# Defending David Lewis's modal reduction

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**Abstract**   David Lewis claims that his theory of modality successfully reduces modal items to nonmodal items. This essay will clarify this claim and argue that it is true. This is largely an exercise within 'Ludovician Polycosmology': I hope to show that a certain intuitive resistance to the reduction and a set of related objections misunderstand the nature of the Ludovician project. But these results are of broad interest since they show that would-be reductionists have more formidable argumentative resources than is often thought. Lewis's reduction depends on a set of methodological commitments each of which is fairly plausible or at least currently popular, and none of which is particular to modality. The choice of which of these commitments to reject I leave to the discerning antireductionist. The essay proceeds as follows: §1 discusses reduction generally and one or two relevant puzzles; §2 discusses Lewis's reduction in particular; the longest section, §3 replies to four objections.

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## § 1

David Lewis claims that his theory of modality successfully reduces modal items to nonmodal items. This essay will clarify this claim and argue that it is true. This is largely an exercise within 'Ludovician Polycosmology': I hope to show that a certain intuitive resistance to the reduction and a set of related objections misunderstand the nature of the Ludovician project. But these results are of broad interest since they show that would-be reductionists have more formidable resources than is often thought. Lewis's reduction depends on a set of methodological

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commitments each of which is fairly plausible or at least currently popular, and none of which is particular to modality. The choice of which of these commitments to reject I leave to the discerning antireductionist. The essay proceeds as follows: §1 discusses reduction generally and one or two relevant puzzles; §2 discusses Lewis's reduction in particular; the longest section, §3 replies to four objections.

The most permissive reduction relation is supervenience, according to which, for some modality, A supervenes on B if and only if there cannot be a change in A-items without a change in B-items. The least permissive reduction relation is identity: everything reduces to itself and nothing else. In this essay we will discuss a reduction of modality to nonmodal items, so supervenience—a modal reduction relation—will be of little help. As we shall see, identity will not quite suffice either. However many interesting relations lie between these extremes.

Within the set of reduction relations there is a subset of *dependence* relations. In contrast with the nonsymmetric supervenience relation and the symmetric identity relation, dependence relations are asymmetric.[1] We distinguish dependence from mutual dependence and self-dependence. Within the set of dependence relations we distinguish *eliminating* reductions from *preserving* reductions. Take the case of *R v. Dudley* and *Stephens*.[2] Before but not after this case one could legally appeal to the Custom of the Sea to defend murder through necessity. This change in common law depended on a set of facts, not least the pronouncement of the Lord Chief Justice Lord Coleridge that 'the conviction should be affirmed.' However the change in law is not identical with those facts; the law depends on such judgements, it is not identical to such judgements (even hardcore legal positivists respect this distinction, cf. John Austin 1832). Or consider the Florida-based Nantucket beverages company. It has 147 staff. Without them there would be no company, so the company depends on its staff. All 147 were all flown to the Bahamas for their Christmas bonus. During that week the employees, managers and shareholders were in the Bahamas, but the company was still in Florida. So the company is not identical with its staff.[3]

*Preserving reductions* are metaphysical relations between two sets of phenomena which obtain whenever the following is true: the two sets of phenomena are nonidentical and there is some asymmetrical dependence relation between the two. There are many examples of this kind of relation in the philosophical literature: in philosophy of mind (Hornsby 1997), the theory of intentionality (Boghossian 2005), the theory of value (Moore 1903; McDowell 1998), the theory of normativity (Parfit 2011; Wedgwood 2007), in social ontology (Pettit 1996), and so on. However there are two problems with preserving reductions. The first is that we are left with vexing intercategorial questions. What exactly is the nature and the modal status of the dependency relation in question, and how is it related to the natures of its relata? Faced with these questions, philosophers either fall silent (McDowell), lean back on supervenience (Moore), or appeal to a primitive grounding relation (Rosen 2010).

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[1] Not all asymmetric reduction relations are dependence relations. Every contingent fact supervenes asymmetrically on every necessary fact, but intuitively the fact that Susan Rumplebottom won the 2009 Gloucestershire Cheese Rolling competition does not depend on Goldbach's conjecture.

[2] In which four shipwrecked seamen were tried for cannibalising their cabin boy.

[3] Perhaps you disagree with the specifics of these examples; perhaps you even reject all preserving reductions. That's fine: my intention here is just to clarify eliminating reductions by the comparison.

The second problem is that these relations do not decrease but increase explananda and ontology. For we began with two phenomena and ended up with two phenomena and an obscure relation. Perhaps a preserving theory is justified by the evidence; perhaps it is true. At least such theories are extremely interesting. But for these two reasons they are, *prima facie*, problematic. In the context of modal realism, a preserving reduction is the least attractive option. Asking us to accept modal realism's ontology without thereby relinquishing commitment to distinct modal items would be like 'buying the dog and barking ourselves.' David Lewis, at least, rejects preserving reductions, and so shall we.

Eliminating reductions also purport to be metaphysical reductions. Before explaining this let me flag one assumption which will run through this paper, namely that, in some appropriately weak sense, truths require truthmakers. (I will mostly be thinking of the truthmakers as states of affairs.)[4] In the case of both preserving and eliminating reductions, before we as theorists propose the reduction, we find ourselves with two sets of phenomena, about which we have two sets of truths. At this preliminary stage we are faced with the existence of two sets of truthmakers—hence two sets of ontological commitments. In the case of preserving reductions, the reduction has the effect of metaphysically linking these two sets of metaphysical items, and showing that one depends on the other. By contrast, an *eliminating reduction* aims to show that the ontological commitments incurred by the As *just are* the ontological commitments incurred by the Bs.[5] Or in other words, the truthmakers for the As just are the truthmakers for the Bs. As its name suggests, when the As are eliminatingly reduced to the Bs, we relinquish existential commitment to the As as a distinct set of items altogether. Thus a respectable 90s Muscovite might insist that a Happy Meal just is the burger, the fries, and the coke. This is a claim about the Happy Meal itself.

Since this reduction is a certain relation between two sets of items which hitherto seemed to involve distinct ontological commitments, it can be called a metaphysical reduction. It is a metaphysical reduction from our point of view *before* effecting the reduction, and from the point of view of anyone who questions the success of the reduction. This is because the metaphysical commitments before and after theorising are different. However after the reduction, if it is successful, we see that there was only ever one set of items. From this point of view the reduction is not metaphysical but semantic.[6]

I am leaning on some distinction between the sense and the reference of a piece of theory. The sense is the meaning of the theory; it need not be reflectively accessible to any speaker. The *reference* is whatever makes the theory true. *Theories*

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[4] By states of affairs I simply mean objects instantiating properties. There is an issue about the extent to which Lewis was really a truthmaker theorist; see the contributions by Lewis and Rosen to Lillehammer and Rodriguez-Pereyra (2003). But there is no doubt that he thought that 'truth supervened on (and was distinct from) being,' and that makes him enough of a truthmaker theorist for my purposes.

[5] For instance Peter Railton talks of 'a synthetic identification of the property of moral value with a complex nonmoral property' (in his 'Reply to David Wiggins,' 1993, p. 317).

[6] For more on this *prima facie* puzzle, see Carl Hempel (2001), *Reduction: Ontological and Linguistic Facets*.

are more or less inclusive chunks of explanatory discourse, with their own singular terms, predicates, and relation symbols. *Idioms* are bits of theory.

In order to get clearer about the nature of eliminating reduction, it will help to contrast it with error theories and claims of identity. According to an error theory, the claims made by some theory are truth-apt but false, because the truthmakers required by these claims do not exist. Error theorists may allow speakers to continue to use the eliminated idioms, but hold that they are epistemically irresponsible to some degree for doing so. The error theories of phlogiston or the ether are good examples. Eliminating reductions are different. They do not show that the theories are false but rather that they are made true by the truthmakers for some other theory. Insofar as the reducing theory is true, the reduced theory will also be true. Speakers may continue to use the idioms of the reduced theory; the Muscovite will still be entitled to talk about Happy Meals. Lots of things will still be true of Happy Meals, for instance that the last one left a strange smell on the leather seats. This should not be too contentious: it is a familiar feature of nonfundamental idioms, for instance economics or biology.

So there are two different jobs for an eliminating reduction. First we must posit some relation between the theoretical relata. This may take the form of a necessitated, universally quantified biconditional or an intertheoretic definitional claim. Second we claim that the truthmakers for the reductionandum are just the truthmakers for the reductionans, and are roughly what we thought the truthmakers for the reductionans were all along. Small revisions in the claims of either theory may be admitted.

The distinction between identity and eliminating reduction is a matter of degree. This sentence is identical with itself. In that sentence the sense, theory and truthmaker were all identical. But this need not be the case for a claim to be one of identity. Often the sense is different, as between Clark Kent and Superman. Suitably enlightened, unless intending to refer to the man *qua* Kent or *qua* Superman, we should pick some word which refers uniquely. So, as with the error theory, the identity theory should change our practice. Unlike in the case of error theory, we do not abandon one set of idioms in favour of the other, rather we see that the two sets have an equal entitlement to the same truthmaker. We can contrast this circumstance with eliminating reductions in two ways. Firstly, eliminating reductions are asymmetric. When the As reduce to the Bs, the A idioms are shown to be less fundamental than the B idioms. Secondly, *we are entitled to preserve different senses* for the A and B idioms. This will be useful since explanations are often specific to a given idiom. So for example once we eliminatingly reduce square pegs and round holes to highly complex arrangements of atoms we will nevertheless occasionally want to use and give explanations in the more familiar idioms.

In sum, in preserving reductions we have two theories with different senses and truthmakers; the reduction preserves the distinctness of these senses and truthmakers while positing some metaphysical relation which asymmetrically links the two truthmakers. In eliminating reductions we have two theories with different senses which are shown to be made true by the truthmakers for the reducing theory. The different senses will be related by some intertheoretic relation, perhaps a biconditional. In error theories we start with one theory with its sense and putative

truthmakers, and preserve the sense while denying on metaphysical grounds that the truthmakers obtain. In singular term identities we show that two singular terms with different senses have the same referent. This will require the following revision to sense: we may continue to use these different senses only to describe their object *qua* that mode of description; we usually establish some new sense for referring to the object *simpliciter*. I will not refer back to these theories; this exercise is directed just at clarifying the precise nature of David Lewis's eliminating reduction. Henceforth by 'reduction' I will mean 'eliminating reduction.'

Let me end this section with three further complications. First, according to Moore's paradox of analysis, no analysis can be both correct and informative. (I use the terms 'analysis' and 'reduction'—by which we now mean 'eliminating reduction'—interchangeably.) Moore presupposes that the sense of a piece of theory is reflectively accessible to one, indeed, so transparently accessible that one can never be surprised by the meanings of one's theories. This seems unlikely (cf. footnote 5 above). But no matter; Moore's paradox is not quite to the point here, since we are dealing with an analysandum and analysans with different senses. However this comes with a cost: once we relinquish the obligation to provide an analysis that preserves the sense of the analysandum, it becomes less clear what the constraints on a successful analysis are. We will return to this worry later in the paper.

Second. Sometimes there will be pressure from *within* a particular discipline to identify some putative item with some other item(s): consider the identification of heat with mean molecular energy. This is a local consideration. Other times there will be pressure from the perspective of (more or less) *total theory* to identify some putative item with another: consider now the reduction of rightness to 'natural facts' proposed by the analytical functionalists (e.g. Jackson 1998). This is a (more or less) global consideration. Quine has made global considerations rather popular. Now, intuitively, local analyses will be more likely to respect the sense of the analysandum; global analyses will be more likely to favour external considerations such as overall ontological parsimony or elegance. These external considerations are more contentious, especially when we are asked to accept highly counterintuitive proposals just on the basis of these abstract considerations. Some philosophers take the absence of either local or sense-based considerations which favour analysis as evidence that the phenomena is not apt to be analysed at all.[7] More on this later; for now we can simply flag a methodological concern: insofar as an analysis strays from the sense of its analysandum or from local considerations, we will require impressive additional reasons to accept it.

Our third complication relates to this last point. As the analysans depart from the analysandum in sense, and the conditions for a successful analysis become more global or 'structural' in nature, the possibility arises that more than one analysis will meet these conditions satisfactorily. This is a well-known problem with the reduction of the natural numbers to sets. The natural numbers: 1, 2, 3, 4,… may be reduced to $\varnothing$, $\{\varnothing\}$, $\{\{\varnothing\}\}$, $\{\{\{\varnothing\}\}\}$,… as in Zermelo's system, or to $\varnothing$, $\{\varnothing\}$,

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[7] From Stalnaker's 2009 Hempel lecture: 'If an account of modality were to meet [the reductive] condition, that would be a sure sign that it was on the wrong track.' Cf. also the literature in philosophy of mind concerning the 'explanatory gap' (e.g. Levine 1998).

$\{\varnothing \cup \{\varnothing\}\}$, $\{\varnothing \cup\{\varnothing \cup \{\varnothing\}\}\}$ as in von Neumman's. Paul Benacerraf (1965) famously takes this as a reason to reject the 'reduction': since identity is transitive, and Zermelo's and von Neumman's analysans are distinct, the natural numbers cannot be identical with both; but little speaks in favour of one of these analyses over the other; so the natural numbers are identical with neither of them. Others disagree: arguing instead that the reduction of numbers to sets is overdetermined (e.g. Paseau 2008).[8] The moral here, I suggest, is that ideally we should look for reasons to accept a reduction which go beyond structural satisfaction.[9] Ideally our reduction will be unique, will appeal only to acceptable theoretical norms, and will provide appropriate relations between the intuitive senses of its relata.

## § 2

Most of us believe that Jamaica might not have had a bobsleigh team in the 1988 Olympics, that the Parthenon Freeze might never have left Greece, and that if Madagascar hadn't broken off the lemurs would have died out. We believe that Avagadro's constant might have been $6.02 \times 10^{22}$ instead of $6.02 \times 10^{23}$, and that some subatomic particles might travel faster than the speed of light. And we believe certain things to be impossible, for instance round square cupolas, and men standing on empty bridges.

Conjoin all these folk beliefs about modality into one big sentence. Then regiment a little: remove ambiguity, fill in indices, and perhaps try to arrange the modal concepts so that many of them are sentential operators. (Let's just assume that some optimal regimentation is available.) Then we conjoin every claim that this regimented sentence logically implies: that's Folk Modality.

Now to modal realism. For our purposes, a theory deserves to be called 'modal realism' just in case (1) the theory together with some intertheoretical principle entails the truth of *most* of Folk Modality, and (2) the truthmakers exist. So far we have taken a stand on a contentious metaphysical question, namely whether some truths require truthmakers. Pragmatists, deflationists and antirealists of various sorts reject this. Unfortunately I cannot debate with them here. Otherwise the definition is extremely permissive. It says nothing about what the truthmakers have to be like: whether they are 'concrete' or 'abstract,' or how they are to be individuated. It does not say that truthmakers must be actual, nor that they cannot be. Of the central modal theories, so far only expressivism (Blackburn 1993), fictionalism (Rosen 1990) and antirealism (Quine 1953, 1961) have been ruled out; modalism (Fine 2005), essentialism (Aristotle) and ersatzism (Armstrong 1989) are modal realisms.

We distinguish modal realism from hardcore modal realism with two further commitments: (3) the truthmakers for possibility claims are of the same 'kind' as the truthmakers for actual claims, and (4) the truthmakers for actual claims are

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[8] Lewis takes the heroic course and rejects the second premise, arguing that since von Neumann's analysis is better adapted to the higher infinities it is the better analysis overall, and since it is the better analysis it is the true analysis. This is a minority view.

[9] Quine's *Ontological Reduction and the World of Numbers* worry about the Lowenheim-Skolem theorem is similar.

ordinary states of affairs, for instance Gilbert's tongue being in his cheek. Again this is permissive: so far the definition says nothing about what distinguishes actual states of affairs from merely possible states of affairs, nor about what unites compossible states of affairs; and importantly it says nothing about how we distinguish and deal with *de re* and *de dicto* claims.

From among the hardcore modal realisms let us honour Lewis's theory with capital letters, as Modal Realism. We do not need an exhaustive description of Modal Realism; I will just describe the relevant aspects of the theory.[10]

We begin with the compositional principles which are used to build Modal Realism. Lewis accepts ZFC set theory and Classical Extensional Mereology. In *Parts of Classes* and 'Mathematics as Megethology' he attempts to reduce the former to the latter plus the singleton function (taken as primitive). The details needn't concern us. To simplify exposition I will assume that this project is successful. With this assumption I risk the possibility that set theory cannot be so reduced, and that moreover there is some furtive modal element in set theory which vitiates Lewis's reduction. This latter seems very unlikely.

First some familiar definitions (1991, p. 73; see also 1993, p. 10):

i. *Definition: x* and *y overlap* iff they have some common part. Iff not, they are (entirely) *distinct*.
ii. *Definition:* Something is a *fusion* of some things iff it has all of them as parts and has no part that is distinct from each of them.
iii. *Definition: x* is a *part* of *y* iff everything that overlaps *x* also overlaps *y*; or iff everything distinct from *y* is also distinct from *x*; or iff *y* is fusion of *x* and some other *z*.

Lewis also accepts the following principles of Classical Extensional Mereology:

iv. *Transitivity:* if *x* is part of some part of *y*, then *x* is part of *y*.
v. *Unrestricted Composition*: Whenever there are some things, there exists a fusion of those things.
vi. *Uniqueness of Composition*: It never happens that the same things have two different fusions.

Now for set theory (1993, p. 10; 1991, p. 95[11]):

vii. *Definition:* An *individual* contains no singleton as a part.
viii. *Definition:* The *null set* is the fusion of all individuals.
ix. *Definition*: A *class* is a fusion of singletons.
x. *Definition: y* is a *member* of *x* iff *x* is a class and the singleton of *y* is *part* of *x*.
xi. *Definition: x* is a *proper class* iff *x* is a class that is not a member of anything.
xii. *Definition: x* is a *set* iff *x* is the null set or *x* is a class that is not a proper class.

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[10] There is a open question about how many of the Lewis's building blocks for his version of modal realism are an essential part of something that can still be called Ludovician Modal Realism. Surely not all of them are; perhaps even his commitment to sets is not. For simplicity I will stick with a view which I take to be as close as possible to Lewis's 1986 and 1993.

[11] A fuller presentation would need choice and replacement; these are not necessary for our purposes.

xiii. *Singleton Axiom 1*. Any part of the null set has a *singleton*; any singleton has a singleton; any small fusion of singletons has a singleton; and nothing else has a singleton.[12]

xiv. *Singleton Axiom 2*. No two things have overlapping singletons, nor does any part of the null set overlap any singleton.

xv. *Singleton Axiom 3*. If there are some things, if every part of the null set is one of them, if every singleton of one of them is one of them, and if every fusion of some of them is one of them, then everything is one of them.

Now finally we can articulate the ontological commitments of Modal Realism. We have:

xv. There are individuals.

xvi. There are classes.

It follows that there is a null set. Given unrestricted composition, it also follows that there are fusions of individuals, fusions of classes, and fusions of individuals and classes.

The individuals we care about are world-bound; properties are sets (not necessarily transworld) constructed of individuals. Properties are more or less *natural*. Lewis is agnostic between three ways of modelling this notion: either naturalness is brutely distributed among the properties; or there is a primitive similarity relation; or perfectly natural properties instantiate immanent universals. For simplicity we'll stick with the last option.

Among the perfectly natural universals are identity, parthood, spatiotemporality, and a few physical properties such as quark colour and charm. Since physical properties are contingent, it is very likely that there will be other properties—*alien* properties—instantiated in other worlds. There will also be alien versions of our spatiotemporal relations, for instance there is a world with Newtonian spatiotemporal relations. It is a commitment of Modal Realism that there is a class of spatiotemporal relations. These are relations with the following properties: they are (i) natural, (ii) pervasive, (iii) discriminating, and (iv) external (not supervenient on intrinsic natures of relata separately).[13] Call these the ST relations.

xvii. *Definition:* An individual $x$ is a *world* iff any two parts of $x$ are ST-related to each other, and no part of $x$ is ST-related to any $y$ that is not part of $x$.

It follows that no two worlds overlap.

xviii. *Definition:* Two items are *duplicates* iff (1) they have exactly the same perfectly natural properties, and (2) their parts stand to each other in the same perfectly natural relations.

Finally we have,

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[12] Definition. $x$ is *large* iff there are some things such that (1) no two of them overlap, (2) their fusion is the whole of Reality, and (3) each of them contains exactly one atom that is part of $x$ and at most one other atom. Otherwise $x$ is *small*.

[13] Cf. Lewis 1986, p. 75; I borrow this list from Divers (2002, p. 99).

xix. *Principle of Recombination:* For any *n* individuals and any ST-relation *Sn* there are duplicates of these *n* individuals standing in *Sn*.

   a. *Qualification:* There is nothing larger than some (currently unknown) mathematical upper bound.

The qualification is in place for two reasons: to avoid the Principle of Recombination having consequences for the possible size of worlds, and to avoid paradox (cf. Forrest & Armstrong, 1984).[14]

And that's it. It follows from the principle of recombination that if you patch together any old chunk of one world with any chunk of another—say, Liza Minnelli's larynx and the star of *Au Hasard Balthazar*—you will get an individual which exists at some world. In fact, saying that this 'follows' from the principle of recombination is misleading. The principle of recombination simply *describes* the distribution of individuals, it does not involve any further ontological commitment. Really all that exists are the individuals and sums so distributed.

Downstream from the main theory we have a number of other commitments.

xx. *Definition: Actuality* is an indexical term which refers to whichever world in which it is uttered.
xxi. *Counterpart Theory: de re* claims concern individuals with similar natural properties in other worlds.

These are contentious, but not for reasons to do with our reduction. I won't say much more about them.

Finally we have the following biconditional:

xxii. *Intertheoretic Biconditional:* possibly *p* iff there is a world at which *p*.

Thus a claim about which could have happened is true just in case some claim about what does happen in some other world is true. We can define necessity and impossibility in the usual way as not possibly not and necessarily not. More restrictive modal claims such as nomological claims are made by restricting the quantifiers on the right hand side to (e.g.) worlds with the same physical laws as this one.

Perhaps instead of a biconditional we should have some more complicated asymmetric relation. The reason is that Modal Realism purports to have greater expressive power than Folk Modality. The difference is not just in precision but also scope. We can say, 'there are five different ways that New South Building could have been designed.' Here we refer in one sentence to five different possibilities. We can say 'one would have complemented the Spelman Building better then the others.' Here we have a comparison across possibilities. There are clearly limits on these sorts of comparisons in folk idioms, though there are not in the technical language of Modal Realism, suggesting the latter's greater expressive power. However we defined Folk Modality as modal platitudes plus their consequences.

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[14] Dan Nolan (1996) has argued that this qualification is unnecessary. It has been suggested to me that David Lewis was persuaded by Nolan's argument. I won't pursue the debate further. See Efird and Stoneham (2008) and Darby and Watson (2010) for some fussing over the details of the principle of recombination; this is not relevant to our concerns here.

Perhaps some of these consequences are very difficult to express, but not impossible. Let's stick with the biconditional.

## § 3

Objection One: modal realism is furtively modal

William Lycan famously objected that Lewis's concept of 'world' really means something like 'possible world' (1979). Likewise it is often alleged that the principle of recombination is modal. Lewis doesn't help to discourage this worry when he introduces the principle by saying that 'anything can coexist with anything else.'[15]

Our reduction proceeds by relating all claims in Folk Modality to claims in Modal Realism with an intertheoretic biconditional. To successfully avoid these charges of furtive modality, we must consider the following necessary condition, the *non-circularity condition*, which applies to the right-hand side of the biconditional and to Modal Realism. There must neither be modal concepts in the statement of the axioms, nor may any concept used in the statement of the axioms be analysable into a modal concept. Only if this condition is met will Modal Realism be able to fend off Lycan's charge.

In order to understand these conditions we need some account of the modal-nonmodal distinction. We have three options. We can define *ad hominem*, by restricting ourselves to concepts and items which famous anti-modal philosophers (such as Quine, *ibid*.) thought were nonmodal. We can appeal to linguistic intuition, insisting that unless certain concepts are nonmodal then the modal-nonmodal distinction makes no sense. Or we can simply stipulate that certain concepts and items are nonmodal, and rest the success of our project on the plausibility of our stipulation, or rather leave to our opponents the burden of demonstrating that these notions are modal. I'm inclined to go for all three.

Just as it is more obvious that what is abstract is abstract than that what is concrete is concrete, so it is easier to say that what is modal is modal.[16] First concepts: contingency, possibility, impossibility, necessity are modal. Can, could, might, may are modal. Dispositional concepts, often ending in '-able,' '-ible,' or '-ile,' are modal. Now worldly items. Powers are modal. Laws are modal. Essential properties are modal.[17] Abilities are modal. Now to logic and metatheory: Strict conditionals and biconditionals are modal. Boxes and Diamonds are modal. Supervenience claims are modal.

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[15] Although in his defense, I think he intended to echo the *Treatise*: 'any thing may produce any thing' (Hume, 1.3.15.1).

[16] There is a worry here, namely that if we do not have a clear enough conceptio nof our reduction base that will undermine the intuitive rationale for the reduction itself (cf. Carl Hempel's 'Reduction: Ontological and Linguistic Facets'). However it seems to me that the worries here all concern non-central cases—but of course the vaguenes of dusk fails to undermine the day/night distinction.

[17] Or rather, facts about certain properties being essential. Such facts may not be modal. But we can do without them anyway, so there's no need to worry about this.

The list is not likely to be exhaustive. However we must assume that some items would be omitted even from an exhaustive list of modal items. Let us call all nonmodal objects *categorical objects*. A quick digression will help to pick out this concept. Scholars of the metaphysics of causation often draw a distinction between categorical properties and non-categorical powers or laws. The idea is that inert categorical properties of an object relate somehow to dispositions or natural laws, which latter explain the transactions between these categorical properties and other items in their environment. This makes the seeming contingency of natural laws intelligible, for we can say that a categorical duplicate of this very object might have reacted differently if the natural laws were different, or if the categorical features had been related to different dispositional features. Further to this idea, eliminative reductionists about natural laws deny the existence of dispositions or laws. Natural law talk, such reductionists insist, does not track distinct powers or laws; it simply tracks certain regularities in the distribution of categorical features themselves. It is this notion of categorical object that I have in mind.

So much for objects, now for the rest of our theoretical machinery. Let us say that the predicate calculus is nonmodal. Hence the operations of conjunction, disjunction and negation will not introduce modal concepts or items; the material condition and material biconditional defined using junctions and negation are nonmodal. Existential quantification as such is nonmodal. Universal quantification as such is nonmodal. This last is slightly unintuitive. One natural way of reading the classical arrow in a sentence like $P \rightarrow Q$ is that if $P$ is true then it cannot be the case that $Q$ is not true.[18] Certainly the strict conditional and subjunctive counterfactuals are modal. But the material conditional defined in terms of junctions and negation is not. If we need a meaningful translation, it would be that it is not the case that $Q$ is true and $P$ is not true. If we are restricted to the material conditional then we will only be able to model a small portion of the logic of the natural language 'if.' But that is all to the good: the material conditional lacks the applicability and robustness we intuitively associate with a modally sensitive operator. This is some evidence that we are drawing our modal-nonmodal distinction in the right place.

Let's now return to the Lycan worry. The concept *world* was introduced in definition *xviii*: an individual $x$ is a world iff any two parts of $x$ are ST-related to each other, and no part of $x$ is ST-related to any $y$ that is not part of $x$. Besides the permissible logical vocabulary in this definition, we find four other notions: *individual*, *world*, *is part of*, and *being ST related*. None is explicitly modal. Now we need to show that none is implicitly modal either. *Individuals* are either arrangements of simple atoms, or bundles of properties. Lewis is an anti-haecceitist. The properties in question are categorical properties: they are certainly not dispositional or normative properties. So they pass. *Parthood* supposedly picks out a natural relation; these are all allegedly categorical. We are left with *ST-related*.

Certainly Lewis *could* have posited some primitively modal relation to dis/unite possible worlds. That would have avoided the potentially awkward consequence of Modal Realism that no possible world contains two parts which are not

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[18] "A syllogism is language [*logos*] in which, certain things being asserted, something else follows of necessity from their being so." Aristotle, *Prior Analytics*, 24b14.

spatiotemporally related to each other. This consequence sounds like an a priori limit on scientific discovery, something which Lewis accepts is a cost. However for obvious reasons the primitive dis/uniting relation option was (far more) unattractive to Lewis. It is an epistemic possibility that no plausible natural and categorical world-uniting relation would have presented itself to the modal reductionist. Then he would have been in trouble. However Lewis argues that spatiotemporality is just such a natural categorical relation.

Lewis would argue that we did not think that spatiotemporal relations were modal prior to reading his account, and that he is in no way altering these relations in his account, and so we should not think they are modal in his account. Moreover they perfectly serve the theoretical role which he needed some nonmodal relation to fill. So it is not *ad hoc* to appropriate these relations to fill this role. The first premise is difficult to evaluate. Kant (1781) taught us at least that spatiotemporal relations were different from relations among physical things; this difference is enough to invalidate any 'no relevant difference' argument from the nonmodal status of less abstract relations among physical things to the nonmodal status of spatiotemporal relations. I accept that this argument is not available. Moreover I accept the Kantian point that spatiotemporal relations are categorically different from less abstract relations. But it doesn't follow that they are modal. All the physical laws and dispositions and normative properties that we know about are invariant over space and over time (though not all invariant across space and time). There are possible laws which are not so invariant, but that isn't sufficient for ST-relations *as such* to be modal, and that's what the anti-reductionist needs. For if ST-relations are powerful in some worlds but not others, Lewis can again distinguish the powerless aspect of the ST-relations in those worlds which is in common with the powerless ST-relations in other worlds, and restrict the term 'ST-relation' just to that powerless aspect. So even if it turned out that our spacetime is not inert, spacetime in some world is, and it is only what our spacetime has in common with that inert spacetime that we refer to with the concept *ST-relation*.

Now to the Principle of Recombination. It says that for any $n$ individuals and any ST-relation $Sn$ there are duplicates of these $n$ individuals standing in $Sn$. So for example if $x_1,…,x_n$ are the books on my desk and $Sn$ is the relation *being piled on top of each other in relativistic spacetime* then the principle guarantees that somewhere these books stand in that relation. The newcomer here is duplication. Duplication was defined in *xvi* using identity and naturalness. Naturalness is primitive, and supposedly not modal. Identity, the other newcomer, is a natural relation.

What about the qualification? Lewis posits a mathematical upper bound which limits the size of possible worlds, and hence the number of them, and hence the number of natural universals. Again, however, this bound is just supposed to be brutely true.

In passing it is worth pointing out a connection with John Divers's (1999) worry about *advanced modalizing*. The worry is that intuitively the theoretical postulates of Modal Realism should be necessarily true, but in order for the reduction to be successful, they could not be necessarily true. We get round this problem when we notice that advanced modal claims are *theorems*, not axioms, of Modal Realism.

Some proposition $Q$ is necessary just in case at all possible worlds it is the case that $Q$. So if $Q$ is the proposition 'there are no gaps in logical space,' then $Q$ will be necessarily true, for at every possible world that proposition will be true. We need to be careful with exactly how the 'truth at' operator works; Divers does an excellent job of figuring out the relevant subtleties. We deal with the status of the mathematical upper bound the same way.

And so on. Similar worries can be raised about nearly every concept in Modal Realism, but the form of response is the same so I will not bore you with the further details.

### Objection Two: modal realism is materially adequate only if furtively modal

Let's grant Lewis that Modal Realism's bits and pieces are nonmodal. They are just matter of fact, categorical bits and pieces, arranged this way and that. The objection now is: why should we believe that all the worlds posited in accordance with the Principle of Recombination exist (i.e. that the Principle of Recombination is true)? If the modal facts obtain just in virtue of this distribution, then there is no *metaphysical force*—how else to put it?—which will ensure, for instance, that some of the worlds aren't missing. No such force ensures that for each and every single possibility, there is a world just that way. We are expected to believe that this precise correlation obtains—*brutely!*—between the modal facts, and a countless infinity of spatiotemporally-isolated and causally-isolated concrete worlds. This objection is inspired by a similar point made by Tom Richards (1975, p. 109 and following); this was picked up by William Lycan (1994, p. 78). Our point here is not quite epistemic (though there is that worry). It is that even in Modal Realism primitive modality must play a specific, essential and irreducible role, namely ensuring that all the worlds posited by the Principle of Recombination really exist, or in other words, that all and only the Folk Modal truths turn out true. The objection is: no brute arrangement of categorical objects can play this role.

Lewis has an ingenious two-part reply. We begin by distinguishing analytical circularity from doxastic circularity. Suppose you are trying to give an analysis of the concept *pen*. You have two options: a pen is either (i) a portable writing implement, or (ii) a nonportable writing implement. Of course you must opt for (i). Your choice of analysans is guided by your beliefs about the analysandum. Things are likewise for the Modal Realism reduction. Our choice of analysans will be guided by our beliefs about the analysandum.

However our choice will not just be guided by beliefs about the analysandum. It will also be guided about our beliefs about other parts of our total theory, and by our fundamental norms for belief revision. Lewis argues that we should believe as true that theory which best balances simplicity, systematicity and conservatism. He says: 'As best we can, I think by seeking a theory that will be systematic and devoid of arbitrariness, we arrive at a conception of what there is altogether' (p. 111); and later, 'A worthwhile theory must be credible, and a credible theory must be conservative' (p. 134).

Thus Lewis sharply distinguishes reasons to believe that Modal Realism is true from whatever it is that makes it true. *A fortiori* we distinguish reasons to believe in

the Principle of Recombination from reasons that make it true. The Principle of Recombination is made true by the brute distribution of worlds. We should believe the Principle of Recombination is true because it is the simplest, least arbitrary, and most conservative principle available to explain modality.[19] We should believe that there are no gaps in logical space because that is a consequence of belief in the Principle of Recombination.

This puts significant pressure on Lewis's choice of theoretical norms. An opponent has three options: she can accept as legitimate the aspirations of total theory, and either dispute Lewis's choice of total theoretic norms, or accept the norms and dispute Lewis's application of them. Or she can reject as illegitimate the aspirations of total theory, at least in its potential to motivate such significant local revisions. Unfortunately a discussion of these oppositional strategies is beyond the scope of this paper. It is important to note, however, that one sort of objection is unavailable. There is an element of *hope* in Lewis's theoretical epistemology. He must simply *hope* that diligently following his best theoretical norms will lead him to a true theory. It follows that he must simply hope that diligently following his best theoretical norms in this case will lead him to a true theory. However the same follows in the case of believing one has hands. I suspect that *hope* plays an eliminable role in any realist non-foundational epistemology. It is not particular to the case of believing in distinct possible worlds.[20]

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[19] Put aside for now the question whether the Principle of Recombination should be qualified with an upper mathematical bound.

[20] Consider a different sort of worry, suggested to me by Jack Spencer. I have argued that Modal Realism satisfies the material adequacy constraint without appeal to primitive modality on the basis of two premises: (1) realism: modal claims obtain independently of modal beliefs; (2) a methodological commitment to simplicity, systematicity and conservatism. In virtue of the second we are entitled to believe that Modal Realism meets the material adequacy constraint, in virtue of the first this is not objectionably circular. The ersatzist has her own material adequacy constraint. From among the possible ersatz items she must select all and only those which represent possible states of affairs. Can she make this selection by appealing to the same two premises as Lewis and thereby also avoid primitive modality?

Lewis distinguishes three types of ersatzist views, according to their manner of representing possibilities: *linguistic ersatzism* posits linguistic items which represent in virtue of stipulated meanings; *pictorial ersatzism* posits pictures or models which represent by isomorphism; *magical ersatzism* posits items in whose nature it is to represent possibilities.

According to linguistic ersatzism: Possibly *p* iff according to some ersatz sentence *p*. An ersatz sentence, for our purposes, is a long conjunction of claims specifying precisely how the world that it represents would be like if it were actualised. All ersatz sentences actually exist; all represent their worlds as actualised; but only that sentence which represents the actual world is actualised. The problem with linguistic ersatzism concerns the representation relation. First let's distinguish explicit claims from implicit claims. Implicit claims are those which are *implied* by explicit claims. But this implication relation is modal. So let us suppose instead that ersatz sentences are maximally specific so that all representation claims are explicit. In order to get the necessary descriptive power, precision and context-independence the syntax had better not be from any natural language; let it be mathematical. This makes vivid the fact that the meanings of the sentences are *stipulated*. Ersatz sentences represent this and not that possibility partly in virtue of a contribution from ourselves, and hence, unavoidably, partly in virtue of our modal beliefs. This violates the realist premise. It follows that the linguistic ersatzist cannot avail herself of the Modal Realist escape from primitivity.

Pictorial ersatzism has a different problem: it is descriptively adequate only if it collapses into linguistic ersatzism or Modal Realism. Lewis does a nice job of showing this (pp. 168–173). According to magical ersatzism, ersatz items are intrinsically such as to represent what they represent. The magical ersatzist must posit some class of *sui generis* abstract objects with these intrinsic representational powers,

The epistemology-reality distinction helps Lewis in another way. Lewis needn't know all the details of the possible worlds. He needn't know exactly how many there are, nor how many alien individuals there are, not what the aliens are like, nor what the upper mathematical bound on world size is. Some of these things we will never know. This is a problem for many theories of modality (fictionalism, expressivism, combinatorialism, Stalnaker's 2009 view); it is a theoretical advantage of realism.

Objection Three: even if not primitively modal, claims about nonactual possible worlds are established only on the basis of modal beliefs

This objection accepts the previous two replies. Modal Realism posits nonmodal truthmakers noncircularly. However it remains the case that Modal Realism posits *more* things than many other theories do. It does so in order to make Folk Modal claims true. The objection is: even if these items are not modal, if the only ground for accepting them into our ontology is that they are required to satisfy irreducibly modal beliefs, then there is *some* sense in which these items are modal.[21]

Here it is helpful to consider the analogy with time. There are three ways to think about a reduction of time. Firstly there is presentism, the denial that the past or future exist. This is the analogue of actualism, the denial that nonactual possibilities exist. Then there are two sorts of spatiotemporalisms. Spatiotemporalisms emphasize the analogy between the temporal dimension and the spatial dimension. Strong Spatiotemporalism holds that all physical transformations are invariant across spatial or temporal axes. Weak Spatiotemporalism holds that some physical transformations are invariant across spatial or temporal axes. Current physics subscribes to Weak Spatiotemporalism. Certain laws, such as the laws of thermodynamics, are not invariant across spatial or temporal axes. So Weak Spatiotemporalism only allows a partial reduction of time. Strong Spatiotemporalism is a radical doctrine. It is committed to rejecting any semblance of a difference between spatial and temporal dimensions. Suppose there had seemed to be three spatial dimensions and one temporal dimension. Strong Spatiotemporalism would claim that there were in fact four spatial dimensions. In this way time—the temporal dimension—would be completely reduced to a spatial dimension. We could still use our temporal idioms, but they would be made true by facts about this spatial dimension; and in theoretical contexts we would be encouraged to speak more correctly. In this scenario folk beliefs about time justify our beliefs in this fourth spatial dimension, and without any experience of time we would only posit the three

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Footnote 20 continued

and from among them, he must grant special status to those which represent genuine possibilities. Both ostensibly require modal primitives. However the magical ersatzist does not violate the realist premise or the methodological premise. So if these premises under certain conditions entitle Lewis to eschew primitivity, they can do the same for the magical ersatzist. So I concede that the methodological strategy in the main text enables the magical ersatzist to avoid a certain appeal to primitive modality. There are other problems with this view, and other appeals to primitive modality, which unfortunately I do not have space to discuss.

[21] Thanks to Carla Merino for this suggestion.

spatial dimensions. But it does not follow that time still exists in this scenario. On the contrary our mistaken beliefs about time led us to the truth about this extant fourth spatial dimension. This is like Modal Realism's claim. Modal Realism analogically differs from the current physics in its commitment to a Strong rather than Weak reduction. (A different claim than *xxi* about actuality would have weakened the view.) According to Modal Realism, folk beliefs about modality and our consequent beliefs in a larger ontology are consistent with claiming that primitive modality is completely eliminated by the reduction. Modal Realism is a bit misleadingly so-called, for it claims that there is no (primitive) modality, really.

Objection Four: modal realism is irrelevant to modality

Our last objection has an impressive heritage. Strains of it can be heard in Plantinga's 1978; these are picked up by van Inwagen 1985; and finally most fully and convincingly pronounced by Jubien 1989. Suppose all these worlds exist, and suppose they are nonmodal. Why should we think they have anything to do with modality at all? Why is this not an elimination (error theory) of modality, rather than a reductive account of it?[22]

At issue here is how the meaning of the analysandum constrains the sense of candidate analysans, and the extent and nature of any other constraints. There are at least two distinct things we could mean by the 'meaning of the analysandum': the sense of Folk Modality, and the model theory of Folk Modality. Let me deal with these in turn.

The senses of some folk theories are clear, thorough, and close enough to the truth: e.g. the folk theory of medium-sized objects, or the folk theory of rational action. The intuitive sense of Folk Modality, I submit, is an ill-defined, ill-thought-through mess. The reason for the difference is that clarity, thoroughness and accuracy are important to the folk in their everyday dealings with objects and people; they are not important to the folk in their infrequent dealings with abstract matters of modal metaphysics. Different modalities differ, but in general there is a requirement to observe and predict modal claims not to understand their grounds. (E.g. I don't need to know about molecular bonding, far less about whether the regularity theory of causation is true, to know that this glass will shatter if dropped.) The extent to which the intuitive sense of the analysandum constrains possible analyses will vary from case to case. In the modal case our rather thin and tenuous understanding of the phenomena has the consequence that the intuitive sense will play a comparatively lesser role in constraining analyses. (Compare: the intuitive sense of the folk theory of light is almost worthless.) Moreover, it is clear that some part of the intuitive sense of folk theory of modality does concern other possible

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[22] Upon learning about the existence of all these worlds why should we not thereby take ourselves to have discovered that *actuality* is larger than we thought? Indeed, the natural next thought is that possibility concerns the different ways this larger actuality, that is, the whole set of worlds, might have been. These two thoughts go beyond this paper. In short, the answers are: (1) No, we distinguish actuality and existence and tell a story about tacitly restricted quantifiers; (2) No, there is no sense in claiming that possibly all the possibilities might not have been actual. See also John Divers's (2002) response to the advanced modalizing worry.

worlds. A large part of folk philosophy in general is theological, hence pregnant with other-worldly possibilities. Possible worlds very often capture the imagination of novelists and poets readers (for example see Pavel 1986). One might even perhaps argue that the intuitive sense of possibility talk is of *alternatives* to actuality, and that these alternatives are possible worlds. Oh to be in another possible world where there's always IPA on tap and it never rains on Saturday afternoons!

Some part of the intuitive sense of Folk Modality concerns possible worlds, but it would be heroic to argue that the senses of Folk Modality and Modal Realism are the same. Or foolish. It remains true, however, that the sense of Folk Modality is vague and unclear. Clarifying matters greatly, Saul Kripke introduced a model theory intended to perspicuously represent the logical relations among Folk Modal claims. Importantly, Kripke's formal models are not intended to capture the *sense* of Folk Modality, but rather to model its *extension* (the structure of its truthmakers). Kripke modelled the obscure notions of *possible* and *necessary* on the well-defined notions of *some* and *all*, with possibility represented by existence at *some* location and necessity by existence at *all* locations accessible from a given location. (Different modalities are modelled by different accessibility relations.) Saul Kripke's model theory very accurately represents the logical relations among Folk Modal claims. Modal Realism takes Kripke's model theory deadly seriously, insisting that the *locations* or *states* posited by the model theory are literally existing objects, namely worlds. This is certainly not a requirement of the model theory (Lewis is explicit about this, see p. 17 and following). However it is certainly the most elegant and simple metaphysical interpretation of the model theory. Modal Realism, then, is acceptable primarily on *extensional* grounds.

With only its thin relation to the intuitive sense of modal talk, however, it might seem that any similarly structured set of objects could serve as the truthmakers for Kripke's models just as well. So the case for accepting Modal Realism as a unique analysis (so avoiding the Benacerrafian worry) is still underdetermined. The 'explanatory gap' remains.

Locally, I don't think there are any argumentative moves left for Lewis to make. More globally, things are different. First, he reminds us of other occasions on which we are more willing to accept that an argument from simplicity can take us across an explanatory gap: the argument for the regularity theory of causation, for instance, or for eternalism. Second he reminds us of the many theoretical possibilities made available by the Modal Realist reduction: modal realism, he says, is a 'paradise for philosophers.' The economy of primitives made available locally is far less than the economy globally: Lewis claims that if we accept Modal Realism we get for free a theory of properties, propositions, causation, supervenience, counterfactuals, and much more (cf. Jackson 1998, p. 11). In the sciences, such fecundity is a pro tanto reason to accept a theory (cf. Witten 1988, Kane 2001[23]); Lewis takes his methodology from the sciences and so suggests the same thing.

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[23] The epigraph for his book quotes Lucretius: 'If you take a little trouble, you will attain to a thorough understanding of these truths. For one thing will be illuminated by another, and eyeless night will not rob you of your road till you have looked into the heart of nature's darkest mysteries. So surely will facts throw light upon facts.' (From his *On the Nature of the Universe*).

Now distinguish quantitative parsimony from qualitative parsimony: that is, distinguish parsimony concerning the number of different types of things versus the number of tokens of things of that type that there are. Lewis plausibly claims we care greatly about qualitative parsimony and very little about quantitative parsimony. Modal Realism is committed just to individuals and classes. It is committed to lots of individuals and classes, to be sure; many more, perhaps, than we expected. But this only violates quantitative parsimony. It is difficult to imagine a more qualitatively parsimonious theory. Modal Realism complements some amount of the intuitive sense of Folk Modality, it almost perfectly provides truthmakers for truths of a whole range of different modalities, it powerfully explains a host of other troublesome phenomena, with great economy of primitives, and it does so without appealing to primitive modality. Faced with such theoretical virtues, Lewis would argue, to insist that Modal Realism is irrelevant to modality is just to express a dogmatic commitment to irreducibility.

To conclude. One need not accept Lewis's basic theoretical assumptions: the commitment to truthmakers; the interest in total theory and strong views about the permissibility of intertheoretic revision; the methodological norms of simplicity, systematicity and conservativism, and their transportation from the domain of science to metaphysics; the sharp distinction between the epistemology and metaphysics of modality. A little less abstractly, one need not accept that individuals, sums, parthood, identity and first-order logic are nonmodal. However these all seem like plausible assumptions, and I would guess that each is held by many if not most analytic metaphysicians. In this essay I have not been arguing that Modal Realism is true. My goal has been to demonstrate that the eliminating reduction succeeds on its own terms. Unfortunately I have not had room to consider every detail in the objections above, nor to consider every possible objection. However I hope to have shown that properly understood Modal Realism easily avoids the worst of these objections. I submit that the reduction is available, for anyone prepared to pay for it.

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