselves to

---

[52]Some (e.g. Swoyer 1982) go so far as to hold that all nomologically necessary truths are metaphysically necessary: this requires either rejecting the Alien Properties Intuition, or adopting an unusually restrictive notion of nomological necessity.

[53]The problems physical symmetries pose for dispositional essentialism are extensively discussed by Hawthorne (2001).

[54]In the unlikely event that the electrons are *structurally indiscernible* from the positrons—if, for example, there is eternal recurrence in both directions, with every second epoch having positrons substituted for electrons—there will be no way to make the necessary distinctions at the purely structural level. But perhaps it wouldn't be so bad to reject the Alien Individuals Intuition in such bizarre circumstances.

giving up the Humean Intuitions, we should not be too concerned to find that some of the truths we end up counting as metaphysically necessary are truths that someone in the grip of those intuitions wouldn't even think of as laws of nature. When the dispositional essentialist idea that objects at a world very unlike the actual world (such as the world with seven static identical particles) could not be electrons starts to seem compelling, it does so precisely because one cannot see what could make objects at a world like that *count* as electrons. Once we start expecting non-trivial answers to questions of this sort, they will seem equally pressing when we consider the putative possibility of electrons and positrons switching roles. We will want to know what could make these things count as the positrons and these as the electrons, rather than vice versa. For a proponent of the Humean Intuitions, this is of course a bad question. But in my experience it's not so hard to get people to feel its force.[55]

(iii)   Brute necessities

If all this is right, the only way to explain necessities like (D) without giving up the Alien Properties Intuition, the Alien Particulars Intuition, or the Humean Intuitions is to reject nominalism. Before we can evaluate this argument, we must ask why such necessities should *need* explanation. What if a nominalist were to maintain that they are "brute" necessities, which cannot be explained by any analyses of their constituent predicates?

One might object to this view on the grounds that necessities never are brute. The only genuinely necessary truths—one might maintain—are those that reduce, upon analysis, to truths of

---

[55]There is a helpful analogy between the problem the predicates 'electron' and 'positron' pose for the Structural Nominalist and the problem 'left' and 'right' pose for those who think that facts about leftness and rightness are not among the basic geometric facts about the world. We are tempted by the intuition that the other geometric facts don't determine the facts about left and right: for example, that a hand in otherwise empty space could be either right or left. Despite this, the received view is that we need not expand our conception of the basic geometric facts to account for leftness and rightness. 'Left' and 'right' can be analysed either using paradigms, or by appealing to some initially contingent-seeming asymmetries in the universe, such as the fact that human beings' hearts are on the left side of their bodies. For further discussion, see the papers collected in van Cleve and Frederick 1991.

logic (in some narrowly-delimited sense of 'logic').

This is the strongest form a ban on brute necessities might take: various natural weakenings would still work in the argument. I will briefly mention three. (i) If we wanted to allow for facts about the *essences* of objects as a distinct source of necessity (see Fine 1994), we might still hold that all *purely general* necessary truths—all truths that do not either implicitly or explicitly involve reference to any particular objects—reduce to truths of logic. (ii) If we were persuaded by Kripke's argument (1972: 156) for the necessity of sentences like 'there are no unicorns' and 'there is no phlogiston' but despaired of finding appropriate analyses of 'unicorn' and 'phlogiston', we might want to make a special exception for such "semantically defective" predicates.[56] (iii) More ambitiously, we might want to make an exception for a category of "non-factual" vocabulary (perhaps including evaluative terms like 'good') whose communicative function is not, strictly speaking, that of expressing our beliefs about reality, but something quite different.[57] Since it is impossible to analyse the non-factual in terms of the factual, most necessary truths essentially involving non-factual vocabulary (e.g. 'love for one's children is good') will not admit of reduction to logical truths. None of these weakenings is of much use to the nominalist faced with the task of explaining the necessity of (D). (i) If we mentioned some particular objects in the analysis of 'electron', we might in principle attempt to explain the necessity of (D) in terms of the essences of these objects; but the Alien Particulars Intuition rules out such analyses. (ii) Only an idealist could take seriously the idea that all basic physical predicates are semantically defective; and the idealist would face an exactly parallel problem involving mental predicates. And (iii) if the distinction between non-factual and factual vocabulary makes sense at all, 'electron' and 'duplicate' seem to belong on the factual side of the line.

But orthodox anti-nominalists are in no position to accept the claim that there are no brute ne-

---

[56]'Phlogiston' was introduced by eighteenth-century chemists as a name for a hypothetical substance emitted in burning and the calcination of metals. See Dorr 2005 (section 16) for a more detailed discussion of the case of semantically defective predicates and its ramifications.

[57]Blackburn (1993) and Gibbard (1990) are the most prominent evaluative non-factualists. For a defence of the distinction between the factual and the non-factual and some interesting ideas about how to draw it, see Fine 2001.

cessities, even when these qualifications are taken into account. For most anti-nominalists will be committed to the necessity of a wide range of axioms specifying conditions under which numbers, sets, and logically complex properties and relations exist. Since these axioms are existential in form, there is no hope of reducing them to truths of standard logic just by analysing predicates like 'set' and 'property'. Moreover, if they are true, many of these axioms are purely general, semantically non-defective, and fully factual. Some anti-nominalists (e.g. Bealer 1982) advocate a wider use of 'logic' on which these axioms will count as logical truths. But I can see no *independent* motivation for a principle that would allow such axioms to be necessary while requiring the necessity of (D) to be explained by analyses of 'duplicate' and 'electron'.

In the absence of such a principle, presumably the debate will have to turn on considerations of economy. The question will be which of the available theories makes do with the smallest, simplest set of brute necessities.[58] But it is not at all clear that anti-nominalists will do better by this criterion. And even if it were, it would not be clear how this kind of economy should be weighed against the considerations of ontological economy that favour the nominalist. On the whole, I doubt nominalists has much to fear once the dispute turns into a contest of economy.

However, not all anti-nominalists accept the necessity of all the usual axioms. For example, some of them have denied that it is necessary that for any two properties p and q, there is (in the fundamental sense) a property instantiated by exactly those objects that instantiate either p or q.[59] We can imagine an extreme version of this view, on which the only necessary general principles about properties and instantiation are those that reduce, under analysis, to truths of logic (narrowly conceived). A proponent of this view would have a principled reason for insisting that the necessity of (D) must be explained via analyses of 'electron' or 'duplicate'.

But the prospects for this kind of view seem poor. Consider, first, a version of the view according to which the predicate 'instantiates' is primitive and unanalysable, so that for sentences

---

[58]The appeal to economy of brute necessities is one of Armstrong's characteristic argumentative moves—see, e.g., Armstrong 1978a: 49–50. Lewis (1983) is also explicit about the role of this sort of economy.

[59]See Ramsey 1925; Armstrong 1978b: chapter 13; Mellor 1991.

whose only piece of nonlogical vocabulary is the predicate 'instantiates', metaphysical necessity coincides with strictly logical necessity, and metaphysical possibility with strictly logical possibility. This seems utterly incredible. Not just any old collection of points and arrows connecting them represent a way things might be, if the arrow is interpreted as meaning 'instantiates'! Is there a possible world with just 17 entities, $a_1 \ldots a_{17}$, such that a_1 instantiates a_2, a_2 instantiates $a_3 \ldots$ and a_{17} instantiates a_1? Is there a possible world just like the actual world in respect of the structure of instantiation except that my nose (or its counterpart) instantiates my little finger? Is there a possible world structurally like the actual world except that any two things instantiate one another if they are actually less than a mile apart? Surely not.

Hence, an anti-nominalist who wants to uphold the ban on brute necessities will have to find some analysis of 'instantiates' that can account for these impossibilities. But what might such an analysis look like? I can't see how anything simple or intuitive could do the job. The only way I can see to get the right necessary truths to fall out of a definition of 'instantiates' (without going so far as to make it impossible for anything ever to instantiate anything else) would be to tailor the definition in such a way that exotic situations like those discussed in the previous paragraph get reclassified, in effect, as possibilities in which nothing instantiates anything else. For example, one might begin with a primitive notion of "proto-instantiation", and propose that for x to instantiate y is for x to proto-instantiate y at a world where the facts about proto-instantiation make up the right kind of overall pattern.[60]

This seems like cheating to me. If we give ourselves free rein to make up new predicates, conveniently free from any involvement in our pre-existing modal beliefs, it will become a trivial task to find analyses of our old predicates on which all the sentences that intuitively strike us as necessary, and none of the sentences that intuitively strike us as contingent, can be reduced to logical truths.[61] We simply analyse each predicate 'F' as 'proto-F such that P', where P is the

---

[60]Ramsey (1925) seems to be proposing something like this, but with a symmetric primitive predicate 'x and y constitute a fact' in place of the non-symmetric 'proto-instantiates'.

[61]Assuming that the set of sentences that intuitively strike us as necessary is logically consistent with any logically consistent hypothesis according to which nothing falls under any of our old predicates.

conjunction of all the sentences we want to turn out to be necessary, with 'proto-' inserted in front of each predicate.[62] Unfortunately, I am not at all sure how to turn this observation into an argument against the proposal. I am tempted to protest that the new predicate 'proto-instantiates' is simply unintelligible. But this kind of objection needs to be handled very delicately if it is not to rule out legitimate conceptual innovation. Another tempting line of argument is epistemological: why should we have any confidence that the world has the distinctive kind of structure it would need to have to contain instantiation rather than mere proto-instantiation?[63] But anyone who wields localised sceptical arguments like this one must be prepared for the inevitable response: 'You tell me how you know that you're not a brain in a vat, and I'll tell you how I know this fact you allege I could not know if my account of its nature were correct.'

In any case, it is clear that if we do allow analyses like this, nominalists have nothing to worry about from the demand for an explanation of necessities like (D), even if they are persuaded by the objections to the physical strategy and the structural strategy discussed above. They can use the very same trick, e.g. by analysing 'electron' as 'proto-electron that is such that any duplicate of a proto-electron is a proto-electron', or by analysing 'x is a duplicate of y' as 'x is a proto-duplicate of y, and any proto-duplicate of an electron is an electron'.

To sum up: we have not managed to find a stable argument against nominalism based on the use of abstract objects in explaining necessities like (D). Instead, we have stumbled on an argument in favour of nominalism. If there are, in the fundamental sense, numbers, properties, relations, or sets, then there are necessary truths about these things that cannot (assuming we can somehow rule out the trivialising 'proto-instantiation' move) be reduced to truths of logic. Thus, only the nominalist, who denies that there are any such things, can adequately respect the idea that there are no brute necessities.[64]

---

[62]See Goodman 1951: 86–89.

[63]Ramsey (1925: 29), following Wittgenstein (1961), embraces the sceptical response to this objection. Since 'we know and can know nothing whatever about the forms of atomic propositions', we can't know whether the fundamental objects divide into two different kinds that behave in the ways that might justify calling them 'universals' and 'individuals'.

[64]Even if nominalism is true, there are still necessary truths having to do with abstract entities whose necessity needs explaining. The most important example is the nominalist thesis itself, if

I think this is quite a powerful argument. To anyone not antecedently convinced of the falsity of nominalism, the idea of a metaphysically necessary truth whose necessity does not flow from real definitions plus logic really should seem quite strange. A notion of necessity that allowed for such necessary truths would seem uncomfortably like nothing more than an extra-strong variety of nomological necessity. But when something strikes us as impossible—say, the hypothesis that some duplicate of an electron is not itself an electron—we don't just think of it as ruled out by a "law of metaphysics": we feel that in some important sense, the idea *just makes no sense at all*. The notion of necessity involved in such intuitions is absolute: it is something that could not be strengthened any further without changing its character in some fundamental way. It is hard to see how any notion of necessity weaker than the notion of reducibility to logical truth, narrowly conceived, could be absolute in this way.[65]

Of course, even for a nominalist, the task of reconciling the ban on brute necessities with the facts about necessity and possibility is not an easy one (assuming we can somehow rule out the trivialising 'proto-electron' move). Resemblance Nominalism, for example, is not an option. All the resemblance-predicates I can think of are involved in manifestly necessary truths that are not logical truths, and contain no other non-logical vocabulary. (A simple example: the necessary truth that any duplicate of a duplicate of an object is a duplicate of that object.) If they are not brute, these necessities must be explained by analysing resemblance-predicates in terms of predicates of some other sort. But the outlook for other nominalist programmes is better. The physical strategy provides one possible approach for foes of brute necessities: it is at least not *obvious* that there are any non-logical necessary truths involving only basic physical predicates.[66] And

it is taken to be necessary. It is certainly not obvious how to formulate analyses of predicates like 'number' and 'property' that would allow sentences like 'there are no numbers' and 'there are no properties' to be reduced to logical truths. The problem here seems quite similar to that posed by sentences like 'there are no unicorns' and 'there are no phlogiston': it is best dealt with, in my view, by making special allowance for "semantically defective" predicates in formulating the ban on brute necessities.

[65]This is of course the merest sketch of an argument; I hope to fill in more of its details in future work. The biggest task in doing so is explaining why the logical truths, narrowly conceived, should be a better place for explanations of necessity to stop than any larger set of truths.

[66]The hardest bullet to bite for those who regard basic physical predicates as primitive and un-

although Resemblance Nominalism is ruled out, Natural Class Nominalism remains a live option for those who prefer the structural strategy. For there is no clear reason why settling the question whether some given objects are (collectively) natural or not should entail anything at all about the naturalness of any other objects. Thus, for those who want to uphold a version of the ban on brute necessities strong enough to place a serious constraint on the shape of our metaphysical theorising, nominalism provides at least two promising research programmes, while anti-nominalism provides none.[67]

References

Alston, William (1963). 'Ontological Commitments.' *Philosophical Studies* 14: 1–8.

Armstrong, David M. (1978a). *Nominalism and Realism*, volume 1 of *Universals and Scientific Realism*. Cambridge: Cambridge University Press.

— (1978b). *A Theory of Universals*, volume 2 of *Universals and Scientific Realism*. Cambridge: Cambridge University Press.

— (1989a). *A Combinatorial Theory of Possibility*. Cambridge: Cambridge University Press.

— (1989b). *Universals: An Opinionated Introduction*. Boulder: Westview Press.

— (1997). *A World of States of Affairs*. Cambridge: Cambridge University Press.

Bealer, George (1982). *Quality and Concept*. Oxford: Oxford University Press.

— (1987). 'The Philosophical Limits of Scientific Esssentialism.' In James Tomberlin (ed.), *Philosophical Perspectives 1: Metaphysics*, 289–365. Atascadero: Ridgewood.

— (1993). 'Universals.' *Journal of Philosophy* 110: 5–32.

Belot, Gordon (1998). 'Understanding Electromagnetism.' *British Journal for the Philosophy of Science* 49: 531–555.

Benacerraf, Paul (1973). 'Mathematical Truth.' *Journal of Philosophy* 19: 661–679.

Black, Robert (2000). 'Against Quidditism.' *Australasian Journal of Philosophy* 78: 87–104.

Blackburn, Simon (1993). *Essays in Quasi-Realism*. Oxford: Oxford University Press.

Boolos, George (1984). 'To Be Is To Be The Value Of A Variable (Or To Be Some Values Of Some Variables).' *Journal of Philosophy* 81: 430–449.

Bradley, F.H. (1897). *Appearance and Reality*. 2nd edition. Oxford: Oxford University Press. Reprinted in *Writings on Logic and Metaphysics*, ed. James W. Allard and Guy Stock. Oxford: Oxford University Press, 1994.

Burgess, John P. and Gideon Rosen (1997). *A Subject with No Object: Strategies for Nominalistic Interpretation of Mathematics*. Oxford: Oxford University Press.

— (2005). 'Nominalism Reconsidered.' In Stewart Shapiro (ed.), *The Oxford Handbook of Philosophy of Mathematics and Logic*, 515–535. Oxford: Oxford University Press.

Campbell, Keith (1991). *Abstract Particulars*. Oxford: Basil Blackwell.

Carnap, Rudolf (1950). 'Empiricism, Semantics and Ontology.' *Revue International de Philosophie* 4: 20–40. Reprinted in *Meaning and Necessity: A Study in Semantics and Modal Logic*. 2nd edn. Chicago: University of Chicago Press, 1956.

Chalmers, David (1996). *The Conscious Mind*. Oxford: Oxford University Press.

Chihara, Charles (1990). *Constructibility and Mathematical Existence*. Oxford: Oxford University Press.

Devitt, Michael (1980). "'Ostrich Nominalism" or "Mirage Realism"?' *Pacific Philosophical Quarterly* 61: 433–49. Reprinted in Mellor and Oliver 1997: 101–11.

Dorr, Cian (2002). *The Simplicity of Everything*. Ph.D. thesis, Princeton University.

— (2005). 'What We Disagree About When We Disagree About Ontology.' In Mark Kalderon (ed.), *Fictionalist Approaches to Metaphysics*. Oxford: Oxford University Press.

Ellis, Brian and Caroline Lierse (1994). 'Dispositional Essentialism.' *Australasian Journal of Philosophy* 72: 27–45.

Field, Hartry (1980). *Science Without Numbers*. Oxford: Blackwell.

— (1985). 'On Conservativeness and Incompleteness.' *Journal of Philosophy* 81: 239–260. Reprinted in Field 1989: 125–146.

— (1988). 'Realism, Mathematics and Modality.' *Philosophical Topics* 19: 57–107. Reprinted in Field 1989: 227–281.

— (1989). *Realism, Mathematics and Modality*. Oxford: Blackwell.

— (1992). 'Physicalism.' In John Earman (ed.), *Inference, Explanation, and Other Frustrations: Essays in the Philosophy of Science*, 271–291. Berkeley: University of California Press.

Fine, Kit (1994). 'Essence and Modality.' In James Tomberlin (ed.), *Philosophical Perspectives 8: Logic and Language*, 1–16. Atascadero: Ridgeview.

— (2001). 'The Question of Realism.' *Philosopher's Imprint* 1.

French, Peter and Howard K. Wettstein (eds.) (2001). *Midwest Studies in Philosophy XXV: Figurative Language*. Oxford: Blackwell.

Gibbard, Allan (1990). *Wise Choices, Apt Feelings*. Cambridge, Mass.: Harvard University Press.

Goodman, Nelson (1951). *The Structure of Appearance*. Third edition. Cambridge, Mass.: Harvard University Press, 1977.

Hawthorne, John (2001). 'Causal Structuralism.' In James Tomberlin (ed.), *Philosophical Perspectives 15: Metaphysics*, 361–378. Cambridge, Mass.: Blackwell.

Hazen, Allen (1996). 'Actualism Again.' *Philosophical Studies* 84: 155–181.

Heller, Mark (1998). 'Property Counterparts in Ersatz Worlds.' *Journal of Philosophy* 95: 293–316.

Hellman, Geoffrey (1989). *Mathematics Without Numbers*. Oxford: Oxford University Press.

Jackson, Frank (1977). 'Statements About Universals.' *Mind* 86: 427–429. Reprinted in Mellor and Oliver 1997: 89–92.

Kripke, Saul (1972). *Naming and Necessity*. Revised edition. Cambridge, Mass.: Harvard University Press, 1980.

Le Poidevin, Robin (2004). 'Space, supervenience and substantivalism.' *Analysis* 64: 191–198.

Lewis, David (1973). *Counterfactuals*. Oxford: Blackwell.

— (1983). 'New Work for a Theory of Universals.' *Australasian Journal of Philosophy* 61: 343–377. Reprinted in *Papers in Metaphysics and Epistemology* (Cambridge: Cambridge University Press, 1999): 8–55, and in Mellor and Oliver 1997.

— (1986). *On the Plurality of Worlds*. Oxford: Blackwell.

— (1993). 'Mathematics is Megethology.' *Philosophia Mathematica* 1: 3–23. Reprinted in *Papers in Philosophical Logic* (Cambridge: Cambridge University Press: 1998): 203–229.

Melia, Joseph (2005). 'Truthmaking Without Truthmakers.' In Helen Beebee and Julian Dodd (eds.), *Truthmakers: The Contemporary Debate*. Oxford: Oxford University Press.

Mellor, D.H. (1991). 'Properties and Predicates.' In *Matters of Metaphysics*, 170–182. Cambridge: Cambridge University Press. Reprinted in Mellor and Oliver 1997: 255–267.

Mellor, D.H. and Alex Oliver (eds.) (1997). *Properties*. Oxford: Oxford University Press.

Nolan, Daniel (1997). 'Impossible Worlds: A Modest Approach.' *Notre Dame Journal of Formal Logic* 38: 535–572.

Oliver, Alex and Timothy Smiley (2001). 'Strategies for a Logic of Plurals.' *Philosophical Quarterly* 51: 289–306.

Pap, Arthur (1959-60). 'Nominalism, Empiricism and Universals.' *Philosophical Quarterly* 9-10: 330–340, 44–60.

Price, H. H. (1953). *Thinking and Experience*. Second edition. London: Hutchinson, 1969.

Putnam, Hilary (1967). 'Mathematics Without Foundations.' *Journal of Philosophy* 64: 5–22. Reprinted in Putnam 1975: 43–59.

— (1972). *Philosophy of Logic*. Harper and Row.

— (1975). *Mathematics, Matter and Method: Philosophical Papers, vol. 1*. Cambridge: Cambridge University Press.

Quine, Willard van Orman (1948). 'On What There Is.' *Review of Metaphysics* 2: 21–38. Reprinted with revisions in Quine 1953: 1–19, and in Mellor and Oliver 1997.

— (1951). 'Two Dogmas of Empiricism.' *Philosophical Review* 60: 20–43. Reprinted with revisions in Quine 1953: 20–46.

— (1953). *From a Logical Point of View*. Second, revised edition. Cambridge, Mass.: Harvard University Press, 1980.

Ramsey, F.P. (1925). 'Universals.' *Mind* 34: 401–417. Reprinted in *Philosophical Papers*, ed. D. H. Mellor (Cambridge: Cambridge University Press, 1990): 8–33, and in Mellor and Oliver 1997.

Rodriguez-Pereyra, Gonzalo (2002). *Resemblance Nominalism*. Oxford: Oxford University Press.

Rosen, Gideon (1990). 'Modal Fictionalism.' *Mind* 99: 327–354.

Russell, Bertrand (1912). *The Principles of Philosophy*. London: Williams and Norgate.

Schiffer, Stephen (2003). *The Things We Mean*. Oxford: Oxford University Press.

Shapiro, Stewart (1983). 'Conservativeness and Incompleteness.' *Journal of Philosophy* 80: 521–531.

Shoemaker, Sydney (1980). 'Causality and Properties.' In Peter van Inwagen (ed.), *Time and Cause*, 228–254. Dordrecht: D. Reidel. Reprinted in Mellor and Oliver 1997: 228–254.

— (1998). 'Causal and Metaphysical Necessity.' *Pacific Philosophical Quarterly* 79: 59–77.

Sidelle, Alan (2002). 'On the Metaphysical Contingency of the Laws of Nature.' In Tamar Gendler and John Hawthorne (eds.), *Conceivability and Possibility*, 309–336. Oxford: Oxford University Press.

Stalnaker, Robert (1968). 'A Theory of Conditionals.' In *Studies in Logical Theory: American Philosophical Quarterly Monograph Series, No. 2*. Oxford: Blackwell.

Stanley, Jason (2001). 'Hermeneutic Fictionalism.' In French and Wettstein (2001), 36–71.

Swoyer, Chris (1982). 'The Nature of Natural Laws.' *Australasian Journal of Philosophy* 60: 203–223.

van Cleve, James (1994). 'Predication Without Universals? A Fling with Ostrich Nominalism.' *Philosophy and Phenomenological Research* 54: 577–590.

van Cleve, James and Robert E. Frederick (eds.) (1991). *The Philosophy of Right and Left: Incongruent Counterparts and the Nature of Space*. Dordrecht: Kluwer Academic Publishers.

van Fraassen, Bas (1980). *The Scientific Image*. Oxford: Oxford University Press.

van Inwagen, Peter (1977). 'Creatures of Fiction.' *American Philosophical Quarterly* 14: 299–308. Reprinted in *Ontology, Identity and Modality* (Cambridge: Cambridge University Press, 2001): 37–56.

— (2001). *Ontology, Identity and Modality*. Cambridge: Cambridge University Press.

— (2004). 'A Theory of Properties.' In Dean Zimmerman (ed.), *Oxford Studies in Metaphysics*, volume 1, 107–138. Oxford: Oxford University Press.

Wittgenstein, Ludwig (1961). *Tractatus Logico-Philosophicus*. Ed. D.F. Pears and B.F. McGuinness. London: Routledge and Kegan Paul.

Wright, Crispin (1983). *Frege's Conception of Numbers as Objects*. Aberdeen: Aberdeen University Press.

Yablo, Stephen (2000). 'A Paradox of Existence.' In Anthony Everett and Thomas Hofweber (eds.), *Empty Names, Fiction and the Puzzles of Non-Existence*, 275–312. Stanford: CSLI Press.

— (2001). 'Go Figure: A Path Through Fictionalism.' In French and Wettstein (2001), 72–102.