

Naturalness

Cian Dorr and John Hawthorne

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1. Introduction

In the wake of David Lewis's seminal paper 'New Work for a Theory of Universals' (1983), a certain use of the word 'natural' has become widespread in metaphysics and beyond. In this usage, properties can be classified as more or less natural, with perfectly natural properties as a limiting case. For example, Lewis would claim that *being negatively charged* is much more natural than *being either negatively charged or part of a spoon*, and may even be perfectly natural.¹

Some philosophers have enthusiastically taken up this way of talking, perhaps with extensions and modifications. Others regard it as marking a grave turn for the worse in contemporary metaphysics. Many others prefer to avoid it, motivated not by any settled conviction that it is a bad thing, but by the sense that if they were to employ it, they would be tying their philosophical fortunes to a piece of controversial metaphysical speculation.

What is at stake in the debate between the enthusiasts and the sceptics? Frustratingly, the differences are often articulated in terms of differing *attitudes*. The sceptics are said to 'reject' the distinction between natural and unnatural properties, while the enthusiasts are said to 'accept' or 'countenance' it, and perhaps even to 'take it as primitive'. But it is far from clear what it *means* to have any of these attitudes to a distinction; and in any case, autobiographical claims of the form 'I reject/accept/take as primitive this distinction' are not the sorts of things around which we should be structuring philosophical debates. Meanwhile, when enthusiasm and scepticism *are* given propositional content, there is great variation as regards how the contents are characterised. In many of the works of naturalness-enthusiasts, the only vision of the sceptical alternative that comes into view seems to involve wild claims such as that it is never the case that one thing is more similar to a second thing than to a third thing, or notoriously obscure claims to the effect that facts of this or that sort fail to be 'objective'.² On the other hand, discussions of the

¹ Following Lewis, we will use 'property' in such a way as to include relations; we will use 'monadic property' when we want to talk about properties in the usual sense.

² For the problems with the obvious ways of interpreting denials of objectivity, see Rosen 1994.

role naturalness plays in Lewis's thought often present the idea as a bold and idiosyncratic 'metaphysical posit', analogous in its justificatory status to Lewis's modal realism—the sort of thing whose final justification would require a comparative assessment of various grand philosophical systems.

Our aim in this paper is not to take sides in the debate between naturalness-enthusiasts and naturalness-sceptics, but to bring some structure to the terrain, replacing displays of contrasting nebulous attitudes with a range of relatively precise and independently debatable questions. Our main strategy is familiar from Lewis's own treatment of novel theoretical terms (Lewis 1970). According to the model presented in that paper, any theory expressed using a newly introduced predicate 'F' is analytically equivalent to its *expanded postulate*—the claim that there is a unique property that does all the things that F-ness does according to the original theory. (A theory's expanded postulate is a close relative of its *Ramsey sentence*, which omits the uniqueness claim.) And assuming the original theory logically entails 'Something is F', it is also analytically equivalent to *that* claim: for 'Something is F' to be true, 'F-ness' has to refer, which it can only do if the expanded postulate is true. If we prefer to avoid the use of the new vocabulary, we can thus do so without losing anything of cognitive significance by replacing both the debate about whether the original theory is true, and the apparently quite different debate about whether anything at all is F, with the debate about whether the expanded postulate is true. If we apply this treatment to Lewis's theory of naturalness, we will take the question whether some properties are more natural than others to be equivalent to the question whether Lewis's entire theory of naturalness is true, and we will take both of these questions to be equivalent to the question whether there is a unique ranking of properties that plays all the roles that the naturalness ranking plays according to Lewis's theory.³

As Lewis recognised, this theory of novel terms is too rigid. Sometimes, a non-empty predicate is introduced into the language as part of a theory that uses it to make many false claims. The most obvious way this can happen is for the theorist to explicitly indicate that one of the sentences of the theory is intended to have the status of a definition of the new predicate. But in many other cases, it can be far from obvious what kind of semantic profile we should think of the novel vocabulary

³ Note that Lewis's talk of relative naturalness is not just about an *ordering*: he wants to be able to ask questions like 'Is F-ness much more natural than G-ness, or only a little bit more natural?'. When we speak of 'rankings' we mean not just orderings, but items with a rich enough structure to interpret such questions.

as having, even if we know exactly which portions of the overall role defined by the theory are satisfied (and which are uniquely satisfied).⁴ The fact that the expanded postulate includes a uniqueness claim also poses problems, in many cases, for the claim that it is analytically entailed by the original theory.⁵ Moreover, other aspects of Lewis's metasemantics which we will discuss below suggest that there may be cases where a vocabulary-introducing theory is false although its expanded postulate is true.⁶

However, one can agree that Lewis's theory of theoretical terms is flawed in all these ways while accepting its central methodological moral: namely, that the focus of the debate between enthusiasts and sceptics about some new piece of vocabulary should be on the question how close the relevant theoretical role comes to being satisfied (or satisfied uniquely). Wholehearted enthusiasts will want to claim that the entire role is uniquely satisfied, while thoroughgoing sceptics will not only claim that the entire role is unsatisfied, but say the same about various interesting fragments and variants of the role. And of course all sorts of intermediate positions will be available, which take different fragments and variants of the role to be satisfied.

The idea that this richly structured landscape of possible views should be the focus for the debate between enthusiasts and sceptics about a new vocabulary item does not require us to think that answers to questions couched in terms of that vocabulary (including the question 'Are there any F things at all?') can be straightforwardly read off an answer to the question which portions of the relevant theoretical role are satisfied. There will be plenty of scope for further disagreement here as well. But typically, when the parties to the debate disagree as regards how to map questions expressed using the new vocabulary onto role-related questions, it will be a bad idea for them to spend much of their time debating the former

⁴ Lewis 1970 suggests that the role the original model assigns to the expanded postulate should properly be played by the claim that the relevant theoretical role comes *near enough* to being realized, and has a unique nearest realizer.

⁵ Carnap (1947) proposes a theory like Lewis's except that the role of the expanded postulate is played by the theory's 'Ramsey sentence', which omits the uniqueness claim. Lewis (1999, p. 347) suggests a more tolerant view that allows a term-introducing theory to be true even when its theoretical roles are multiply realized, provided that the many realizers are 'sufficiently alike', with reference-failure occurring only when the many realizers are 'sufficiently different'; in the former case, it will be a vague matter what the new terms apply to.

⁶ We are thinking of cases where some property that isn't too far from playing the relevant role is sufficiently more natural than the unique property that plays the role perfectly that the new predicate ends up expressing it.

questions. There is a strong danger that such debates will be infected with the pathology characteristic of ‘merely verbal disputes’, whatever the nature of that pathology might be. More specifically, the problem is that one’s policy for using the new vocabulary will depend in part on one’s answers to very detailed and localised questions about the semantics of theoretical terms, which are unlikely to be of much relevance to the subject matter to which the term-introducing theory was supposed to be a contribution. Thus for example, the question ‘Are there any F things at all?’ will be answered negatively both by those who think that some property comes very close to doing all the things that F-ness does according to the original theory but hold a draconian view of theoretical terms on which even this is not good enough to prevent ‘F’ from being empty, and by those who have a much more tolerant view of what it takes to introduce a non-empty predicate but think that relevant theoretical roles are so far from being satisfied that ‘F’ fails to meet even this low standard. The best policy is first to get as clear as we can on the answers to the questions we can state without using the new predicate. For those who don’t care about tricky puzzle cases in metasemantics, this might be enough; those who do care can conduct a parallel debate about what we should think about the extension of the new predicate, conditional on various answers to those questions.

These morals apply whenever new vocabulary is introduced as part of a controversial theory, whether in science or in philosophy. In particular, they apply to ‘natural’. We propose, then, that the debate between naturalness-enthusiasts and naturalness-sceptics should be conducted in a way that gives a central role to the question how much of the theoretical role defined by the use of ‘natural’ by Lewis and his followers is satisfied by *some* ranking of properties.⁷ For many pieces of philosophical jargon, this advice would be hard to follow. All too often, such terminology comes to us as part of a large system of interrelated terminology which we would need to Ramsify out simultaneously in order to make dialectical progress, but which is so pervasive in the relevant theory that the result of Ramsification risks triviality. In these cases, the debate between enthusiasts and sceptics will have to be approached in some other way. Fortunately, Lewis’s theory of naturalness is exemplary in this regard. Lewis propounds a broad array of claims about naturalness, which connect it with a wide range of other subject matters, and thereby

⁷ We are thus in agreement with Sider (2011, p. 10), whose central positive claim on behalf of the notion of ‘structure’ (a close cousin of naturalness) is that its associated ‘inferential role’ is occupied.

provide a richly articulated structure for the debate about the extent to which the role is satisfied. Sections 2 of the present paper will set out the role, while section 3 will consider some arguments that bear on the question how much of it is satisfied.

We should emphasise that we are *not* suggesting that ‘natural’ is analytically, or even extensionally, equivalent to anything of the form ‘has the property of properties that plays such-and-such role’.⁸ Naturalness enthusiasts will surely think that there are important psychological and epistemological differences between belief in their theory of naturalness and belief in its Ramsey sentence (or its expanded postulate).⁹ Some will want to draw a sharper contrast in this case than they would draw between, say, belief in Maxwell’s theory of electromagnetism and belief in *its* Ramsey sentence.¹⁰ The only status we are claiming for the Ramsey sentence, and its weakenings and variants, is that of being a good thing to focus on if one is looking for an articulate, argument-driven debate.

Is there really nothing more to Lewis’s enthusiasm about naturalness than the claim that a unique property of properties plays the relevant role? You might think that this debate completely misses out on the central point at issue. What about the question whether there are objective joints in reality? Whether all properties are ‘on a par’? Whether the structure of the realm of properties is ‘elitist’ or ‘egalitarian’? The problem with these questions as foci for debate is that that they seem to be nothing more than variants of the question ‘Are there any natural properties?’, or ‘Are some properties more natural than others?’ For example, it is uncontroversial that there are *some* respects in which properties fail to be ‘on a par’; and the obvious answer to the question ‘How do you mean, *on a par*?’ is ‘With respect to naturalness’. If this is right, the negative moral of our general discussion of theoretical terms comes into play, namely that it is unhelpful for the debate between enthusiasts and sceptics about some novel expression to focus on questions expressed using that

⁸ Still less are we proposing this as a ‘reduction’ of naturalness. Whatever it means to give a reduction of something, one is not supposed to give reductions that go in circles. Thus reducing ‘natural’ to ‘having a property of properties that does such-and-such’, where doing such-and-such is partly specified in terms of ‘similarity’, would prevent one from reducing ‘similar’ to anything specified in terms of ‘natural’. For reasons we will discuss in section 5, we think it is dangerous to treat the notion of ‘reduction’ as unproblematic common ground in the debate about naturalness.

⁹ This is certainly true of Sider (2011), who says that ‘if the entire theory of this book were replaced with its Ramsey sentence, omitting all mention of fundamentality, something would seem to be lost’ (p. 11).

¹⁰ For example, Chalmers (MS, chapter 7) is sympathetic to the thought that while the concept of *fundamentality* is ‘conceptually primitive’, the concept of *negative charge* is not.

expression. The answers to such questions will unhelpfully depend on the details of one's approach to the metasemantics of theoretical jargon. For example, some who say no property is more natural than any other will think that the Lewisian role comes very close to being satisfied, while accepting a draconian metasemantics on which even this is not good enough to prevent 'natural' from being defective. Meanwhile, some who accept that some properties are more natural than others will think the trend towards giving 'natural' a central role in metaphysics is completely lamentable, but endorse a forgiving metasemantics according to which the manifold errors made by Lewis and his followers do not prevent 'natural' from acquiring a non-trivial extension, any more than the errors of astrology prevent 'being a Gemini' from having a non-trivial extension. Indeed, this reason for not spending much time on questions like 'Are all properties on a par?' applies even if we refuse to treat them as tantamount to 'Are some properties more natural than others?' (as we might if we think of expressions like 'on a par' as less tightly tied to Lewis's particular theoretical commitments than 'natural' itself). The same problem arises, namely that people's answers will depend on a complex mixture of their metasemantical views about the conditions for the relevant expressions to be non-empty, together with views about the extent to which certain associated roles (specified without using any such vocabulary) are satisfied. While formulae like 'Properties are not all on a par' are useful devices for initially conveying the flavour of one's view, the idiosyncratic interpretative questions they raise make them poorly suited to serve as the central focus of any argument-driven debate.¹¹

This is not to say there is *nothing* more going on in the debate between enthusiasts and sceptics about naturalness than the question how much of the Lewisian role is satisfied. In sections 4, 5 and 6 we will consider some further questions that might be thought central to the debate. A number of these turn out to be red herrings. However, we do identify one other fruitful topic for debate, namely the question whether and to what extent expressions like 'natural', 'more natural than' and 'perfectly natural' are *vague*. Some naturalness-sceptics will want to claim that all these expressions are *massively* vague; some naturalness-enthusiasts will want to

¹¹ One might gloss 'All properties are not on a par' as something like 'There is a metaphysically interesting ranking of properties' or 'There is a metaphysically interesting property that is had by some but not all properties'. But 'interesting' is *prima facie* much too vague for the kinds of debate we are trying to foster, and 'metaphysically' only makes things worse, since few questions are less interesting than the question how metaphysics is to be demarcated from other branches of philosophy.

claim that at least one of them is perfectly precise. Since these questions about vagueness are more or less orthogonal to the questions about role-satisfaction which we will be discussing in the next two sections, the upshot will be that there are two good axes along which the debate about naturalness can be structured.

2. The naturalness role

The aim of the present section is to list Lewis's central theoretical claims involving the word 'natural', taking 'New Work' as our main text. We should stress again that we are not trying to suggest that any of the principles on our list should be accorded any kind of definitional status. (Given the important role paradigm cases play in introducing people to the concept of naturalness, this is an especially unpromising territory for sustaining claims of analyticity.) We don't even want to want to claim that the rejection of any one of these principles amounts to a departure from full-blooded enthusiasm about naturalness—certainly, many of them have been explicitly rejected by philosophers who think of themselves as fully in agreement with Lewis about the importance of naturalness in metaphysics. Our aim is just to survey interesting questions in the general vicinity of the debate between sceptics and enthusiasts about naturalness. This does not require isolating any claims as singly or jointly analytic of naturalness.

Now to the list.

1. *Supervenience*: Everything supervenes on the perfectly natural properties.

There are several relevant ways of making *Supervenience* precise. Setting aside glosses that presuppose modal realism, the most obvious interpretation of *Supervenience* is that whenever two possible worlds differ as regards the truth value of any proposition, they differ as regards the truth value of at least one proposition predicating a perfectly natural monadic property of a particular object, or predicating a perfectly natural relation of a sequence of particular objects. A second gloss on *Supervenience*, more in keeping with Lewis's 'anti-haecceitism', still treats it as a claim of propositional supervenience, but restricts the domain of supervenient propositions to *qualitative* ones (e.g. that there are at least seven blue chairs), while restricting the supervenience basis to propositions about the *pattern* of perfectly natural properties (e.g., perhaps, that there are at least 10^{70} negatively charged

items).¹² The third possible gloss is a claim about qualitative indiscernibility as a relation between individuals, as opposed to worlds: necessarily, if there is a permutation of the domain of all objects that maps x to x' and preserves all perfectly natural properties and their negations, x is qualitatively indiscernible from x' .¹³ ('Qualitatively indiscernible' here expresses a relation that holds between distinct objects only in *perfectly symmetric* worlds, such as worlds of two-way eternal recurrence.) The fourth gloss extends this to a notion of cross-world qualitative indiscernibility: if there is a bijection π from the domain of w to the domain of w' that maps x to x' , such that for any perfectly natural property F and objects $y_1, \dots, y_n, y'_1, \dots, y'_n$ instantiate F at w iff $\pi(y_1), \dots, \pi(y_n)$ instantiate F at w' , then x as it is at w is qualitatively indiscernible from x' as it is at w' . The fourth gloss entails the third, since we can take $w=w'$; it also entails the second, given that it cannot be true that x at it is at w is qualitatively indiscernible from y as it is at w' unless the same qualitative propositions are true at w and w' .^{14, 15}

¹² What does it mean for a proposition to be 'about the pattern of perfectly natural properties'? One possible definition uses possible worlds: it is for the proposition not to divide any pair of worlds w_1 and w_2 for which there is a bijection from the domain of w_1 to that of w_2 which preserves perfectly natural properties. Another is more linguistic: it is for the proposition to be expressible in some language (perhaps infinitary) whose non-logical vocabulary is limited to predicates expressing perfectly natural properties. A third is algebraic: it is for the proposition to be contained in the smallest algebra of propositions and properties that contains all perfectly natural properties and is closed under a certain range of logical operations.

¹³ Perhaps this should be strengthened to read: if there is a permutation of the domain of all objects that maps x_1 to x'_1 and ... and maps x_n to x'_n and preserves all perfectly natural properties and their negations, then for any qualitative relation R , $Rx_1 \dots x_n$ iff $Rx'_1 \dots x'_n$.

¹⁴ One could also try to cash out *Supervenience* using the standard definitions of strong and weak individual supervenience (Kim 1984), but the resulting claims are too strong, and too implausible by Lewis's lights, to be usefully thought of as part of the naturalness role. Given how Lewis is thinking, it would not be at all surprising to suppose that a certain chair and a certain table instantiate exactly the same monadic perfectly natural properties. Indeed, it might well be that neither the chair nor the table instantiates *any* monadic perfectly natural properties—Lewis takes seriously the hypothesis that only point-sized objects do so. If so, the property *being a chair* does not even weakly supervene on the monadic perfectly natural properties, according to the standard definition. And since weak and strong supervenience as standardly defined are relations between sets of *monadic* properties, it is not clear what it would even mean to ask whether *being a chair* weakly or strongly supervenes on the set of all perfectly natural properties *and relations*.

¹⁵ In stating these versions of *Supervenience*, we have helped ourselves to quantification over possible worlds and over objects existing in arbitrary possible worlds. Further issues arise if one attempts to cash them out in a way that is consistent with the widely believed 'contingentist' view that some things are such

The various glosses on *Supervenience* come apart in several interesting ways. Note, first, that the test provided by the first gloss is, under plausible assumptions, consistent with such hypotheses as that *existence*, or *truth*, or *instantiation*, is the one and only perfectly natural property. For example, if one believes in *facts*, it may be plausible to think that all truths about the world supervene on truths about which facts exist; but in that case, the propositions attributing *existence* to particular facts will together constitute a supervenience base for everything. Certain views on which material objects are extremely abundant may generate the same result, for example by entailing that every material object coincides with a worldbound material object. Similarly, given an abundant ontology of propositions, all propositions will supervene on the propositions about which propositions are *true*, and given an abundant ontology of properties, all propositions will supervene on propositions about what instantiates what. Perhaps the first gloss can be refined so as to rule out these deeply un-Lewisian suggestions—most obviously, we might impose some restriction on the entities whose perfectly natural properties can figure in the supervenience base.¹⁶ The second, third and fourth glosses on *Supervenience*, by contrast, already prohibit these super-minimalistic proposals about what the perfectly natural properties are. At least, they do so on the assumption that we have some independent grip on the notion of qualitiveness in terms of which they are stated. (Some speculations put pressure on standard judgments about qualitiveness—for example, it is standard to suppose that the property of having a certain mass is qualitative while the property of being located in a particular place is not, but this is disrupted by the speculation—see Arntzenius and Dorr 2012—that that one’s mass is a matter of occupying a point in a ‘mass space’ whose ontological status is similar to that of ordinary space.)

Another notable divide between the glosses on *Supervenience* is this: the first and second are consistent with the hypothesis that familiar everyday objects (tables, trees, people...) neither instantiate any perfectly natural properties, nor stand in any perfectly natural relations to anything, while still being qualitatively discernible

that they could fail to be identical to anything. This project is relatively straightforward for the first, second and third glosses, but the attempt to extend it to the fourth gloss plunges us into the extremely difficult question what sense, if any, contingentists can make of quantification over sets of impossible objects (see Williamson 2013, chap. 7).

¹⁶ If, unlike Lewis, we had a notion of perfect naturalness applicable to *objects*, the restriction could be to the perfectly natural objects. We will discuss the prospects for such a distinction further towards the end of section 2.

from one another. By contrast, the third and fourth glosses require at least one of any two qualitatively discernible objects to instantiate at least one perfectly natural property, or stand in at least one perfectly natural relation.¹⁷

2. *Independence*: The perfectly natural properties are mutually independent.

Lewis entertained several different claims that can be regarded as precisifications of *Independence*. In 'New Work', the main focus is on a claim of *Non-supervenience*: no perfectly natural property is such that the facts about it supervene on the facts about all the other perfectly natural properties. In conjunction with *Supervenience*, this is equivalent to the claim that the perfectly natural properties constitute a *minimal* supervenience base for everything, where the relevant sense of 'supervenience base for everything' could be spelled out in any of the ways considered above.¹⁸

Another kind of independence claim is the principle of *Recombination* discussed in Lewis 1986. The basic idea here is that for any two parts of worlds, there is a single world containing a duplicate of each.¹⁹ Given the connection between perfect naturalness and duplication (to be discussed below), this entails that for example, no two perfectly natural properties are such that it is impossible for them to be instantiated in the same world.²⁰ The basic idea can be strengthened along a few dimensions: (i) We could generalise from pairs to pluralities, although as Lewis points out, paradox will threaten if we impose no cardinality requirement whatsoever on the pluralities. (ii) We could strengthen the principle to allow any number of duplicates of each of the items (again subject to cardinality constraints). (iii) We could claim not only that some world contains duplicates of the items

¹⁷ So, for example, the first and second glosses, unlike the third and fourth, are consistent with the proposal that while there are many things, not all qualitatively indiscernible, there is only one thing (the Absolute?) that instantiates any perfectly natural properties or relations.

¹⁸ The following stronger claim in the same direction is also worth considering: it never happens that the complete description of a world in terms of some subset of the perfectly natural properties entails the complete description of that world in terms of the rest.

¹⁹ Lewis's version of *Recombination* includes the proviso 'size and shape permitting', whose intended interpretation is not exactly clear. While he mostly applies the proviso in connection with the cardinality-based worries discussed below, the mention of shape as well as size might suggest that there would be exceptions even to the basic, two-object version of *Recombination*. But we will not worry about this: it seems plausible that even infinitely extended objects can be duplicated together in a world with higher dimensions.

²⁰ Note that *Recombination* is consistent with the claim that some perfectly natural properties supervene on others.

perhaps along with other things, but also that some world is entirely composed of (is a fusion of) duplicates of the items. (iv) We could try somehow to capture the idea that the duplicates can be ‘in any arrangement’: the thought is that the intrinsic natures of things do not much constrain the perfectly natural relations they bear to one another, although it is not clear how to articulate this precisely.²¹

Lewis 2009 entertains an even stronger independence principle, ‘Combinatorialism’, according to which the distinct ‘parts of reality’ which can be freely recombined ‘include not only spatiotemporal parts, but also abstract parts—specifically, the fundamental [perfectly natural] properties’ (p. 209). This means, for example, that no perfectly natural property is entailed by any other. The general idea might be spelled out as follows: in an appropriate language in which all predicates express perfectly natural properties, the only sentences that express metaphysically necessary propositions are the logical truths. This can be fine-tuned in several ways, depending on how we specify the ‘appropriate language’ and the notion of logical truth. (i) We can make the principle stronger by allowing the language to contain infinitary operators, infinitary blocks of quantifiers, and/or higher-order quantifiers.²² (ii) We could adopt the standard conception of logical truth, on which ‘ $\exists x \exists y y \neq x$ ’ does not count as logically true, or the alternative conception (defended in Williamson 1999) according to which all truths involving only logical vocabulary count as logical truths. (iii) We could think of the quantifiers in the ‘appropriate language’ as restricted somehow—e.g. to concrete objects, or to some unspecified collection of objects—or as unrestricted. In the latter case, if we also adopt the standard conception of logical truth, we will be committed to the metaphysical possibility of there being very few objects.²³ (iv) We could allow the

²¹ Lewis’s version speaks only of spatiotemporal relations, but it is not clear exactly which spatiotemporal relations he has in mind: he would probably not want to be committed to the existence of a possible world in which a duplicate of a large doughnut fits inside the hole of a duplicate of a much smaller doughnut.

²² If we use the infinitary language $L_{\infty, \infty}$ in which we can take conjunctions and disjunctions of arbitrary sets of formulae, and quantify arbitrary sets of variables simultaneously, then so long as we do not think that the perfectly natural properties are too numerous to form a set, we can fully specify any set-sized model for a language with predicates corresponding to all perfectly natural properties. Given the cardinality restrictions that need to be built into *Recombination* to avoid paradox, it is plausible that the infinitary version of *Combinatorialism* entails all reasonable interpretations of *Recombination*.

²³ If one takes the quantifiers in the ‘appropriate language’ to be distinct from those of ordinary language (see Dorr 2005), one might combine this with the claim that ‘necessarily, there are infinitely many sets’ is true when interpreted in the ordinary

‘appropriate language’ to contain names for some or all objects, as well as predicates, thereby ruling out a wide range of putative *de re* necessities involving the given objects.²⁴

We should be clear that there is no chance that a version of the naturalness role containing just *Supervenience* and *Independence* will single out the set of perfectly natural properties uniquely, even if we adopt the strongest interpretations of those principles. If *any* set of properties satisfies this fragment of the role, so do many other sets of properties. For example, if a set of properties satisfies *Supervenience* and *Combinatorialism*, so does the set of their negations, and so does a set which replaces two properties F and G with F-iff-G and F-iff-not-G. Other techniques will generate a very large proliferation of families satisfying *Supervenience* and *Combinatorialism* on the assumption that there is at least one such family. Given a set of properties S, say that w_1 and w_2 are S-opposites iff there is a bijection π from the domain of w_1 to that of w_2 such that whenever $F \in S$, $Fx_1 \dots x_n$ at w_1 iff is not the case that $F\pi(x_1) \dots \pi(x_n)$ at w_2 , and say that a proposition P is S-invariant if it never distinguishes between two worlds that are S-opposites. (For example, propositions about the cardinality of the universe are automatically S-invariant.) Suppose we have some set S that satisfies

way. If one wanted to make such a distinction, one would naturally hope for some helpful way of singling out the *intended* interpretation of the quantifiers. A salient option here is to say that the relevant quantifier-meanings are the *most natural* ones (cf. Sider 2011, chap. 9) having a certain basic logical profile. Given that standard semantic theories take quantifiers to express properties of properties, or relations between properties, or relations between properties and propositions, there is nothing especially surprising in the idea that they can be assessed as more or less natural. However, once we start talking about properties of properties, the need to decide what we are going to do about the property-theoretic paradoxes becomes urgent; we will discuss one possible response to this below. Note that one could say that there is a unique *most natural* property with the relevant logical profile without saying that any such property is *perfectly natural*; indeed, if we extend *Combinatorialism* to properties of properties in the obvious way, it entails that if there are any perfectly natural properties of properties, their instantiation by different properties is independent in a way that is not true for any property with the logical profile required to be an interpretation of ‘ \exists ’.

²⁴ Note that we would need a version of *Combinatorialism* that allows names for at least some objects into the appropriate language if we want it to entail that the version of *Non-supervenience* according to which the propositions about which particular things instantiate a given perfectly natural property never supervene on the propositions about which particular things instantiate all the others.

Supervenience (gloss 4) and *Combinatorialism*; then for any S-invariant proposition P, the set $S_p = \{F\text{-iff-}P: F \in S\}$ will also satisfy *Supervenience* and *Combinatorialism*.²⁵

3. *Duplication*: If some bijection from the parts of x to the parts of y maps x to y and preserves all perfectly natural properties, x and y are duplicates.
4. *Non-duplication*: If no bijection from the parts of x to the parts of y that maps x to y preserves all perfectly natural properties, x and y are not duplicates.

The concept of duplication is supposed to be intuitive: it is the relation that would hold between the copies produced by an ideal copying machine (Lewis 1983, p. 355).²⁶

²⁵ To prove that S_p satisfies *Supervenience*, suppose that π is an S_p -preserving bijection from the domain of w to that of w' that maps x to x' . It cannot be that w is a P-world and w' is not, since in that case it would have to be the case that for each $F \in S$, $Fx_1 \dots x_n$ at w iff not $F\pi(x_1) \dots \pi(x_n)$ at w' , in which case w and w' are S-opposites, which is ruled out by the S-invariance of P. But if w_1 and w_2 are both P-worlds, or are both not-P worlds, π must also be an S-preserving bijection, so that x at w is qualitatively isomorphic to x' at w' .

To prove that S_p satisfies *Combinatorialism*, consider a logically consistent sentence ϕ in a language whose atomic predicates stand in one-to-one correspondence with members of S. Let Q_1 , Q_2 and Q_3 be the propositions expressed by ϕ under, respectively, an interpretation on which the atomic predicates express the corresponding members of S; an interpretation on which they express the negations of the corresponding members of S; and an interpretation on which they express the corresponding members of S_p . Since S satisfies *Combinatorialism*, Q_1 is metaphysically possible. So is Q_2 , since the result of negating every atom in a logically consistent sentence is always logically consistent. We need to show that Q_3 is also metaphysically possible. Since $Q_1 \wedge P$ is equivalent to $Q_3 \wedge P$, while $Q_2 \wedge \neg P$ is equivalent to $Q_3 \wedge \neg P$, it suffices to show that at least either $Q_1 \wedge P$ or $Q_2 \wedge \neg P$ is metaphysically possible. But this follows from the S-invariance of P: given that every Q_2 -world is the S-opposite of a Q_1 -world, so if no Q_1 -worlds are P-worlds, no Q_2 -worlds can be P-worlds either; since there we know there are some Q_2 -worlds, we can conclude that in that case there must be some $Q_2 \wedge P$ -worlds.

²⁶ *Duplication* and *Non-duplication* are endorsed in Lewis 1986, p. 61. Two other ideas about the connection between duplication and naturalness are also to be found in Lewis's work. Lewis 1983 gives a simpler account on which duplication is simply the sharing of all perfectly natural properties. However, getting that account to work requires a very abundant supply of perfectly natural properties. For example, chairs would have to have many perfectly natural properties if any two non-duplicate chairs are distinguished by some perfectly natural property. Since such an abundance of perfectly natural properties fits poorly with many other components of the role (such as *Independence*), we suspect that it is a slip, and will concentrate on the 1986 account. Langton and Lewis 1998 and Lewis 2001 explore a different account of duplication in terms of comparative rather than perfect naturalness. Lewis accepted this account as well as *Duplication/Non-duplication*: for him, the interest of the Langton-Lewis account was that it could be addressed to

For Lewis, the concept of duplication is tightly connected to that of an *intrinsic property*: an intrinsic property is one that never divides duplicates within or across worlds; duplicates are things which share all their intrinsic properties. However, others have found this connection more problematic. For one thing, it entails that anything necessarily equivalent to an intrinsic property is itself intrinsic—a claim that might give you pause, if you take seriously the suggestion that the property of *being identical to Prince Charles* is distinct from, but necessarily equivalent to, the property of *being descended from such-and-such sperm and egg*, or that the property *being a cube* is distinct from, but necessarily equivalent to, the property *being a cube and either five metres from a sphere or not five metres from a sphere*.²⁷ To avoid distraction by these issues, we will focus on duplication rather than intrinsicness.

5. *Empiricism*: The right method for identifying actually-instantiated perfectly natural properties is empirical.

For Lewis, the relevant empirical method is one that involves paying close attention to developments in physics. The claim is not, of course, that every word that physicists use is to be counted as expressing a perfectly natural property: Lewis would not be sympathetic to the suggestion that *being a Nobel prizewinner* is perfectly natural. Even if we only looked at the words the physicists use when stating what

'philosophers more risk-averse than Lewis', who doubt that it 'makes sense to single out a class of *perfectly* natural properties'. The Langton-Lewis account has proved much more controversial than *Duplication / Non-duplication*, even among naturalness-enthusiasts: for some criticism, see Marshall and Parsons 2001 and Hawthorne 2001.²⁷ Another source of concern about Lewis's account of 'intrinsic' in terms of 'duplicate' involves the need to make sense of cross-world duplication. It is by no means obvious that philosophers who do not endorse Lewis's modal realism should even regard claims like 'x at w_1 is a duplicate of y at w_2 ' as intelligible. After all, not just any two-place relation among objects corresponds in any interesting way to a four-place relation among two objects and two worlds—for example, it is hard to see what nontrivial sense could be made of 'x at w_1 kicks y at w_2 '. However, those who endorse *Duplication* and *Non-duplication* have some natural options for making non-trivial sense of 'x at w_1 is a duplicate of y at w_2 '. The most obvious strategy is to take it as equivalent to 'there is a bijection f from things that are part of x at w_1 to things that are part of y at w_2 , such that $f(x) = y$, and for every perfectly natural n-ary relation R , $R(z_1, \dots, z_n)$ at w_1 iff $R(f(z_1), \dots, f(z_n))$ at w_2 . This definition is, however, problematic if the facts about what there is are contingent—in deciding whether 'x at w_1 is a duplicate of y at w_2 ' is true, we do not want to be limited to considering the properties at w_1 and w_2 of *actually existing* parts of x and y. It is not clear whether there is a way for contingentists to simulate quantification over 'non-actual objects', and over set-theoretic constructions out of objects existing at different possible worlds, which would allow them to avoid this problem (see Williamson 2013, chap. 7).

they call ‘laws’, we will be apt to find our list of perfectly natural properties contaminated by properties like *being a measurement*, *being an experiment*, and *being an observer*, whose presence on the list would disturb many of the other roles. As we are understanding *Empiricism*, it does not even require the thought that the single words that physicists use *ever* express perfectly natural properties—for example, it is compatible with *Empiricism* to maintain that the relation ‘the mass of x is between the masses of y and z ’ is perfectly natural, even though physicists prefer to encode mass using numerical mass values.²⁸ Nor does endorsement of *Empiricism*, as we are construing it, require agreement with Lewis about the special role of physics. A view that treats all the sciences as equally good guides to perfect naturalness (e.g. Schaffer 2004) will still count as conforming with *Empiricism* (although clearly such a view will fit less well with *Independence*). Those with dualistic leanings might even wish to add something like introspection as another relevant empirical method. The kinds of views we want *Empiricism* to rule out are those on which the task of determining whether a property is perfectly natural is primarily a matter of *a priori* reflection. One example is the suggestion that *existence* is the one and only perfectly natural property, which we considered in connection with *Supervenience* above. We will consider more views of this sort in section 3(e) below.²⁹

6. *Simplicity*: One property is more natural than another iff the former has a definition in terms of perfectly natural properties that is simpler than any definition of the latter in terms of perfectly natural properties.

‘Definitions’ of a property here are simply expressions which provide necessary and sufficient conditions. A definition ‘in terms of perfectly natural properties’ will be an expression in a language in which all syntactically simple non-logical vocabulary expresses perfectly natural properties, and in which only certain standard

²⁸ There are other ways in which physics could be a useful guide to (some of) the instantiated perfectly natural properties without any such properties being expressed by the predicates of physics. According to Chalmers (1996, p. 154), for example, ‘mass is an extrinsic property that can be “realized” by different intrinsic properties in different worlds’. While Chalmers never mentions naturalness, the picture suggested might be one where, even though the extrinsic properties expressed by physical predicates are not perfectly natural, each of them stands in the ‘realization’ relation to a unique perfectly natural property.

²⁹ Lewis may allow that a few relations can be revealed to be perfectly natural by *a priori* methods, for example identity and parthood (Lewis 1986, n. 47). Whether these should count as perfectly natural is a vexed issue: they don’t fit so well with *Independence*, but do fit quite well with many of the other roles.

connectives figure as ways of building complex expressions.³⁰ We don't think it is in the spirit of Lewis's thinking to be too legalistic about symbol-counting as a measure of the simplicity of an expression. For example, it would not go against the spirit of *Simplicity* to claim that disjunctions detract more from simplicity than conjunctions. Nor would it go against the spirit of *Simplicity* to rank the simplicity of an expression by counting the number of states in the smallest Turing machine that outputs that expression, even though this will assign high simplicity scores to some quite long, but regular, expressions.³¹

7. *Laws*: The laws of nature all follow from some proposition that can be expressed simply in terms of perfectly natural properties.

For Lewis, of course, the status of *Laws* is intimately bound up with a Humean analysis of lawhood under which, necessarily, the laws are whichever generalisations follow from the system of propositions that achieves an optimal combination of simplicity and 'strength'. (Lewis says little about how one should go

³⁰ Should we allow the non-logical vocabulary of the language to contain *names* alongside predicates for perfectly natural properties? If we do not, the risk is that *Simplicity* will be completely silent about the relative naturalness of haecceitistic properties like *living in Oxford*: only on the widely rejected view that such properties supervene on the qualitative will they have any definitions in the canonical language. If we do, the risk is that all properties will count as very natural. For example, if we have names for *properties* and a predicate 'instantiates', every property will have a definition of the form 'instantiates *p*'; even if we only allow names for particulars, we will be in trouble if our ontology of particulars is an abundant one in which, e.g., there is a particular that is at each world composed of all and only the grue things at that world. If we had a notion of perfect naturalness that applied to *objects*, we could allow the canonical language to contain names for only the perfectly natural objects: see note 54 below.

³¹ In a hyperintensionalist account of properties, one would expect there to be some notion of definition more demanding than simply that of necessary and sufficient conditions. However, many hyperintensionalists (e.g. Soames 2002) would also want to posit a rich supply of 'unstructured' properties that lack non-trivial definitions, in the demanding sense. If we cashed out *Simplicity* using the demanding notion, it seems we will have to count all of these unstructured properties as perfectly natural. If there are a lot of them—if, for example, every property is necessarily equivalent to some unstructured property—this will fit very badly with the rest of the naturalness role. On the other hand, hyperintensionalists will also be uncomfortable with the version of *Simplicity* on which the relevant notion of definition is just that of giving necessary and sufficient conditions, since this requires necessarily equivalent properties to be equally natural. Perhaps some hybrid story would allow the hyperintensionalist to use something like *Simplicity* to rank both structured and unstructured properties, using an initial scale for the unstructured properties plus further length-of-definition penalties for the structured ones.

about measuring strength. Given that there are infinitely many possible worlds, presumably what is needed is a measure on the space of possible worlds, where the strength of a proposition is given by some monotonically decreasing function of the measure of the set of worlds where it is true. Considerations of naturalness might have a role to play in specifying the relevant measure, perhaps by way of a metric of resemblance among worlds.)

Lewis's analysis does not obviously entail our *Laws*—perhaps there are worlds where considerations of strength lead to a not-very-simple best system—but Lewis was clearly optimistic that the actual world is not one of these. For our purposes, even if *Laws* is contingent, it is more useful to focus on it than on Lewis's final analysis of lawhood, given that we are trying to articulate some naturalness-related debates that aren't just repackagings of familiar debates about the Humean programme.³²

Given *Simplicity*, *Laws* is more or less equivalent to the following claim:

*Laws** The laws of nature all follow from some very natural proposition.

Making sense of *Laws** requires extending the notion of naturalness from properties and relations to propositions, but this is no great conceptual departure if we think of propositions as the 0-ary analogues of properties and relations, or as properties of worlds. And note that if one doesn't like *Simplicity*, one might have reasons for resisting *Laws* that would not extend to *Laws**.

Note that even if we knew exactly which propositions were laws, given an intensional conception of propositions there is no hope that *Laws* (or *Laws**) could be used all by itself to determine which properties are perfectly natural—at best, one could rule out certain candidate lists of perfectly natural properties. Some authors discuss a principle relating naturalness to lawhood which looks as if it could be used to establish the perfect naturalness of certain properties: namely, that the natural properties are those that 'figure in' the laws (cf. Sider 2011, p. 15). However, for the notion of 'figuring in' to do this kind of work, we would need to use a notion of lawhood that applies to structured propositions, and that can thereby apply to some but not all members of a family of necessarily equivalent propositions. Unless one had some independent grip on which properties are perfectly natural, it is very hard

³² The notion of lawhood employed by *Laws* had better be understood quite strictly. We shall not consider how naturalness might relate to more relaxed notions of lawhood that encompass generalisations with a high objective chance of being true, or which have a merely *ceteris paribus* status, and so on.

to see how one could be confident in elevating one member of such a family to the status of lawhood.

8. *Similarity*: The more natural a property is, the more it makes for similarity among things that share it.
9. *Dissimilarity*: The more natural a property is, the more it makes for dissimilarity among things that are divided by it.

Lewis dwells heavily on these aspects of the role when he is introducing readers to the concept of naturalness. This is in part because of his interest in the continuity between the theory of naturalness and the traditional doctrine of universals, the central arguments for which turned on premises about similarity, or ‘having something in common’.

Note that while claims in the vicinity of *Similarity* are more common in the literature, it is *Dissimilarity* that most directly captures the metaphor according to which natural properties ‘carve nature at its joints’. In this metaphor, the naturalness of a property turns on the amount of discontinuity at the boundary it draws between the things that have it and those that lack it. This suggests a relatively straightforward modal gloss on *Dissimilarity*: a property’s degree of naturalness is given by (some monotonically increasing function of) the *minimum possible* degree of dissimilarity between an instance of the property and a non-instance. However, this gloss has some surprising consequences. It entails that a property and its negation are always equally natural. It also entails that the conjunction or disjunction of some properties is never less natural than all of those properties, since any two things divided by the conjunction or disjunction of some properties must be divided by at least one of them. This does not fit well with other components of the role: *Simplicity* and *Magnetism* (see below) both suggest that the conjunction and disjunction of some properties is often less natural than any of them (especially when the properties are numerous); while the *Non-supervenience* version of *Independence* tells us that negations, conjunctions and disjunctions of perfectly natural properties are never perfectly natural.³³

³³ The modal gloss on *Dissimilarity* produces further unexpected results if we limit ourselves to intra-world dissimilarity. For example, the property *being extremely unlike anything else* (in one’s world) will have to be counted as highly natural. Things go more smoothly if one is willing to take a cross-world perspective on the relevant dissimilarity claims. However, it is not obvious how to think of cross-world

One could also give *Similarity* a modal gloss, according to which a property's degree of naturalness is given by (some monotonically decreasing function of) the *maximum* degree of dissimilarity that could obtain between two instances of the property. But the consequences of this interpretation of *Similarity* are even more unexpected than those of the modal interpretation of *Dissimilarity*. For example, *being both negatively charged and grue* will be at least as natural as *being negatively charged*. And on plausible assumptions, the most natural properties will all have to be complete qualitative profiles (properties that entail every qualitative property with which they are consistent). A ranking that works like this fits poorly with all the other components of the role, with the exception of *Supervenience*.

One way to deal with these issues would be to keep the basic idea of the modal glosses on *Similarity* and/or *Dissimilarity* while throwing in a 'ceteris paribus' clause, which allows for some slippage between the naturalness-ranking and the 'maximum dissimilarity of sharers'/'minimum dissimilarity of dividees' rankings. The obvious worry about such a move is that it will make questions about the co-satisfiability of parts of the naturalness role that include *Similarity* or *Dissimilarity* too vague for fruitful debate to be possible. It would certainly help a lot if we could say something more articulate about the nature of the further factors that make for divergence between the rankings.³⁴

A very different way of cashing out both *Similarity* and *Dissimilarity* would picture the degree of similarity between two objects as arising from some kind of comparison of two scores, one derived by 'adding up' the degrees of naturalness of all the properties they share, and another derived by 'adding up' the degrees of

similarity from a non-modal-realist point of view. We could speak of 'the degree of dissimilarity between x_1 at w_1 and x_2 at w_2 '; or we could use a notion of dissimilarity between complete qualitative profiles as a surrogate for the modal realist's ontology.

³⁴ Lewis 2011 employs a conception of the naturalness-similarity link under which two separate similarity-theoretic factors can 'detract from' the naturalness of a property: *spread* (maximum dissimilarity distance between instances) matters, but so does *scatter* ('the way non-instances are interspersed with instances') (Lewis 2001, p. 391). A property whose set of possible instances was *convex* under the dissimilarity metric would have low scatter. (Cf. 'Criterion P' in Gärdenfors 2000, which defines a natural property as 'a convex region of a domain in a conceptual space'.) However, since *complete qualitative profiles* have minimal scatter as well as minimal spread, scatter does not help to explain why they should not be counted as maximally natural.

naturalness of all the properties that divide them.³⁵ The higher the former number, and the lower the latter number, the more similar the objects are.³⁶ Making rigorous sense of this approach will of course require somehow controlling for the fact that any two things share uncountably many properties, and are divided by uncountably many properties, a task we will not try to undertake here.³⁷

Note that whereas the modal glosses on *Similarity* and *Dissimilarity* suggest that the facts about each property's degree of naturalness can be read off the totality of facts about the degrees of similarity among actual and possible objects, the 'additive' glosses plausibly will leave us quite a lot of freedom in the assignment of naturalness-scores, even when all the similarity facts are held fixed. As an exercise, imagine there are only n consistent complete qualitative profiles. To complete the total package of facts about qualitative similarity, we need just $n(n-1)/2$ numbers, one for each unordered pair of qualitative profiles. Our task is to recover these numbers from an assignment of naturalness scores to each of the 2^n qualitative properties. Even without knowing anything about the function which yields the degrees of similarity as functions of the naturalness scores, we can see that it would have to work in quite bizarre ways for there to be only one assignment of naturalness-scores which generates the given similarity-facts.

Another difficult interpretative question raised by *Similarity* and *Dissimilarity* concerns the manifest vagueness and context-sensitivity of 'similar' (and 'more similar'). In one context, our answer to the question 'Which of these two people is more similar to this third person?' might be driven by facts about the relevant peoples' appearances; in another, we will ignore the appearances and focus only on facts about their personalities. Even among contexts where both appearance and

³⁵ Given the way *Similarity* and *Dissimilarity* have been formulated, they do not clearly rule out a view where the degree of similarity also depends on some further factors having nothing to do with sharing or being divided by natural properties.

³⁶ We could implement this by ranking the degree of similarity as the difference between the two numbers, or their ratio, or some other function that is increasing in its first argument and decreasing in its second. Given that the two scores seem closely related, we might also consider computing degrees of similarity based on only one of them.

³⁷ Some will be comfortable glossing 'making for similarity' using an ideology of *grounding* or *in virtue of*. But we note that Lewis was not comfortable giving ideology of this sort any important role in his theorising. And even those who are comfortable need to be careful here. Given that similarity facts are non-fundamental, and that all non-fundamental facts are supposed to be grounded in fundamental facts, it is a challenge to articulate a *distinctive* grounding-theoretic connection between similarity and naturalness. (Thanks here to Ted Sider.)

personality are relevant, there are differences as regards their relative importance. And in any ordinary context, there are lots of borderline cases of ‘more similar’—quadruples of objects of which ‘... is more similar to ... than ... is to ...’ is neither definitely true nor definitely false. This raises two related worries about *Similarity* and *Dissimilarity*. One worry is that context-sensitivity makes them toothless: the effect of endorsing *Similarity* or *Dissimilarity* is simply to establish an esoteric local context in which the use of ‘similar’ is forced to fit in the relevant ways with the use of ‘natural’. The other worry is that vagueness makes them untenable: one might suppose that ‘similar’ is so very vague (in the relevant philosophical contexts) that there is nothing we could say using it that would be both interesting and definitely true.

On one very controversial picture, there is a certain range of contexts that uses of ‘more similar’ in metaphysics tend to be in, across which the context-sensitivity of ‘more similar’ is resolved in *exactly* the same way, and in which ‘more similar’ is perfectly precise. The proponent of this picture might liken the context-sensitivity of ‘more similar’ to the context-sensitivity involved in the fixing of quantifier domains, as this is understood by fans of absolutely unrestricted quantification. Just as speeches like ‘Let us quantify unrestrictedly’ arguably force a particular, precise resolution of the context-sensitivity of quantifiers, so it might be thought that we can force a particular, precise resolution of the context-sensitivity of ‘more similar’ by making a speech like ‘Let all respects of similarity matter, and let us stipulate nothing about their relative importance’. However, this view looks very implausible, and we know of no evidence that Lewis endorsed it. It is just too arbitrary to suppose that the relevant philosophical speech manages to impose a particular definite answer to a question like ‘Is Bill Clinton more similar to Albert Einstein than to Fred Astaire?’ And once this is conceded, even the claim that the relevant philosophical uses all involve exactly the same resolution of the context-sensitivity of ‘more similar’ looks problematic. On many accounts of vagueness, including Lewis’s, vagueness always involves a kind of context-sensitivity, since we are always free to sharpen up a vague expression by settling some of its borderline cases. If vagueness and context-sensitivity are closely related in this way, it is hard to see how any reasonably broad class of uses of some expression could involve exactly the same resolution of its context-sensitivity unless they also involve rendering it perfectly precise.

Of course, this controversial picture need not be endorsed by those who want to use 'more similar' in theorising about naturalness. In philosophy, we often get by perfectly well using language that is quite vague and context-sensitive. Local practices can spring up in which the vagueness and context-sensitivity are kept within limits; this can happen even when participants have no helpful way of explaining *which* interpretations of the relevant expressions are the intended ones. But while this *might* be how things stand as regards the relevant theoretical uses of 'more similar', it would be dialectically inappropriate simply to presuppose that it is the case in a debate with 'naturalness sceptics'. In that context, we will perhaps do best to find ways of casting the claims in such a way as to avoid *using* the vocabulary which is suspected of being too vague or context-sensitive to be theoretically useful. The cause of clarity will best be served by semantic ascent. Instead of cashing out the connection between naturalness and similarity using the object-level *Similarity* and *Dissimilarity*, we could replace them with claims involving some kind of quantification over contexts, or over the relations which are admissible interpretations of 'more similar' in some contexts.

Here are some thoughts one might try out in this connection:

- *Similarity/Dissimilarity* is true in some not-too-unusual context.
- *Similarity/Dissimilarity* is true in every not-too-unusual context.³⁸
- The more natural a property P is, the more unusual a context needs to be for 'Things that have P can be very similar to things that lack P' / 'Things that have P can be very dissimilar from one another' to be definitely true / not definitely false at it.
- The less the total naturalness of the properties that divide x and y, and the greater the total naturalness of the properties they share, the more unusual a context needs to be for 'x and y are very dissimilar' to be definitely true at it.
- The more the total naturalness of the properties that divide x_1 and x_2 exceeds the total naturalness of the properties that divide y_1 and y_2 , the more unusual a context needs to be for ' x_1 and x_2 are more similar than y_1 and y_2 ' to be definitely true at it.

³⁸ Note that if we cash out *Similarity/Dissimilarity* as involving existential quantification over functions, it will be possible for them both to be true across a wide range of contexts which interpret 'similar' differently but agree on the interpretation of 'natural'.

Each of these claims requires us to make sense, in some rough-and-ready way, of the degree to which a context is unusual (as regards the interpretation of ‘similar’ and related vocabulary). We could try cashing this out either in some quasi-statistical way, or by means of questions like ‘How much special priming does it take to get into this context?’³⁹

We will not attempt to single out any one principle as the right one to focus on in debates about how much of the naturalness role is satisfied. But we are hopeful that fully-fledged enthusiasts for naturalness will be able to find something that they can accept in this general vicinity. The connection they want to make between naturalness and similarity is surely not just supposed to apply to the relation expressed by ‘similar’ in philosophical contexts—for example, it is surely part of the vision that even in the contexts where we are primarily concerned with resemblance in people’s characters, more natural character-related properties will count for more than less natural ones.

10. *Magnetism*: The more natural a property is, the easier it is to refer to, *ceteris paribus*.

In Lewis’s thought, this aspect of the role of naturalness is presented in the form of a certain proto-theory about how semantic facts supervene on certain non-semantic facts. The most widely discussed version of this theory is an account of linguistic interpretation in which it is necessary and sufficient for an interpretation to be correct that it does the best job of simultaneously balancing two factors—‘use’ (interpreting people as disposed to speak the truth) and ‘eligibility’ (assignment of natural meanings). But for Lewis, this was just a toy theory. In his considered view, the primary role for naturalness is in the theory of mental content, although it does also play a subsidiary role in the story about how semantic facts supervene on mental ones (see Lewis 1992).

(What, exactly, is the role of naturalness in Lewis’s final theory of mental content? ‘New Work’ presents the following simplified story: for C and V to be, respectively, the credence and value function of a certain agent *a* is for them to achieve an optimal

³⁹ If we go for a statistical construal, we will probably find it beneficial to consider just the contexts in which ‘similar’ is used by English-speakers in the actual world, but some broader range of contexts encompassing many different possible worlds, and expressions in different languages that play a role like that of ‘similar’. See the discussion of *Magnetism* below for some ways in which one might make sense of the required measure over possible worlds.

balance of *fit*—being such that the options to which C assigns the highest expected V-value are those a actually takes—and certain desiderata of *humanity*, among which that of eligibility—that ‘the properties the subject supposedly believes or desires or intends himself to have’ not be too severely unnatural (p. 375).⁴⁰ As it stands, this view looks inconsistent with certain other considered commitments of Lewis’s. For one thing, Lewis’s philosophy of mind is functionalist as opposed to behaviourist, but the view just sketched is a form of behaviourism: facts about the agent’s internal structure are relevant only in so far as they make a difference to the agent’s dispositions to act. Also, the view is hard to square with Lewis’s claim, that, at least ideally, one has high credence in all the propositions (no matter how unnatural) that are entailed other propositions in which one has high credence. The second tension could be remedied by taking eligibility as the desideratum that C and V *themselves* should be as natural as possible. This requires making sense of naturalness for relations between properties and numbers, but it is hard to see why this should be regarded as more problematic than naturalness for any other relations. Figuring out how to remove the first tension requires perusing some of Lewis’s other works in the philosophy of mind, such as Lewis 1980. Here is one way a non-behaviouristic analysis might go. Step one: analyse ‘a has credence function C and value function V’ as ‘the three-place relation that plays the credence-value role for a’s species holds between a, C and V’. Step two: analyse ‘R plays the credence-value role for species s’ as a matter of R’s achieving an optimal balance of several desiderata, one of which is that it should not be too common for members of s to perform actions that are not optimal according to the C and V to which they are mapped by R, and another of which is that R itself should not be too unnatural. On this way of doing things, the generalisation that people tend not to have very unnatural credence and value functions stems from the generalisation that natural Rs tend not to map people onto such functions. It is fine to interpret a person as having some rather weird and arbitrary C and V, so long as we have reason to think that their internal structure is weird and arbitrary in some corresponding way, so that a reasonably natural R can map them onto that C and V.⁴¹)

⁴⁰ Recall that according to Lewis 1979, the basic objects of credence and value are properties rather than propositions.

⁴¹ The idea that the naturalness desideratum applies in the first instance to relations between people and contents, rather than directly to contents, is reminiscent of Sider’s claim that the generalisation that referents tend to be natural is to be explained by the fact that ‘the reference relation must be a joint carving one’ (Sider

We won't be concerned here with the fortunes of any particular account of the supervenience of content-theoretic facts on facts of other kinds. Our purposes are better served by the bare-bones formulation of *Magnetism*, which could be integrated in many ways into a larger and more ambitious theory of content, and which does not even presume that a reductive theory of content is available.

What could 'easy to refer to' mean, taken apart from any particular reductive programme? Here is the basic thought. Sometimes, our referring to a given property with a word depends on lots of detailed facts about our use of that word: the property is hard to refer to in the same sense in which the bullseye of a target is hard to hit. On other occasions, the fact that we refer to a given property with a word is much less sensitive to the exact details of use. In these cases, referring to this property rather than any other is a lesser achievement, like hitting some much larger region on the surface of a target. As a very crude first pass, the degree to which a property is easy to refer to might be measured by the number of worlds in which it is referred to. But since the relevant sets of worlds are infinite, simply counting the worlds is no good. What we need to make sense of this thought is something like a measure on possible worlds.

One shouldn't be excessively sceptical here: measures over certain sets of nomically possible worlds are quite integral to the practice of physics and other sciences. This suggests that one can at the very least make sense of the notion of 'easiness' required by *Magnetism* by appealing to some such measure. Given that *Magnetism* incorporates a *ceteris paribus* caveat, the claim that a given ordering satisfies this version of the *Magnetism* role will be tricky to evaluate. But since the spaces of nomically possible worlds on which these measures are defined will usually contain a vast variety of possible language-users and thinkers, it is unlikely that the *ceteris paribus* clause will need to be interpreted so liberally as to deprive *Magnetism* of any bite whatsoever.

Of course, this is not the only possible way of making sense of the notion of 'easiness' in *Magnetism*. Other interpretations can be derived from other measures

2011, sect. 3.2; and cf. Williams 2007 and Hawthorne 2007). But note that the relation R that plays the credence-value role for a given species is distinct from the relation *being an a, C, V such that a's credence function is C and a's value function is V*. Thus the fact that R is natural is not directly relevant to the question how natural the latter relation is. Indeed, Lewis often treats such functional properties as highly unnatural: for example, the property of having some property that plays the pain role is much less natural than the property that actually plays the role (Lewis 1983, p. 349).

over possible worlds, for example an epistemologically-based measure of ‘a priori plausibility’, or a measure extracted from the dissimilarity-distances between worlds, or a measure defined directly in terms of naturalness. Plausibly, some of these more global measures will allow one to place less reliance on the *ceteris paribus* clause than is required by interpretations of *Magnetism* in which the relevant measure is one derived from physics. However, physics-based interpretations of ‘easy to refer to’ are likely to be especially useful in the context of the debate between naturalness-enthusiasts and naturalness-sceptics, since the sceptics are less likely to have qualms about their intelligibility.

This idea of ‘reference’ to a property could be cashed out in different ways. One choice point concerns speaker versus semantic reference. Another concerns expression by a simple word versus by a complex predicate. And further issues arise in connection with vagueness. Some supervenientists work in a framework where reference is thought of as being (or as needing to be replaced by) a one-many relation of ‘candidate reference’ or ‘partial denotation’ (cf. Field 1973). This suggests two measures of magnetism for a property: how easily can it be a candidate referent, and how easily can it be a *determinate* referent (i.e. the one and only candidate referent)? The former, candidacy-based notion may behave quite strangely vis-à-vis Lewis’s original vision. If it is fairly commonplace for communities to have a word like ‘bald’ that is vague across a wide range of hair-distribution properties, whereas the flourishing of physics is a modally rare event, then many hair-distribution properties might prove easier to have as candidate referents than the property of being an electron. By contrast, if determinate reference is what counts, concerns about the rarity of physics might not be at all disruptive, if the study of physics is the most common route to determinate reference in the realm of the concrete. Other theorists of vagueness are happy to work with a predicate ‘refers *simpliciter*’, conceived of as unique but often very vague. One could use this to gloss *Magnetism*, at the risk that its extensive vagueness will generate an awful lot of vagueness in ‘easy to refer to *simpliciter*’—for example, if it is not definitely false that ‘bald’ refers *simpliciter* to exactly the same hair-distribution property at all not-too-distant worlds, no precisification of ‘bald’ will definitely fail to be easy to refer to. We will generally work with a gloss on ‘easy to refer to’ as ‘easy to determinately refer to’, since this seems to fit more unproblematically with the rest of the role.⁴²

⁴² One might, like Williamson (1994), have the view that despite the fact that it is vague what ‘bald’ refers to *simpliciter* at each world in our modal neighbourhood, it

Finally, we should make explicit a claim about naturalness that Lewis presupposes in much of his discussion:

11. *Necessity*: Facts about a property's degree of naturalness are non-contingent.

The denial of *Necessity* would be quite alien to Lewis's thought, and would require rethinking many of the other components of the role.⁴³ Recall that *Supervenience* requires whatever properties are in fact perfectly natural to be such that, whenever *any* two possible worlds differ (or differ qualitatively), they differ in the distribution of those properties. This generates some pressure to think that there are properties that are actually perfectly natural but uninstantiated. Are there other possible worlds that differ from the actual world *just* as regards the relative naturalness of these alien properties? It is hard to believe that there are; but it is also hard to think of any reasonable story about how the contingent facts about the naturalness of these alien properties could supervene on any other facts at the worlds where they are uninstantiated. Likewise, *Similarity* and *Dissimilarity* relate truths about the naturalness ordering to *modal* facts (about possible levels of similarity and so on); at least on an S5-friendly conception of metaphysical modality, it is obscure how one could coherently combine this with the thought that the naturalness ordering is contingent.⁴⁴

Of course, those who reject *Necessity* might be able to formulate surrogates for the other Lewisian principles that preserve some of their spirit. For example, *Supervenience* might be replaced by a claim to the effect that no two possible worlds at which exactly the same properties are perfectly natural differ qualitatively without differing in the pattern of instantiation of those properties. *Magnetism* might

is still definitely true that its reference *simpliciter* varies from world to world in a very fine-grained way. In that case it will also be definitely true that neither baldness itself, nor any of the other hair-distribution properties which 'bald' does not definitely fail to express, is easy to refer to (at least in our modal neighbourhood), so that glossing *Magnetism* in terms of reference *simpliciter* is more promising. See Dorr and Hawthorne MS for further discussion of the considerations for and against such extreme 'semantic plasticity'.

⁴³ See Lewis 1986, note 44 (p. 61). The view that the naturalness-facts are contingent is favourably entertained by Cameron (2010).

⁴⁴ With weaker modal logics, a whole range of decision points open up, including an S4-rejecting view that keeps *Necessity* while denying that the naturalness ordering is necessarily necessary.

be replaced by a claim to the effect that for any given property, it is hard to refer to that property in a world where it is not very natural. And so on.

The denier of *Necessity* faces a range of difficult and delicate questions about the possible distributions of perfect and relative naturalness. Among the properties which are not in fact perfectly natural, which ones could be perfectly natural? One possible view is that every property whatsoever could have been perfectly natural.⁴⁵ While it seems like an attraction of this view that it enables us to dodge the need for making a distinction between the possibly perfectly natural properties and the rest, plenty of other awkward questions remain. For example, assuming that it is still necessary that no perfectly natural property supervenes on all the rest, there must be limits on which sets of properties can be perfectly natural *together*; and it is hard to think of a good way to answer questions like ‘Which properties are such that they could be perfectly natural in a world where *being a spoon* was perfectly natural?’ Also, it is unclear whether there is any prospect of making headway with the question, concerning a given list of properties, which among the possible patterns of distribution are consistent with all of them being perfectly natural, and which are consistent with none of them being perfectly natural. For example, could the properties that are in fact perfectly natural have been distributed as they actually are while the property of being perfectly natural had a different distribution?⁴⁶ One possible retreat that is still rather plenitudinous in spirit is to say that while not every property could be perfectly natural, it is still true that necessarily, every property is coextensive with at least one possibly perfectly natural property. Of course, there are also much more restrictive views available; for example, one might think that it is only qualitative properties, or intrinsic properties, or properties feature in some interesting way in the special sciences, that are coextensive with possibly perfectly natural properties. Finally, the most conservative way to deny *Necessity* involves saying that the only properties that are not perfectly natural but could be are uninstantiated ones. However, this last view threatens to collapse into a notational variant on Lewisian orthodoxy, since it suggests the generalisation that being possibly perfectly natural and instantiated is necessary and sufficient for being

⁴⁵ One might want to make an exception for necessary and impossible properties, and perhaps also for certain cardinality-related properties which could never be part of any minimal supervenience basis over any set of worlds.

⁴⁶ If perfect naturalness is itself perfectly natural, the answer is obviously no, but a question remains about the extent to which the other perfectly natural properties could have a matching distribution compossible with a different list of perfectly natural properties.

perfectly natural. Since we don't have much sense of how to steer a disciplined path through this garden of decision points, we will assume *Necessity* for the remainder of our discussion.⁴⁷

* * *

The eleven claims on our list give us enough to go on for the purposes of this paper, although there are certainly other roles for naturalness which can with some plausibility be extracted from Lewis's discussion, and which have been taken up to varying degrees in subsequent work. For example, it is clear that Lewis wants to make some connection between the fact that greenness is more natural than grueness and the epistemological fact that a disposition to infer that all emeralds are green from the evidence that all observed emeralds have been green is more reasonable than a disposition to infer that all emeralds are grue from the evidence that all observed emeralds have been grue. However, Lewis does not provide us with many clues about the form this connection should take. Given Lewis's other commitments, one would hope to be able to characterise it in a Bayesian framework, where facts about the rationality of inductive inferences boil down to facts about which prior credence functions are reasonable. If one could make sense of comparisons of naturalness for probability functions—and there is no obvious obstacle to doing so, given that such functions can be thought of as relations between propositions and numbers—one could propose a view where the reasonableness of having a certain probability function play the role of one's priors is tied directly to

⁴⁷ One motivation for denying *Necessity* is the thought that there are possible worlds where, unlike the actual world, electrons are made of smaller particles, and where electronhood fails to be perfectly natural in the same way that *being a hydrogen atom* fails to be perfectly natural at the actual world. If one were gripped by this thought, one might be tempted to say too that there is a world where hydrogen atoms are simple, and where *being a hydrogen atom* is perfectly natural. But this conflicts with the compelling thought that to be a hydrogen atom is to be an atom containing exactly one proton—about as compelling an instance of the necessary a posteriori as one could hope to find. Perhaps, however, the proponent of the view will say that while this account of what it is to be a hydrogen atom is correct, there is a property which is coextensive with *being a hydrogen atom* at worlds where the list of perfectly natural properties is what it actually is, but which is instantiated by simples, and perfectly natural, at certain other worlds. Our own view is that the claim that electrons are simple as just as good a candidate to be necessary if true as the claim that hydrogen atoms aren't.

the naturalness of that function.⁴⁸ But this can't be right, since some probability functions which other parts of the role suggest are quite natural would make horribly unreasonable priors. Consider for example a probability function that treats all coin-tosses as fair and independent: having this play the role of one's prior credence function would mean being disposed to assign credence 1/2 to the proposition that a coin will land Heads the next time it is tossed irrespective of facts about the coin's track record, even when the track record strongly suggests that the coin is biased. However, there are more attractive ways in which we might connect naturalness to the reasonableness of priors. We could say, for example, that a reasonable prior function is a matter of taking a weighted average of many probability functions, in such a way that more natural probability functions are weighted more heavily, and roughly equally natural probability functions are weighted roughly equally.

(Note that if the connection between naturalness and inductive rationality turns on the naturalness of probability functions, there will be no straightforward route from a claim about the naturalness of a property of objects to any epistemological claim. There is no obvious need to employ any notion of the 'degree of projectibility' of a property; and if we do manage to devise a measure of projectibility that makes sense in a Bayesian framework, there is no obvious reason to expect that only natural properties will achieve high projectibility scores.)

A second normative concept which one might want to connect to naturalness is that of *intrinsic epistemic value*. While Lewis says little about this, it plays a starring role in Sider 2011. One attractive idea relates naturalness to the fact that some true beliefs (or items of knowledge) are more valuable than others. If we care about the truth in the way we should, we will prefer the opportunity to find out whether neutrinos have mass to the opportunity to memorize the contents of a telephone directory. So long as we can make sense of naturalness for propositions as well as properties, it is tempting to explain this by claiming that the more natural a true

⁴⁸ One issue that we would need to resolve in formulating an appropriate measure of naturalness for probability functions comes from the fine-grained considerations that seem to play a role in individuating propositions (conceived of as the objects of credence). If we think of propositions as including Fregean 'guises', our measure will somehow need to take into account the naturalness of the guises as well as, or instead of, the naturalness of the properties of which they are guises. For example, the projectibility of greenness looks rather less when the relevant guise is given by the description 'Fred's actual favourite property'. These issues also complicate the attempt to connect naturalness to epistemic value (see below).

proposition is, the more epistemic value one achieves in believing it (or knowing it, or having high credence in it), at least *ceteris paribus*.

If we accept this claim, how should we generalise it to false propositions? Is believing a natural false proposition worse or better than believing an unnatural one? Sider's discussion, in which naturalness and truth are treated as two independent 'aims of belief', might be read as suggesting that it is *better*: a natural false belief is good in one way and bad in another, while an unnatural false belief is bad in both ways (see Sider 2011, p. 62). But this strikes us as odd. If forced to choose, shouldn't one prefer a pill that will inculcate millions of false beliefs about strangers' phone numbers to one that will inculcate a mistaken belief as regards whether neutrinos have mass? Moreover, if one believes a false natural proposition P (e.g. that electrons are more massive than protons), one will thereby be in a position to infer a vast array of less-natural consequences of that proposition (P or at least one zebra wears pyjamas; P or at least two zebras wear pyjamas; ...). A good theory of epistemic value should not entail that there is great disvalue attached to actually carrying out these inferences.

(Sider also endorses a different, and according to him stronger, version of the thesis about epistemic value, according to which it is 'better to think and speak in joint-carving terms', and 'worse to employ non-joint-carving concepts' (2011, p. 61). This strikes us as much more problematic than the 'weak version' of the thesis, insofar as it is supposed to be a claim about *intrinsic* value. It is easy to see how speaking or thinking in a language whose syntactically simple expressions have unnatural semantic values could have various kinds of *instrumental* disvalue. It will mean one has to work much harder even to entertain the true and natural propositions belief in which brings epistemic value according to the weak version of the thesis. Indeed, on some views, it may make it *impossible* to entertain these propositions—if one thinks of propositions as structured entities, one might suppose that no natural propositions can be expressed in a language whose syntactically simple predicates express unnatural properties. Moreover, having a badly engineered language of thought may also tempt one to form false beliefs about naturalness and similarity. But how could anything of intrinsic value turn on the nature of one's system of representation?)

The putative normative components of the naturalness role have an important role to play in the debate between naturalness enthusiasts and naturalness sceptics; they are especially strongly evoked by labels like 'elitism' and 'egalitarianism'. But

we are not going to have much more to say about them, in part because they don't figure much in Lewis, and in part because we haven't yet come up with many interesting things to say about their relation to other aspects of the role.⁴⁹

Some will be thinking that our list has left out an absolutely crucial component of the naturalness role. What about the claim that the perfectly natural properties are exactly the *fundamental* properties, or that the more natural a property is, the closer it is to being fundamental?⁵⁰ What about the claim that all facts *obtain in virtue of*, or *reduce to*, the facts about the instantiation of the perfectly natural properties? Or what about the claim that the perfectly natural properties are the ones that give reality its structure? Our reason for not putting this sort of thing into the role is that the dispute we are trying to illuminate is one in which one side—that of the 'naturalness-sceptics'—is sceptical not just about 'natural property' but about expressions like 'fundamental property', 'irreducible property', etc. For *this* dispute, our methodological advice to focus on questions that can be asked without using the contentious vocabulary requires 'fundamental', 'irreducible', and the rest to be Ramsified out along with 'natural'.⁵¹

⁴⁹ Weatherson (forthcoming) suggests that there might be no ranking that satisfies both the role of 'M-naturalness' (our *Supervenience, Duplication, Non-Duplication, Laws, Similarity* and *Dissimilarity*) and that of 'E-naturalness' (the connection with inductive rationality). He suggests two arguments: (i) greenness is highly projectible but not very M-natural; (ii) electronhood is very M-natural but not very projectible (the claim that observed electrons do such-and-such does not *by itself* support the claim that all electrons do such-and-such, unless one also has positive reason to *believe* that electronhood is M-natural). These arguments depend on what seems to us an overly simple way of cashing out E-naturalness, as essentially equivalent to 'projectibility'. The second argument also raises subtle issues connected with the role of 'guises' in the epistemic part of the naturalness role—the problem might be attributed to a lack of naturalness in the guises under which we think of electronhood rather than to a lack of naturalness in electronhood itself.

⁵⁰ When Lewis uses 'fundamental' as a term of metaphysical art, he treats it as interchangeable with 'perfectly natural' (e.g. in Lewis 2009).

⁵¹ Of course, we can also imagine a debate about naturalness in which both sides take it for granted that, say, some properties are more fundamental than others; this debate will involve new questions about which of the other naturalness roles are satisfied by the fundamentality ranking. Many of the arguments about this question will recapitulate arguments about the extent to which our naturalness roles are co-satisfiable. For example, if one assumes that the fundamental properties form a supervenience base, one can argue that the fundamental properties are not all easy to refer to from the premise that the properties that are easy to refer to do not form a supervenience base. For the introduction of fundamentality into the role to give rise to new and interesting *arguments*, the disputants will need to find ways of supporting claims about fundamentality that do not depend on the assumption that fundamentality satisfies one of the other naturalness roles.

* * *

Throughout the above discussion, we have followed Lewis in using ‘natural’ as a predicate of *properties*, conceived of as ‘abundant’. In treating properties as abundant, we have implicitly been helping ourselves to the instances of the schema ‘The property of being F is, necessarily, instantiated by all and only the things that are F’. While this is all very convenient, anyone who wants to talk like this had better face up eventually to the fact that the schema is inconsistent: it entails that the property of not instantiating oneself instantiates itself iff it doesn’t instantiate itself.⁵² This is not the place for a survey of all the candidates for a consistent replacement for the inconsistent practice. Let us just mention the best known, namely to officially replace all talk about properties with higher-order quantification, i.e. quantification into predicate position (see Williamson 2003). In this way of talking, ‘natural’ would no longer appear as a predicate of the same syntactic type as ‘cheerful’: rather, it would become a higher-order predicate—something that takes a predicate and makes a sentence. Or rather, it would have to give way to an infinite family of higher-order predicates: ‘natural_{((i))}’ (taking a one-place first-order predicate as argument), ‘natural_{((i,i))}’ (taking a two-place first-order predicate as argument), etc.⁵³ Similarly, we would have many different versions of ‘more natural’, ‘perfectly natural’, etc.

Indeed, this may only be the tip of the iceberg. If we had been wanting to talk about the naturalness of *properties of properties*, we will also need versions of ‘natural’ of higher types: ‘natural_{((i))}’, ‘natural_{((i,i))}’, ‘natural_{((i,i,i))}’, ... as well as ‘natural_{((i),(i))}’, ‘natural_{((i),(i),(i))}’, and so on. The question whether we have any need for versions of ‘natural’ taking higher-order predicates as arguments will depend on how much interesting work we were originally hoping to do by talking about the naturalness of properties of properties. Insofar as the focus is on the theory of reference, there seems to be no relevant difference between the orders: for example, we can discuss how easy it is to have an expression whose meaning is this or that generalised quantifier. On the other hand, similarity for properties is a far more rarefied concern than similarity for objects, while duplication for properties is deeply obscure.

⁵² This is inconsistent in classical logic; new possibilities open up for those who regard ‘P iff not-P’ as consistent (see Field ****).

⁵³ The subscripts indicate type, in the usual notation: an expression of type *i* is a singular term, and an expression of type $(t_1 \dots t_n)$ is something that yields a sentence when combined with an expression of type $t_1 \dots$ and an expression of type t_n .

If one has versions of ‘natural’ of higher types, one might also wonder whether there would be any use in a predicate ‘natural_(i)’ that makes a sentence when combined with a term referring to an *object*. What work could be done by a notion of naturalness that allows us to make discriminations among objects? Here one can’t appeal to contingent features of objects such as how sharply they stand out from their surroundings, at least assuming that *Necessity* is not to be sacrificed. Nor do *Similarity*, *Dissimilarity*, *Duplication* or *Non-Duplication* give such a predicate much life. *Magnetism*, on the other hand, seems well-suited to making discriminations between objects, especially if we have an abundant ontology with objects corresponding to all sorts of arbitrary modal profiles. If one wants to speak of *perfectly* natural objects, the obvious strategy is to use them to refine the first of our glosses on *Supervenience*, so that the universal supervenience base consists of propositions of the form $F\alpha_1\dots\alpha_n$, where $\alpha_1\dots\alpha_n$ as well as F are perfectly natural. *Independence* could then be taken as requiring certain forms of independence among those special propositions—on the Combinatorialist version, the upshot would be that the perfectly natural objects are modally completely interchangeable. As at the level of properties, these ideas about the role played by object-naturalness may push in different directions. For example, the suggested revision of *Supervenience* encourages such views as that the perfectly natural objects include all fundamental particles, or all spacetime points, whereas *Magnetism* suggests a starkly different assessment of the naturalness of such objects relative to, e.g., the number two.⁵⁴ We will not have anything more to say about natural objects in the present paper.

One consequence of moving to a higher-order approach is that certain apparently intelligible thoughts can no longer be encapsulated in a finite sentence. For example, no finite sentence corresponds to ‘There are no perfectly natural relations of arity greater than 3’. The problem is that every variable has to have a particular syntactic type, and only finitely many types of variables can occur bound in any finite sentence. For similar reasons, the higher-order approach will not give us any finite sentence that could serve as a replacement for ‘All facts supervene on the totality of facts about which things have which perfectly natural properties’. If we can understand what these claims are getting at, our ability to do so seems to rest on our ability to grasp what would be meant by certain sentences in an *infinitary* higher-order language. This is controversial, but those who are sceptical about our ability

⁵⁴ Given the problem of the many, the judgment that *people* are easier to refer to than spacetime points is not straightforward.

to reach into the infinite in this way should probably not be amenable to the higher order approach in the first place.⁵⁵

The idea that it is best to theorise in this area using an expression that can make a sentence by combining with expressions other than singular terms, rather than an ordinary predicate applying to properties or entities of any other sort, is a key theme in Sider 2011. However, it is worth noticing some features of Sider's regimentation that distinguish it from a higher-order approach of the sort gestured at above. (i) Rather than many different versions of 'natural', Sider suggests that one could legitimately use a single promiscuous expression \varnothing that can univocally combine with expressions of myriad types—including its own promiscuous type. (In section 4 we will discuss Sider's argument that ' $\varnothing\varnothing$ ' is not only meaningful but *true*.) (ii) Another aspect of the promiscuity of \varnothing is that it can combine with all manner of expressions, many of which would not typically be thought of as having 'semantic values'. He includes variable-binders (e.g. ' λ '), and it is not clear whether he has any grounds for denying the well-formedness of ' $\varnothing un$ ' (an \varnothing followed by the morpheme 'un'), ' $\varnothing,$ ' (an \varnothing followed by a comma) or ' \varnothing ' (an \varnothing followed by a left parenthesis).⁵⁶ (iii) Given that Sider's \varnothing can combine with expressions where it is obscure what it would mean to quantify into the relevant position, or to flank an identity-like symbol with such expressions, his notation leaves it obscure what it would mean to claim *exhaustiveness* on behalf of a particular list of \varnothing claims. Even for predicates, it is not clear whether any of the extant ways of making sense of identity would fit with Sider's purposes, given the extremely fine-grained distinctions he wants to make.

⁵⁵ In so far as the expressibility problems merely involve the absence of any higher-order sentence corresponding to a quantification over relations of arbitrary arity, we might remedy it by using monadic predicates applying to ordered tuples as surrogates for polyadic predicates. In interpreting 'natural' applied to such predicates, we would need to be careful not to confuse the original sense of 'natural' with the new sense that enables us to use ordered pairs as surrogates. Those who are very concerned about expressibility will likely doubt that we could understand the new sense.

⁵⁶ Note that if we could make sense of questions like these, they would not be questions *about* the relevant bits of language, any more than ' $\varnothing red$ ' is about the word 'red'.

3. How much of the role is satisfied?

Our aim in this section is to draw attention to a range of subsets of the roles listed in section for which one might reasonably doubt their joint satisfiability. In some cases we will simply point to a set of claims whose joint satisfiability is not obvious; in others, we will present distinctive reasons for doubting the relevant co-satisfiability claim. (We make no claim of exhaustiveness.) While this will give the section a somewhat negative cast, we will not be endorsing any of the reasons for doubt; nor do we want to get sucked into a debate about the proper location of burdens of proof. Our main aim is to show how, once the debate about naturalness is structured as we think it should be, the ‘naturalness sceptic’ becomes a more interesting and dialectically formidable character than the Goodmanian crypto-idealists that we tend to encounter in the works of naturalness-enthusiasts.

In general, the fragments of the role for which doubts about satisfiability arise comprise more than one of the principles. For example, given a general framework in which we don’t worry about the existence of properties and facts, and conceive of properties as necessary existents, it is unproblematic that there is a collection of properties upon which all facts supervene, namely the collection of all properties. Thus, barring a challenge to this background framework (one that is not normally the focus for disputes about naturalness), there is no worry about the satisfiability of *Supervenience* taken by itself. We could make it true simply by interpreting ‘more natural’ in such a way that no property is more natural than any other, so that all properties whatsoever count as perfectly natural. Similarly, if one interprets *Magnetism* in the bare-bones way sketched above, rather than treating it as a placeholder for Lewis’s entire theory of linguistic and mental content, doubts about its satisfiability look far-fetched: surely some properties are easier to refer to than others. But as soon as one starts to combine the roles, space for reasonable doubt opens up.⁵⁷

(a) *Supervenience + Magnetism*

⁵⁷ We will not be considering any tensions there might be between the principles on our list and *intuitive* judgments about certain properties’ degrees of naturalness. These aren’t the kind of arguments that are appropriate to naturalness-scepticism. Even for those who are completely comfortable using ‘natural’, there is much to be gained—at least by way of dialectical clarity—by trying to settle questions about which portions of the role are satisfied *at all* before going on to ask which of them are satisfied by naturalness.

Whatever exactly we mean by 'easy to refer to', it looks unlikely that the properties that are tied for first place will be numerous enough to provide a supervenience base for everything. Of course, *Magnetism* as we stated it contains a *ceteris paribus* clause, which could allow for some slippage here. Nevertheless, one could consistently maintain that *all* supervenience bases involve properties that are so hard to refer to that there is no reasonable interpretation of the 'ceteris paribus' clause which would allow us to sustain the combination of *Magnetism* and *Supervenience*.

(b) *Supervenience + Magnetism + (Non-duplication or Independence)*

Even if there are interpretations of 'perfectly natural' that satisfy *Supervenience* and *Magnetism*, new worries may arise when we include a third principle. For example, if every supervenience base whose members are reasonably easy to refer to contains at least one property that divides duplicates, *Non-duplication* will not be jointly satisfiable with *Supervenience* and *Magnetism*.

In thinking about the joint satisfiability of *Supervenience*, *Magnetism* and *Independence*, we need to distinguish between the different versions of *Independence*. *Non-supervenience* should not be hard to satisfy: given the ceteris paribus clause in *Magnetism*, we do not have to say that every property that is maximally easy to refer to is *perfectly* natural, so we need not be concerned even if it turns out that some maximally easy-to-refer-to properties supervene on others. However, there is more reason to worry about stronger versions of *Independence*, which require a richer denial of necessary connections between the perfectly natural properties beyond a failure of supervenience. One might reasonably suppose that every set of reasonably easy-to-refer-to properties is either too small to be a supervenience base or else full of rich modal connections which would violate the stronger construals of *Independence*.

(c) *Independence + ((Duplication and Non-duplication) or Supervenience)*

Suppose there were only two perfectly natural monadic properties, F and G, and one perfectly natural relation, R. Then by *Duplication*, there could not be more than eight equivalence classes of duplicate atoms. For given any nine atoms, there must be at least two atoms x and y such that $Fx \leftrightarrow Fy$, $Gx \leftrightarrow Gy$ and $Rxx \leftrightarrow Ryy$; *Duplication* tells us that any such atoms x and y are duplicates. Moreover, *Combinatorialism* and *Non-duplication* jointly entail that it is possible that there are *at least* eight equivalence classes of duplicate atoms: *Combinatorialism* entails that there could be eight atoms

no two of which satisfy the above biconditionals, and *Non-duplication* tells us that any duplicate atoms would have to satisfy the biconditionals. And the point obviously generalises: if there is some finite number n of perfectly natural properties, the maximum possible number of equivalence classes of duplicate atoms is exactly 2^n . Thus, anyone who wants to remain noncommittal as regards whether the maximum number of such equivalence classes is a power of two has reason to doubt whether there is any interpretation of ‘perfectly natural’ that satisfies *Combinatorialism*, *Duplication* and *Non-duplication*.⁵⁸

Similar cardinality-based considerations can be used to put pressure on the combination of *Combinatorialism* with *Supervenience*. If F , G and R are the only perfectly natural properties, then the second gloss on *Supervenience* tells us that there are at most eight qualitatively discernible worlds containing exactly one object, while *Combinatorialism* tells us that all eight combinations are metaphysically possible. In general, the number of equivalence classes of qualitatively indiscernible one-object worlds is guaranteed to be a power of two. Here again, those who wish to be noncommittal will have reason to be hesitant about the combination of *Supervenience* and *Combinatorialism*.⁵⁹ However, these kinds of worries do not arise in any obvious way for the other interpretations of *Independence*—for example, given that there are supervenience bases at all, there must be some minimal ones.⁶⁰

⁵⁸ Note that if we appeal to the infinitary-language version of *Combinatorialism*, the result extends to the case where the number of perfectly natural properties is infinite. Thus, even those who are confident that there could be infinitely many atoms no two of which are duplicates do not automatically escape the worry, since not all infinite cardinalities are powers of two.

There are also interesting issues here for the view that there are at least as many perfectly natural properties as sets. A natural generalisation of *Combinatorialism* to such a view suggests that in that case, every plurality of perfectly natural properties is such that possibly, there is an atom that instantiates just those properties. Given Lewisian modal realism, it will then follow that there are more atoms than perfectly natural properties. We would thus require three more-than-set-sized cardinalities: that of the perfectly natural properties, that of the atoms, and that of the fusions of atoms, where for Lewis 1986, any things that are fewer than the atoms are few enough to form a set.

⁵⁹ One can also, with more work, use *Combinatorialism* and *Supervenience* to calculate the number of equivalence classes of worlds with domains of any given size, given a specification of the number of perfectly natural relations of each arity. As in the one-object case, there are plenty of numbers that cannot be generated in this way.

⁶⁰ For example, take the set of all properties of the form *being in a Q world*, where Q is a complete qualitative world-description, and throw away one of its members; the result is guaranteed to be a minimal supervenience base in the sense corresponding to the second gloss on *Supervenience* (any qualitatively discernible worlds differ in the distribution of perfectly natural properties). The hypothesis that every

(d) *Duplication + (Independence or Dissimilarity or Laws or Magnetism)*

Consider the following *prima facie* plausible claims: (i) it is impossible that there should be duplicate objects with different masses, and (ii) any positive real number could be the mass in grams of some mereological atom. Given *Duplication*, these commitments impose a severe constraint on the extension of ‘perfectly natural’. For one thing, it must be infinite, since any finite set will (as noted under (c)) allow for only finitely many equivalence classes of duplicate atoms.⁶¹ Which properties should we throw into the set so as to give us the necessary plenitude of mass-difference makers? The most obvious strategy (and one that Lewis seems sometimes to endorse) is to say that all the maximally determinate mass properties, such as *having a mass of 4.183748 grams*, are perfectly natural. However, this move makes for severe tension with several other parts of the package.⁶²

- There is a worry about some versions of *Independence*. The determinate mass properties seem to be pairwise incompatible, whereas according to *Combinatorialism*, perfectly natural properties never are.⁶³
- There is a worry about *Dissimilarity*. It is quite intuitive to think that every degree of similarity short of the maximum possible degree is consistent with difference in mass. For it would be strange if the function that takes a real number x and returns the maximum degree of similarity that could obtain between two objects whose mass differed by x grams failed to be continuous at 0. On this picture, being divided by a determinate mass property like *being exactly three grams* would seem to do practically nothing to ‘make for dissimilarity’. (Contrast the property *having some mass or other*, which seems a much more potent dissimilarity-maker.)

supervenience base has a proper subset that is also a supervenience base is not quite so easy to rule out on the interpretations of ‘supervenience base’, but it does not look very promising.

⁶¹ Note that if (ii) were weakened to the claim that any positive real number could be the mass of some *object* (perhaps non-atomic) it would have no such implication.

⁶² Many of the points below are also discussed in chapter 11 of Hawthorne 2006.

⁶³ Also, if there are necessary truths about how the masses of composite objects depend on the facts about the masses of their parts, the version of *Independence* mentioned in note 18, according to which the complete description of a world in terms of only some of the perfectly natural properties never entails its complete description in terms of the rest, is threatened. In a world with two point particles of masses 2 and 3 grams whose fusion has mass 5 grams, each of the three mass properties is redundant.

- There is a worry about *Laws*. Propositions which express functional relationships between mass and other quantities will score terribly for simplicity if we have to express them as giant disjunctions of claims about all the determinate mass properties. We could try to avoid this problem by including further mass-theoretic relations on our list of perfectly natural properties alongside the determinate masses, but in that case we will have to give up even the *Non-supervenience* version of *Independence*.^{64, 65}
- There is a worry about *Magnetism*, since determinate mass properties seem to be very hard to refer to.⁶⁶ (Perhaps it is easy *given how things actually are* for us to refer to various integer multiples of one gram—e.g. because a certain platinum bar whose mass happens to be one kilogram is crisply demarcated from its surroundings. But this is irrelevant to *Magnetism* as we are understanding it, given that at almost all close worlds the bar will have a marginally different mass, so that people do not use predicates like ‘three grams’ to express the same properties they actually express.) In response to this worry, one could of course lean on the *ceteris paribus* clause we built into *Magnetism*. If we take the use-plus-eligibility theory as our model, it is easy to see how *ceteris* could fail in this case to be *paribus*. For on that account, even a perfectly natural property could be very hard to refer to, if it belongs to a large family of ‘competitor’ perfectly natural properties which will typically score roughly equally well as regards ‘use’. On this picture, if we want to predict how easy it is to refer to a property, its absolute level of naturalness is less useful than the degree to which it is more natural than its competitors. This way of sharpening up *Magnetism* is not inevitable, but is clearly in the spirit of Lewis’s account.

⁶⁴ Another option is to replace *Laws* with *Laws**, give up *Length*, and say that the supervenient relations required for a simple statement of the laws are very natural, but not perfectly natural.

⁶⁵ Eddon (2013) explores a related route from the claim that determinate mass properties are perfectly natural to the denial of *Non-Supervenience*. She argues (appealing to *Laws*, *Similarity* and *Dissimilarity*) that metric relations among determinate mass properties (like *being the sum of*) are very natural, and (implicitly appealing to something like *Simplicity*) that some such relations must be *perfectly* natural. Since the facts about the holding of these relations are non-contingent, they trivially supervene on everything.

⁶⁶ Recall that we are glossing *Magnetism* in terms of ease of determinate reference, for reasons explained earlier.

Counting the determinate masses as perfectly natural is not the only way to prevent atoms that differ in mass from ever sharing all their perfectly natural properties. Another approach would include all the properties corresponding to intervals on the mass scale, e.g. *being between three and four grams in mass*. Or, more subtly, we could use properties of the form *having a one in the n th place of the binary expansion of one's mass in grams*.⁶⁷ We could also achieve the required discriminations by including families of hybrid properties like *being square while having mass three grams*, or even *being square if and only if one's mass is three grams*. Some of these approaches can plausibly escape concerns arising from *Independence*. However, it is hard to see any escape from the worries about *Magnetism* and *Dissimilarity*. Suppose there is a possible world in which each determinate mass is instantiated by a mereological atom, where these atoms are otherwise as similar as can be. Given (i) (the claim that duplicates can never differ in mass) and *Duplication*, whatever properties we choose to count as perfectly natural will have to divide all these things. But it seems to be possible that some of the atoms in the world in question attain any degree of similarity consistent with lack of duplication; and, relatedly, that there are no easy-to-refer-to properties which are instantiated by only some of the atoms.⁶⁸

One could respond to these concerns by discarding *Duplication* or by rejecting (i). These moves open up many new candidate lists of mass-relevant perfectly natural properties. One might, for example, use relations of mass-betweenness and mass-congruence holding among massive objects, as in Field 1980. Or one might posit a 'mass space' conceived in substantivalist way, with a perfectly natural 'occupation' relation between massive objects and points in the space, together with suitable relations to structure mass space (see Arntzenius and Dorr 2012, sect. 8.3).^{69,70}

⁶⁷ Cf. Moss forthcoming.

⁶⁸ At worlds where the total mass of all particles is finite, we can make non-trivial divisions using easy-to-refer-to properties like *being less than half the total mass of the universe*; but these divisions are not available in the world we were imagining because of its infinite mass. Moreover, counting properties like that as perfectly natural would not sit well with *Non-duplication*, so long as we are comfortable with the ideology of transworld duplication: the claim that if x is less than half the total mass of the universe at w and y is more than half of the total mass of the universe at w seems to be consistent with the claim that x at w is a duplicate of y at w .

⁶⁹ There is precedent for the thought that there are certain entities which, although not among an object's parts, are still such that relational properties involving them are 'intrinsic' and hence as relevant to questions of duplication. For example, some believers in universals might think that, although universals are not parts of the objects that instantiate them, an object's instantiation relations to universals should play the same kind of role in our theory of duplication as its relations to its parts.

(e) *Empiricism + Independence*

According to ‘dispositional essentialists’ about the theoretical vocabulary of physics, predicates like ‘negatively charged’ express properties that necessarily involve the disposition to behave in certain ways under certain circumstances. On some versions of the idea, an upshot is that many interesting sentences entirely couched in the proprietary terminology of fundamental physics (and hence not involving words like ‘cause’, ‘disposed’, etc.) that are normally taken to express merely nomically necessary truths are in fact metaphysically necessary. For example, perhaps it is necessarily not the case that there are two particles, one negatively charged and the other positively charged, which remain relatively at rest throughout eternity in a world with no other massive objects. If this kind of dispositional essentialism is correct, those who want to count the properties expressed by such theoretical predicates as perfectly natural will have to give up some versions of *Independence*—at least *Combinatorialism*, and probably also *Recombination*.

Other dispositional essentialists may not want to go along with the suggestion that the proprietary vocabulary of actual-world physics yields interesting metaphysical necessities. For example, they may think that it *is* possible that a negatively charged and positively charged particle should remain relatively at rest without the presence of any other massive objects, provided that there are some instances of alien properties whose dispositional effects *mask* the disposition to attract that is conferred by the facts of opposite charge. Perhaps the right sorts of alien maskers could sustain pretty much *any* logically consistent pattern of physical properties. But such a view still threatens some versions of *Independence*. For to

⁷⁰ A question for those who reject the combination of (i) and *Duplication* is whether to keep the following weakening: If there is some permutation of the domain of all objects which maps x to y and preserves all perfectly natural properties and their negations, then x and y are alike in mass. (Here ‘the domain of all objects’ includes not only points and regions of spacetime but also points and regions of mass space, if there are such things.) There are apparent possibilities which put even this thought under pressure. Consider a static infinite plenum with uniform, positive mass-density, and choose an arbitrary point o . Let our permutation π map each point x onto the point twice as far from o in the same direction as x , and extend this to regions in the natural way. (If we are substantivalists about mass space, let π also map each point of mass space onto the point that is eight times further than it from the zero point.) While this π obviously fails to preserve mass, it will plausibly preserve all the properties and relations that are perfectly natural according to the theorists we are considering. If they admit that the case is possible and accept the third gloss on *Supervenience*, they will have to say that determinate masses are haecceitistic rather than qualitative properties.

preserve *Supervenience*, some of the relevant alien maskers must be perfectly natural, so that the fact that oppositely charged particles cannot remain at rest in a world without any of the alien maskers will still constitute a counterexample to the infinitary-language version of *Combinatorialism*.⁷¹

(f) (*Empiricism* or *Duplication*) + (*Dissimilarity* or *Magnetism*)

Suppose that (like many dispositional essentialists) you think that it is impossible that electrons should behave in such a way as to render the actual laws of nature radically, pervasively false. You might still be willing to countenance the possibility that electrons should exist in a world where there are some small, localized exceptions to the actual laws. Such tolerance for small exceptions is plausible in a wide range of cases where a predicate is associated with a theory in such a way that it could not apply to anything in a world where the theory was radically and pervasively false; it has considerable attractions even in the realm of particle physics. This combination of views—call it ‘tolerant physical necessitarianism’—strongly suggests that predicates like ‘electron’ are vague. For we can construct a Sorites sequence of sentences expressed using such predicates, starting with a sentence which entails the actual ‘electron’-laws, and ending with a sentence which entails that these laws are radically and pervasively false; for familiar reasons, it will be hard to maintain that there is a *definitely correct* answer to the question which is the first sentence to express a metaphysical impossibility. As we discussed under *Magnetism*, the fact that our predicate ‘F’ is vague strongly supports the claim that F-ness is not in the relevant sense easy to refer to. Thus, insofar as tolerant physical necessitarianism is supposed to apply to *all* predicates introduced in the course of scientific theorizing, it makes the combination of *Empiricism* and *Magnetism* hard to sustain.

Tolerant physical necessitarianism also generates a tension between *Empiricism* and *Dissimilarity*, if we take the latter to concern a ‘cross-world’ notion of dissimilarity. Take a possible world *w* near the outer limits of the set of worlds at which there are electrons: at *w*, the exceptions to the actual laws are about as widespread as it is possible for them to be, consistent with there being any electrons at all. It would be tempting for the tolerant physical necessitarian to suppose that

⁷¹ The view in question will also be inconsistent with the version of *Recombination* that entails that the world could consist *entirely* of duplicates of any given objects. For given *Non-duplication*, a world composed entirely of duplicates of actual-world objects cannot contain any instances of alien natural properties.

there is another world w' that is very similar to w , but that just crosses the line, so that there are no electrons at w' . This claim of similarity among worlds suggests that the following claim about cross-world similarity of objects will be true: 'for some x and y , x is an electron in w and y is not an electron in w' and x as it is in w is very similar to y as it is in w'' . This seems inconsistent with the claim that electronhood is a property division by which 'makes for dissimilarity' to a high degree.

It is interesting to consider whether views like tolerant physical necessitarianism and dispositional essentialism provide reason to doubt the co-satisfiability of subsets of the naturalness role that do not include *Empiricism*. To investigate this question, we will need to consider what the perfectly natural properties might be, if they are not the kinds of properties liable to be expressed by theoretical predicates of physics. One possibility is to say that the instantiated perfectly natural properties are not expressed by *any* of our predicates; but this makes for *prima facie* difficulties with *Magnetism*. A more promising avenue is to look to metaphysics to provide the relevant predicates. Here are some possible candidates:

'identical to'

'part of'

'member of'

'is a duplicate of'

'... resembles ... at least as much as ... resembles ...' (cf. Price 1953)

'... is the degree to which ... resembles ...' (cf. Rodriguez-Pereyra 2002)

'is a natural class'⁷²

'are, collectively, natural' (cf. Dorr 2007)

'instantiates' (cf. Armstrong 1978)⁷³

'are compresent' (cf. Russell 1940, Williams 1953)

Let us use call predicates like these, and the properties they express, 'structural'.⁷⁴
(For our purposes it is not important to specify the exact boundaries of this

⁷² It is sometimes taken for granted that the 'natural classes' are just the extensions of the (perfectly?) natural properties. But in the present setting, the interest of the idea that the property of being a natural class is perfectly natural depends on rejecting this assumption. We would want to be able to say, e.g., that the class of electrons is natural, even though neither the property of being an electron nor any property coextensive with it is perfectly natural.

⁷³ We are thinking here especially of instantiation taken as a relation between objects and *universals*, where these are conceived of as entities of a completely different sort from the abundant 'properties' with which we have been concerned up to now.

category.) If we drop *Empiricism*, might all or most of the remainder of the naturalness role be played by some ranking in which all of the top-rated properties are structural in character? The answer is not obvious. Let us consider some components of the role for which doubts are especially likely to arise.

- *Supervenience*. Humeans will likely deny that the facts about which things instantiate which structural properties constitute a supervenience base for everything. For example, they may think that there is a world where positive and negative charge have switched places, in which there are exactly the same things standing in exactly the same pattern of structural relations. However, those sympathetic to dispositional essentialism may be unmoved by such counterexamples. Questions which dispositional essentialists like to press, such as ‘what could make the difference between the actual world and one where positive and negative charge have switched places?’, seem to suggest a picture where the facts about (e.g.) negative charge *do* supervene on the structural facts.⁷⁵
- *Independence*. Most of the structural predicates on the above list figure in sentences (e.g. ‘whenever x is a duplicate of y and y is a duplicate of z, x is a duplicate of z’) which are not logically valid but seem to express metaphysically necessary truths. Counting those properties as perfectly natural would thus violate *Combinatorialism*. However it is not obvious that this is true of all of predicates on our list: Dorr (2007) claims that it is not true of ‘are collectively natural’, for example.

⁷⁴ This is of course a quite different use of ‘structural’ from that in Sider 2011, where ‘structural’ is roughly synonymous with our ‘perfectly natural’.

⁷⁵ Suppose we think there is a possible world where the universe is mirror-symmetric except that the mirror image of each particle is an anti-particle. In such a world, the permutation that maps each object to its mirror image will preserve all structural properties. Thus, if we want to say that all perfectly natural properties are structural and preserve the third gloss on *Supervenience*, we can admit such a possibility only if we are prepared to classify *being an electron* as a non-qualitative, or haecceitistic property—one which can only be defined in terms of perfectly natural properties if we allow ourselves to mention certain particular objects in the definition. For example, ‘is an electron’ might be equivalent to ‘belongs to a natural class which plays such-and-such nomological role in relation to the other natural classes, and instances of which are much more common *on Earth* than instances of the other class that plays that nomological role. For more on the options for defining predicates like ‘electron’ in structural terms, see the discussion of ‘structural nominalism’ in Dorr 2007.

- *Duplication*. It is hard to believe that the mere fact that the parts of two objects (e.g. a hydrogen atom and its antimatter counterpart) stand in the same pattern of *structural* relations suffices for those objects to be duplicates. Moreover, most of the structural relations on our list seem to be either necessarily reflexive or necessarily irreflexive: if our list of perfectly natural properties was composed of such relations, *Duplication* would require us to accept the outlandish claim that necessarily, all mereological atoms are duplicates of one another.
- *Magnetism* suggests that the perfectly natural properties should be properties we are capable of expressing precisely. The obvious vagueness of our actual use of expressions like ‘... resembles ... at least as much as ... resembles ...’ thus poses an obstacle to the view that *comparative resemblance* satisfies a version of the perfect-naturalness role that includes *Magnetism*. But this is not a decisive obstacle, since one might hold that some distinctive theoretical way of using the relevant resemblance predicate suffices to eliminate its vagueness. The same objection may be made, with varying degrees of plausibility, to the other structural predicates on our list.

(g) *Similarity + (Simplicity or Dissimilarity or Magnetism)*

Similarity suggests the degrees of naturalness of a property and its negation are often quite far apart. For on a natural reading of *Similarity*, it entails that no nontrivial property with at least a moderate degree of naturalness could have instances that are *extremely* dissimilar from one another. But insofar as we are allowed to rely on our intuitive judgments about similarity, it seems that it could very easily happen that there are three objects each of which is extremely dissimilar from the other two. If there were three such objects, it would have to be the case that for every property, either it or its negation has two extremely dissimilar instances. Thus given *Similarity*, it looks like we have to say that it never happens that a property and its negation are both even moderately natural.⁷⁶ By contrast, *Simplicity*, *Magnetism* and (on some

⁷⁶ A different *Similarity*-based argument that the negation of a property is often much less natural than it can be extracted from the claim that determinate masses are very natural: given that the determinate masses are pairwise inconsistent, it is necessary that any two objects share the negations of continuum many of them. The claim that determinate masses are very natural could be motivated by *Duplication* in conjunction with certain ancillary premises as in (d) above, or directly by *Similarity*

interpretations) *Dissimilarity* all encourage the view that a property's negation is at most slightly less natural than it. This follows from a crude implementation of *Simplicity* in terms of symbol-counting, and it is unclear how this could be affected by a more liberal interpretation. Since reference to the negation of a property is easily achieved once one is in a position to refer to that property, *Magnetism* will not draw any sharp contrast between properties and their negations. And as we have already pointed out, the obvious modal gloss on *Dissimilarity* entails that there is never any difference in naturalness between a property and its negation, since the objects divided by a property are also divided by its negation.

A parallel tension arises in the case of disjunction. *Similarity* suggests that the disjunction of two very natural properties can be extremely unnatural. By contrast, *Simplicity* and *Magnetism* suggest that the disjunction of two very natural properties will still be fairly natural. And, as we have seen, the modal gloss of *Dissimilarity* entails that the disjunction of two properties is never less natural than both of them.⁷⁷

Perhaps, however, these apparent tensions can be made to disappear by adopting the 'additive' interpretation of *Similarity* and *Dissimilarity*, according to which the

together with the claim that objects having exactly the same determinate mass are always very similar. However, as emerged in the discussion of (d), this claim also risks trouble with *Independence*, *Magnetism*, *Laws* and *Dissimilarity*.

⁷⁷ We could also consider the question whether there is a systematic difference between conjunction and disjunction. *Similarity* is naturally read as entailing that there is. By contrast, *Magnetism* suggests that there isn't. Of course, on a non-hyperintensional picture of properties, it is easy to contrive examples where the conjunction of two properties is much easier or harder to refer to than their disjunction. For example, the disjunction of *being negatively charged and not extremely happy* and *being negatively charged and not extremely unhappy* is *being negatively charged*, which is quite easy to refer to; their conjunction, *being negatively charged and neither extremely happy nor extremely unhappy*, is not easy to refer to. But such examples can be constructed in both directions, and suggest no systematic reference-theoretic difference between the operations of conjunction and disjunction. (Meanwhile, in a hyperintensional theory of properties, one might take it that properties have a structure and can only be expressed by predicates that share this structure; if so, then assuming that creatures are not much more or less likely to have a word for *and* than to have a word for *or*, there will never be a big difference in ease of reference between the conjunction of two properties and their disjunction.) Similarly, the most straightforward implementations of *Simplicity* will treat conjunction and disjunction symmetrically; and while we could of course introduce various asymmetries by hand (e.g. by tweaking the symbol-counting measure to give extra weight to disjunctions), it is a tall order to set things up in such a way as to fit with the judgments elicited by *Similarity*. For the spirit of *Simplicity* surely requires the disjunction of seventeen perfectly natural properties to be much less natural than the disjunction of two of them; whereas *Similarity* suggests that in many cases, the disjunction of two is already about as unnatural as any property.

degree of similarity between two objects depends on the total naturalness of all the properties they share and/or the total naturalness of all the properties that divide them. If we embrace the picture where the negation of a property is at most a little less natural than it, and the disjunction of two very natural properties is still quite natural, then the former value will have a quite high lower bound. For given any two very natural properties F and G , $F \vee G$, $\neg F \vee G$, $F \vee \neg G$, and $\neg F \vee \neg G$ will all be pretty natural, and any two objects whatsoever must inevitably share at least one of these properties. But the additive interpretation is consistent with the thought that even when objects are as dissimilar as they could possibly be, they share many quite natural properties. For two objects to be extremely dissimilar, the total naturalness of the properties they share need not be close to zero—it is enough if it is about as low as it could possibly be.

(h) (*Similarity or Dissimilarity or Magnetism*) + (*Independence or Empiricism*) + *Simplicity*

According to one kind of moral realism (as developed, e.g., in Wedgwood 2007), certain moral properties, such as the property of being a morally permissible action, are very easy to refer to. Provided that a linguistic community has some word which they use to regulate their conduct in a certain characteristic way, that word will express the property of being morally permissible, even if the pattern of judgments using the relevant word are very foreign to our own. It would be unsurprising if a proponent of this view also took moral permissibility to play an important role in making for similarity and dissimilarity.

One possibility for a proponent of this view is to count moral permissibility as a perfectly natural property. However, this conflicts with the spirit of *Empiricism*, since natural science does not draw our attention in the relevant way to normative properties such as this. It also raises a worry for various versions of *Independence*, insofar as moral permissibility seems to be bound up in rich patterns of necessary connections with other similarity-making, dissimilarity-making, and easy-to-refer-to properties (including the properties with which physics is concerned).⁷⁸

⁷⁸ Wedgwood himself denies that the permissibility facts supervene on the physical facts in the sense that any two possible worlds with the same physical facts have the same permissibility facts. However, by denying the S4 and S5 principles for metaphysical necessity, he manages to combine the rejection of supervenience in this form with the acceptance of another kind of supervenience claim: necessarily, the totality of physical facts entail the totality of permissibility facts. The key is that

The alternative is to say that moral permissibility is very natural but not perfectly natural. But this leads to a problem with *Simplicity*, since plausibly any properties in terms of which moral permissibility can be given a simple definition (e.g. *morally good*, or *maximizing happiness*, or *not prohibited by God's commands*) will also lead to the problems with *Empiricism* and *Independence* noted in the previous paragraph.⁷⁹

This kind of issue also arises in other domains. For example, there are views where *consciousness* is very easy to refer to, and/or of great similarity-theoretic importance, while being of no concern to physics; these will generate an analogous dilemma. One might worry, indeed, that the *Magnetism-based* version of the problem will arise all over the place—aren't properties like *being a table*, *being red*, and *being a battle* very easy to refer to?⁸⁰ However, in these latter cases, one feels more comfortable answering *no* by appealing to the vagueness of words like 'table', 'red' and 'battle', which precludes any property from being their determinate referent.^{81, 82}

whenever two physically indiscernible but morally discernible worlds are possible relative to the actual world, they are not possible relative to one another (Wedgwood 2007, chap. 9).

⁷⁹ As we formulated *Empiricism*, it says nothing at all about what the perfectly natural properties uninstantiated at the actual world are like. But given *Empiricism*, it is very implausible that there is a short expression in the language of physics that provides necessary and sufficient conditions for moral permissibility even within the 'inner sphere' of worlds where no alien perfectly natural properties are instantiated; if there is no way to do this, there is also no short metaphysically necessary and sufficient condition for moral permissibility in terms of the instantiated perfectly natural properties together with *any* properties not instantiated in the inner sphere.

⁸⁰ The version of the problem based on *Dissimilarity* does not seem to arise for *being red* and so on. A very purplish red thing can be extremely similar to a very reddish purple thing; a very peaceful battle can be extremely similar to a very turbulent altercation. *Similarity* might be thought to generate problems, but it is hard to see how to get these going without assuming a modal gloss on *Similarity*, which as we have already noted leads to many other highly unexpected judgments about naturalness.

⁸¹ One can also make a vagueness-based case against the magnetism of *being a battle*, etc., even if one glosses 'easy to refer to' as 'easy to refer to *simpliciter*', provided that one holds the 'extreme plasticity' view of reference *simpliciter* mentioned in footnote 42.

⁸² Of course, one can construct Sorites-like arguments for 'morally permissible action'. (Van Fraassen 1980 reports one from Sextus Empiricus that begins, 'Touching your mother's big toe with your little finger is morally permissible.) Do these count against the claim that moral permissibility is easy to refer to? Proponents of the Wedgwood-style view will perhaps bite the bullet and think that there is a non-vague line in such series. The hardest cases for such bullet-biting concern sequences where what varies is not the moral quality of an action, but the claims of some event to count as an action at all (cf. the literature on actions as things 'caused in the right way' by certain mental states).

(i) *Simplicity + (Dissimilarity or Magnetism)*

As already noted, the modal gloss on *Dissimilarity* entails that for any set of properties, no matter how large and miscellaneous, the conjunction and disjunction of the properties in the set never does worse than all of them as regards 'making for dissimilarity'. This is true even when all of the properties concerned 'make for dissimilarity' to a degree far less than the maximum possible degree. A ranking based on this interpretation of *Dissimilarity* thus fails to behave in anything like the way predicted by *Simplicity*.

One can also easily imagine metasemantic views in which the ranking of properties in terms of how easy it is to refer to them behaves in ways that fail to fit with *Simplicity*, so that there are big differences in magnetism among properties which are far from the top of the magnetism scale, without significant differences in the complexity of their definitions in terms of items higher up the scale.

(j) *(Similarity or Dissimilarity) + Magnetism*

Can we make sense of the thought that there are some properties which, although very easy to refer to, do little or nothing to 'make for' similarity or dissimilarity? If there were such properties, there would be a severe tension between *Magnetism* and *Similarity* or *Dissimilarity*. However, insofar as a property is easy to refer to, it is hard to see how it could be all *that* hard for speakers to get themselves into a context where the sharing of that property by two objects counts in favour of applying some cognate of 'similar' to them, while division by that property counts against it. While there certainly will be other contexts where 'similar' expresses a relation to which the property in question is irrelevant, that is true of any property. Thus, so long as we think of *Similarity* and *Dissimilarity* as generalizations about the relations that get expressed by 'similar' and its cognates at a range of actual and hypothetical contexts, the idea that a magnetic property could be *systematically* irrelevant to similarity or dissimilarity becomes hard to sustain.

(One rather common kind of context, at least in philosophy, is one where 'similar' expresses an internal relation—a relation which holds between x and y whenever it holds between any duplicate of x and any duplicate of y. It is natural to suppose that in these contexts, extrinsic properties don't 'make for similarity' at all—or at least, that this is true of *purely* extrinsic properties, those that are consistent with any consistent intrinsic profile. But it is clear that if we can make sense of 'easy to refer

to' at all, there are many extrinsic properties which are quite easy to refer to, and some of these can be argued to be purely extrinsic (e.g. *being between two massive objects*). If you insist on construing *Similarity* and *Dissimilarity* as uttered from such intrinsicness-favouring contexts, their tension with *Magnetism* will thus be quite stark. However, since there are plenty of contexts in which the relation expressed by 'similar' is not internal, this tension might not show up if *Similarity* and *Dissimilarity* are construed as generalizations over many contexts.)

The other direction in which a radical disconnect might arise would involve a property that scores highly by the lights of *Similarity* or *Dissimilarity*, while being very hard to refer to. As we have already pointed out, this kind of disconnect is inevitable on the modal glosses of *Similarity* and *Dissimilarity*. Conjunctions of (compossible) similarity-conducive properties will be even more similarity-conducive; conjunctions and disjunctions of dissimilarity-conducive properties will never be less dissimilarity-conducive. Since this holds no matter how numerous and miscellaneous the properties in question might be, the resulting rankings will clearly clash with *Magnetism* in a way that cannot plausibly be cushioned by the *ceteris paribus* clause. However, it is much less clear how the 'additive' construal of *Similarity* and *Dissimilarity* could force us to classify a hard-to-refer-to property as highly natural, since (as we pointed out), the additive approach leaves one plenty of plenty of latitude in assigning naturalness scores even when all the facts about dissimilarity-distances are held fixed.

(Still, it is far from obvious how one could set up a *Magnetism*-friendly naturalness ordering in such a way as to recover the apparently obvious fact that objects whose masses are close are more similar to one another than objects one of which is much more massive than the other.⁸³ *Magnetism* suggests that all properties of the form *being more than/less than x grams in mass* are on a par as regards naturalness, as are all conjunctions or disjunctions of two such properties. But any two objects with different masses will share continuum many properties of these kinds, and be divided by continuum many others. Sustaining the additive construals of *Similarity* and *Dissimilarity* thus seems to require finding some principled way of 'adding' these infinities in such a way as to get a higher total for items that are close in mass. Here it is hard to say anything very precise in the

⁸³ Some theorists will simply deny this fact. For example, if one thought of mass-facts as involving location in mass space, one might be led to think that that in the relevant sense of 'similar', difference in mass has no more bearing on similarity than spatial distance.

absence of a positive programme for dealing with the infinity-related problems for the additive construals.)

4. How vague is 'natural'?

Lewis's discussion of relative naturalness suggests that he would have been happy to accept that 'more natural than' is rather vague. From the standpoint of someone who thought that there was a precise fact of the matter as regards the relative naturalness of any two properties, *Simplicity* in particular seems a very poor basis for a research programme: it is hard to imagine that the questions that arise when one is trying to figure out how to measure simplicity all have definitely correct answers.

On the other hand, Lewis often gives the impression of thinking that 'perfectly natural' is not at all vague. 'Perfectly natural' is used to state various speculative hypotheses—for example, the hypothesis of Humean Supervenience, according to which the only actually-instantiated perfectly natural properties are monadic properties of point-sized things and spatiotemporal relations—and nowhere does Lewis consider the deflating thought that it is just vague whether these hypotheses are true or not. Metaphysicians often aspire to set themselves apart from ordinary discourse by formulating their central questions in a precise language, and in the tradition inaugurated by Lewis, it is envisaged that 'perfectly natural' will play a central role in making good on this aspiration.

The question whether and to what extent 'perfectly natural' is vague can thus serve as a second axis for debate between 'naturalness enthusiasts' and 'naturalness sceptics'. It's not just that the claim that 'perfectly natural' is vague goes against something Lewis happened to think. The more general point is that often, when philosophers introduce theoretical jargon with which one is unhappy, the appropriate complaint to make is not that the jargon is literally meaningless or empty, but that it is hopelessly vague, to such an extent that it provides no scope for epistemic advance—for pretty much any interesting argument in which the jargon plays an essential role, it will simply be indefinite whether the conclusion is true.^{84, 85}

⁸⁴ Of course, this talk of 'interesting' questions and 'epistemic advances' is itself quite vague, and the task of precisifying it raises delicate questions. For example, even when a word is 'horribly' vague, we should probably allow that there might be interesting arguments of a metasemantic character which settle some definite truths about its extension.

⁸⁵ Any list of examples where such a treatment is appropriate will inevitably be tendentious. Each of the following terms is on at least one of our lists: 'analytic',

This question is largely orthogonal to the questions discussed in the previous section, about the extent to which the naturalness role is satisfied. It is coherent to suppose that ‘perfectly natural’ is vague even though the entire role is satisfied. On one possible view, the entire role is satisfied by several different classes of properties, and several of these classes are candidate extensions for ‘perfectly natural’.⁸⁶ On another possible view, while it is definitely true that the role is uniquely satisfied and that the perfectly natural properties satisfy it, there is no set of properties that definitely satisfy the role and hence no set of properties that definitely are all and only the perfectly natural ones.⁸⁷

Meanwhile, there are also coherent views on which ‘perfectly natural’ manages to be precise in spite of the fact that the Lewisian role is quite far from being satisfied (let alone uniquely satisfied). There are any number of episodes in the history of science that illustrate the fact that even theories that are full of errors can sometimes be used to introduce useful, precise theoretical vocabulary. We think that this is one of the clear insights behind the idea of reference magnetism; it can certainly be embraced even by those who deny that the whole naturalness role is even close to being satisfied. Perhaps, then, ‘perfectly natural’ determinately expresses a certain property of properties which satisfies only a small portion of the role, just as, arguably, Descartes’s term ‘quantity of motion’ determinately expresses *momentum* despite the fact that Descartes’ laws of motion are a complete disaster. For instance, ‘perfectly natural’ might definitely pick out a particular minimal supervenience base whose members are not at all easy to refer to.

The question whether ‘perfectly natural’ is vague is intimately connected with the question how easy to refer to (‘magnetic’) the property of *being a perfectly natural property* is. Given the connection between vagueness and magnetism, those who claim that ‘perfectly natural’ is precise should think that perfect naturalness is at

‘acquaintance’, ‘justified belief’, ‘dispositional property’, ‘autonomous action’, ‘free will’.

⁸⁶ Note that because the classes in question satisfy *Supervenience* and *Independence*, the union of two of them will not satisfy the role.

⁸⁷ Sustaining the claim that there is no unique satisfier requires exploiting the *ceteris paribus* clause in *Magnetism*. Whatever ‘easy to refer to’ means, it is inconsistent to suppose that there are two distinct classes of properties each of which contains properties that are easier to refer to than any property outside the class. The vagueness of ‘easy to refer’ does not affect this point: at most, it prevents there from being any class of which it is *definite* that it contains all and only the properties that are maximally easy to refer to. By contrast, the package that combines unique realisation and vagueness need not place any special weight on the *ceteris paribus* clause. (An analogous point holds for *Similarity* and *Dissimilarity*.)

fairly magnetic—it is not plausible that our success in determinately referring to it is some kind of modal freak. Conversely, those who think that ‘perfectly natural’ is vague will have some reason to say perfect naturalness is not very magnetic. In Williamson’s theory of vagueness, for example, ‘perfectly natural’ will be vague only if there are close words where its reference is different; but if perfect naturalness is magnetic, most of the worlds where people refer to it lack close neighbours of that sort. In a use-and-eligibility framework, the idea would be that it is improbable that the use facts should be *almost*, but not quite, enough to overcome the pull of eligibility. So long as we preserve *Magnetism* as part of the naturalness role, there is thus pressure on those who hold ‘perfectly natural’ to be precise to claim that perfect naturalness is at least *fairly* natural, and on those who hold that ‘perfectly natural’ is vague to deny this.⁸⁸ However, there is no obvious vagueness-related reason to want to say that perfect naturalness is *perfectly* natural.

Once questions about whether properties instantiate themselves are in view, we are pushing up against the property-theoretic paradoxes. If our resolution of those paradoxes embraces a type-theoretic hierarchy of the sort described in section 2, the question ‘how natural is perfect naturalness?’ is illegitimate. On the obvious reconstruction, it will give way to an infinite series of questions, using an infinite hierarchy of naturalness-predicates: How natural_{((i))}(perfectly-natural_{((i))})? How natural_{((i,i))}(perfectly-natural_{((i,i))})?... How natural_{((i,i,i))}(perfectly-natural_{((i,i,i))})?... It is not immediately obvious that these would need to be answered in the same way. For example, one might think that it is very easy to have an expression that definitely means_{((i,i,i))} perfectly-natural_{((i))}, and on that account conclude that very-natural_{((i,i,i))}(perfectly-natural_{((i))}), while rejecting the analogous argument for the claim that very-natural_{((i,i,i))}(natural_{((i,i,i))}).

It might look to be a step forward for the debate to replace the linguistic question ‘How vague is “perfectly natural”?’ with the non-linguistic questions ‘How magnetic is perfect naturalness?’ or ‘How natural is perfect naturalness?’. However, one also loses something important in setting the linguistic questions aside in this way. Someone might hold that ‘perfectly natural’ ended up very vague, and expressing on each precisification a very unmagnetic, very unnatural property of properties, while also holding that if only Lewis had left out some especially problematic part of his

⁸⁸ Those who reject *Magnetism*, on the other hand, could consistently hold that perfect naturalness is very magnetic but not very natural, and indeed that no perfectly natural property is very magnetic. The magnetism of a property of properties is one thing, that of its instances another.

paper he would have succeeded in giving ‘perfectly natural’ a different semantic profile, on which it would have been perfectly precise. On this view, Lewisian materials provide a *path* to precision. There is a property of properties in the vicinity which even creatures without superhuman abilities are capable of expressing precisely. But achieving this requires us to jettison some tendencies in our use which, as things stand, make for vagueness.⁸⁹ Someone who holds this seems to agree about something important with some who holds that ‘perfectly natural’ is already precise. If we want to use the concept of vagueness to help articulate the disagreement between naturalness-enthusiasts and naturalness-sceptics, we need to consider such paths to precision alongside the questions about the vagueness of ‘perfectly natural’ as we actually use it.

The idea that ‘perfectly natural’ is at least *somewhat* vague has considerable appeal. For there are cases where it seems tempting to think that there are some perfectly natural properties within a certain set, but where the question exactly which of them are perfectly natural seems quite intractable. In such cases it is often a great relief to be able to sidestep the challenging question by denying that it has a definitely right answer. (Of course, different theories of vagueness explain the nature of this relief in quite different ways.) For example, while the most commonly encountered axiomatisation of topology takes ‘open region’ as the key undefined predicate, everything goes just as smoothly if one treats ‘closed region’ as undefined, defining ‘open region’ as ‘complement of a closed region’. It is quite tempting to think that at least one property from the topological family is perfectly natural; but one might well be embarrassed to think that there is a definitely right answer to the question whether it is openness or closedness that is perfectly natural. Similar issues emerge whenever we have a set of interdefinable properties none of which does strikingly better than the others on the score of *Similarity*, *Dissimilarity* or *Magnetism*. Consider the various predicates treated as primitive in rigorous axiomatisations of Euclidean

⁸⁹ The idea that deleting some of the role would achieve precision might, but need not, be based on the thought that the whole role is unsatisfied while the fragment in question is satisfied. But the thought could also be that the fragment in question is close enough to being satisfied by a magnetic property of properties which is much further from satisfying the entire role. And of course, the envisaged ‘path to precision’ might involve some change in use other than simply deleting part of the role. In principle, given that minute differences in use can sometimes make the difference between vagueness and precision—consider a Sorites sequence from a world where a word is vague to one where it is precise—even some apparently trivial variation in our practice with ‘perfectly natural’ might be thought capable of rendering it precise.

geometry: while the best-known system (Tarski 1959) uses a three-place ‘between’ and four-place ‘congruent’, many other approaches have been explored—for example, Pieri (1908) uses ‘ x and y are equally far from z ’ as its sole primitive predicate. Real-world non-Euclidean geometry generates a similar array of choice points.⁹⁰ It is tempting to think that some properties from the geometrical realm are perfectly natural. And while there may be metaphysical considerations which rule out some of the packages, it is optimistic to think that these will leave no one with no residual awkward questions.⁹¹ The same structure arises in classical extensional mereology, different axiomatisations of which variously treat parthood, proper parthood, overlap and disjointness as primitive; and in the theory of location, where the candidate perfectly natural relations include weak location, entire location (insideness), pervasive location, and exact location (see Parsons 2007).⁹²

In each of these cases, another way to dodge the need to choose is by claiming that *all* of the properties in question are perfectly natural. Insofar as the proffered

⁹⁰ See Arntzenius and Dorr 2012.

⁹¹ *Duplication* provides a potentially powerful tool for rejecting certain candidate lists of perfectly natural geometrical properties, for those who are willing to rely on pre-theoretic judgments about the geometric conditions that duplicates need to satisfy. For example, if *betweenness* and *congruence* are the only perfectly natural geometric properties, *Duplication* yields the surprising result that any two regions which contain the same number of points are duplicates, so long as none of the points are between any others or exactly as far apart as any others (see Skow 2007). Similarly, one might use *Duplication* to argue that neither topological openness nor topological closedness is perfectly natural, since any region, whether open, closed or neither, can have a duplicate that is both open and closed by virtue of not being topologically connected to anything else. (Maudlin 2010 raises some related worries about the standard approach to topology.) This mode of argument thus rules out many candidate lists of perfectly natural properties which might otherwise seem attractive. But it would be too much to hope that it will never leave us with awkward dilemmas which it would be nice to be able to dodge by appeal to vagueness: it is not hard to think of competing lists which generate exactly the same conditions on duplication. (Example: *x and y are equally long* and *x is longer than y* , considered as relations on line segments.)

Another kind of metaphysical argument that might be relevant turns on the claim that it is possible for there to be gunky space, which might tell against approaches where the perfectly natural geometrical properties are properties of points. Also, if one thought that there was a difference between a world with just one point—a zero-dimensional manifold—and a world with just one object that is not a point, this might also provide a filter.

⁹² The rejecters of *Empiricism* considered under (f) in section 3 will think that none of the properties considered so far are perfectly natural, since according to them the only perfectly natural properties are ‘structural’ ones, like duplication or resemblance. But awkward dilemmas might well arise even within the structural realm.

‘interdefinitions’ really are modally adequate, this will mean sacrificing *Non-supervenience* (‘no perfectly natural property supervenes on all the rest’). Even if one were willing to sacrifice this aspect of the role, one would not thereby avoid awkward questions: once one has started extending the list of perfectly natural properties, it will be hard to know where to stop. (In topology, is *connectedness* perfectly natural? *Path-connectedness*? *Hausdorffness*?)

On the other hand, if we are willing to respond to these dilemmas by invoking vagueness in ‘perfectly natural’, we can if we wish embrace all versions of *Independence*. So for example, we might say that it is definite that just one of openness and closedness is perfectly natural, but indefinite which one it is.⁹³

Considerations of the sort we have just been discussing do nothing to support the claim that ‘perfectly natural’ is *horribly* vague in the sense given earlier—roughly, that no interesting argument one could formulate in terms of it has a definitely true conclusion. Moreover, they are consistent with a perspective on which the vast majority of properties are not even candidates to be perfectly natural.⁹⁴ However, there is an interesting line of thought which might be thought to destabilize the view that ‘perfectly natural’ is only mildly vague. The central moves in this line of thought are inspired by Sider (2011, sect. 7.13), although the connection to vagueness is not one that directly concerns Sider. Sider’s target is ‘Melianism’, the view that ‘structure is not structural’: in a nutshell, his argument is that ‘if structure is not perfectly structural then it is disjunctive and therefore highly nonstructural’, and therefore incapable of being genuinely explanatory. The line of thought we are interested in takes the extreme non-naturalness of perfect naturalness to pose a distinct (though related) threat, namely that ‘perfectly natural’ is *horribly* vague. The argument can be spelled out as follows:

1. If ‘perfectly natural’ is vague, then perfect naturalness is not perfectly natural.
2. If so, the simplest definitions of perfect naturalness in terms of the perfectly natural properties are long disjunctions of the form ‘is identical to P_1 , or is identical to P_2 , or...’.

⁹³ We will need to posit a measure of higher-order vagueness too, if we want to avoid a definite cutoff between the topological properties that are definitely not perfectly natural and those that are candidates to be perfectly natural.

⁹⁴ They might, on the other hand, support the claim that no property is *definitely* perfectly natural. But neither the question ‘how many things definitely fall under the predicate?’ nor the distinct question ‘how many things definitely fail to fall under the predicate?’ provides a very good diagnostic for the kind of vagueness that makes for theoretical fruitlessness.

3. If so, perfect naturalness is extremely unnatural.
4. If so, 'perfectly natural' is horribly vague.

We see several ways of resisting this argument.

Step 1 we have discussed already. If we endorse *Magnetism*, there is a decent *prima facie* case that that any predicate of ours that manages to express a perfectly natural property does so precisely. It is hard to see how to argue that 'perfectly natural' is one of the exceptions to this generalisation. The interesting ways of resisting Step 1 thus seem to require giving up on *Magnetism*.⁹⁵

One kind of theorist who will have no trouble resisting Step 2 is one who thinks that there just aren't very many perfectly natural properties, so that the definition 'property identical to P_1 or identical to P_2 or ... or identical to P_n ' will not be long. There are various views of this kind that we think deserve to be taken seriously. One such view takes actual-world physics, reconstructed in such a way as to rely on a small family of relations (*mass-betweenness* and so on) rather than infinite families of determinates, as the sole guide to the realm of perfectly natural properties. Another such view rejects *Empiricism* in favour of a short list of 'structural' perfectly natural properties (e.g. a single comparative resemblance relation). Other ways of rejecting Step 2 will appeal to non-list-like definitions, expressed in terms of putatively perfectly natural properties of properties other than perfect naturalness itself. For example, Mundy (1987) suggests a picture where there are infinite families of perfectly natural properties of objects (the determinate masses, the determinate distances...) and just a handful of perfectly natural properties of properties (e.g. *addition* and *betweenness* relations), which only the perfectly natural properties of objects instantiate. On such a view, 'perfectly natural' might have a short definition along the lines of 'property that is either identical to *addition*, or identical to *betweenness*, or such as to bear *addition* to some other properties, or such as to bear *betweenness* to some other properties'.

Step 3 will not seem very compelling to any theorist who rejects *Simplicity*. Even those who accept *Simplicity* can resist this step so long as they are not wedded to symbol-counting as a measure of the complexity of a definition. As we pointed out in discussing *Simplicity*, some long disjunctions are intuitively much less complex

⁹⁵ One might try to reconcile *Magnetism* with the rejection of Step 1 by appealing to a non-linguistic theory of vagueness, according to which there are properties such that it is a vague matter what instantiates them. In this setting, if one thought that property of perfect naturalness was a vague one, 'perfectly natural' could definitely express this property while still being vague.

than others—for example, long disjunctions which are regular enough to be printed out by a small Turing machine can strike us as quite simple. If we were trying to devise a measure of complexity for formulae in a formal language with many atomic predicates, it would not be unreasonable to assign a low complexity-score to a long disjunction with exactly one disjunct for each atomic predicates, where the disjuncts are all short and all identical except for the substitution of one atomic predicate for another. Thus it is open to us to claim that the disjunction ‘identical to P_1 or identical to P_2 or...’, even if it is very long, counts as rather simple in the sense at issue.

Step 4 also looks eminently resistible. While it is plausible that we do not determinately refer to extremely unnatural properties, it is hard to see why predicates whose candidate referents were extremely unnatural would have to be *horribly* vague. There are many vague predicates—including vague predicates that figure in explanatorily successful theories in the special sciences—each of whose admissible precisifications might plausibly be classified as extremely unnatural. For example, given the vast array of independent arbitrary decisions that one would have to make in order to precisely specify any of the precisifications of ‘alive’, or ‘bird’, or ‘parliamentary democracy’, or ‘demand shock’, anyone who has sympathies for anything in the direction of *Simplicity* must surely think that the precisifications are each very unnatural. If so, the fact that all the precisifications of a predicate are extremely unnatural does not block the relevant kind of theoretical fruitfulness.⁹⁶

(Sider’s argument differs from the one we have just discussed in two ways. First, as already noted, his conclusion is that if perfect naturalness is not perfectly natural, it fails to be ‘explanatory’. Second, his emphasis seems not so much to be on the *length* of the definition as on the mere fact of its being disjunctive. We are suspicious of the idea that no property whose simplest definition in terms of the perfectly natural properties is disjunctive is explanatory.⁹⁷ Suppose betweenness is perfectly

⁹⁶ Note that there may be some other positive naturalness-theoretic status that predicates can enjoy even when their precisifications are very unnatural. For example, a natural second-order property might unify a group of unnatural precisifications. Thus the present point does not straightforwardly block all connections between theoretical fruitfulness and naturalness.

⁹⁷ Nor are we clear what the relevant notion of disjunctiveness would be. Obviously any disjunction can be eliminated in favour of negation and conjunction, but this surely marks no difference in explanatory power. Also, given set-theoretic or property-theoretic resources, subtler ways of eliminating disjunction in favour of quantification become possible; for example, we could replace ‘ x is F or x is G ’ with ‘whenever a set is contained in every set that contains both the set of F things and

natural; then it is plausible that the simplest definition of 'x, y and z are collinear' is 'x is between y and z, or y is between x and z, or z is between x and y'; but this hypothesis does not seem to vitiate geometrical explanations involving collinearity. Moreover, it seems obvious that disjunctive facts do sometimes figure quite legitimately in humdrum explanations: for example, if I have decided to put everything in the room that is either a jellyfish or a spoon into a certain box, the fact that something is either a jellyfish or a spoon seems quite relevant to explaining its ending up in that box.^{98, 99)}

5. 'Is naturalness primitive?'

Some discussions of naturalness focus on a question which might seem to be orthogonal to the questions we have discussed so far: whether naturalness is 'primitive' ('basic', 'irreducible'). The idea that there is an important question here may be encouraged by Lewis's discussion (1986, p. 63–9) of a certain range of options for theorising about naturalness between which he claims to be undecided. Two of these options involve explicit conceptual analyses of 'natural' (in terms of universals or tropes), while the third consists in taking the distinction between natural and unnatural properties as primitive. However it is somewhat mysterious what theoretical posture this 'naturalness primitivism' amounts to. Does being a naturalness primitivist just mean using the word 'natural' without endorsing any particular analysis of it? Naturalness primitivism on this gloss is not a claim but a course of action, and indecision about it, if it comes to anything, will just be kind of practical indecision about what to do. Moreover, on this gloss Lewis just *is* a naturalness primitivist, as opposed to being 'undecided', given that he does not *endorse* the universal-based or trope-based analyses. If the indecision is to be

the set of G things, it contains some set to which x belongs'. Sider seems to be confident that ordinary special-science predicates are not disjunctive, but we find it hard to see what the basis for this confidence would be. The usual functional analyses of such predicates do not settle this question, since they involve expressions like 'tends to cause' that are not perfectly natural according to Sider.

⁹⁸ Disjunctive facts also seem often to be useful in explaining other disjunctive facts. Since it is plausible that if 'perfectly natural' is disjunctive, 'refers', 'similar', and many other such expressions are disjunctive in a similar way, this makes it hard to raise a disjunctiveness-related worry for the naturalness-based explanations that Sider focuses on, e.g. 'Why are these objects similar?' or 'Why is this property easy to refer to?'

⁹⁹ Thanks to Ted Sider for discussion of the material in this section.

theoretical and not practical, then ‘naturalness primitivism’ needs to be some kind of *claim*. But what claim is it to be?

Given that the alternatives are presented as involving conceptual analyses, the obvious candidate is the claim that there is no true conceptual analysis of ‘natural’, or of the concept *natural*. But what does *that* mean? There is a picture of the enterprise of conceptual analysis as part of cognitive science—the claim that a predicate has a conceptual analysis is something like the claim that we understand it by translating it into a syntactically complex expression in Mentalese. But this is (a) surely not what Lewis had in mind (see Lewis 1995); (b) of dubious interest beyond the philosophy of mind; (c) unlikely to make any interesting distinction between ‘natural’ and any other moderately technical term in philosophy; and (d) not legitimately thought of as equivalent to any claim about *naturalness* itself as opposed to our particular vehicles for thinking about it, since there is no obvious reason why a single property should not be expressed by both simple and complex Mentalese expressions. Is the claim just that there is no complex predicate in our language, not involving ‘natural’, that is necessarily equivalent to ‘natural’? Even if that claim were true—and it is quite problematic when one takes context-sensitive and rigidifying vocabulary into account—it seems much too strongly tied to the contingent facts about the array of words available in English. We could introduce single words ‘F’ and ‘G’ in such a way as to make ‘a property is F iff it is natural or mentioned in the Bible’ and ‘a property is G iff it is natural or not mentioned in the Bible’ express necessary truths; then ‘a property is natural iff it is F and G’ will express a necessary truth.¹⁰⁰ Examples like this suggest that the pertinent way in which a predicate might be primitive is to be understood in naturalness-theoretic terms: ϕ is primitive iff it is syntactically simple, and not equivalent to any complex formula in any language whose simple predicates express properties more natural than the property expressed by ϕ . If we hold fixed *Supervenience* and allow the relevant formulae to be infinitary and to contain names for any objects we wish, the upshot is that a predicate is primitive iff it expresses a perfectly natural property. This makes ‘primitive’ a predicate of predicates; perhaps we can talk of properties as ‘primitive’ in an extended sense, but the ‘primitive’ properties will then either just be the perfectly natural ones, or those that are both perfectly natural and expressed by some simple predicate. So on this approach, the debate over ‘naturalness

¹⁰⁰ The same problem arises if we replace ‘necessary’ by ‘a priori’ or ‘necessary and a priori’.

primitivism' adds nothing to the debate about whether naturalness is perfectly natural, a debate which we have already discussed in section 4.¹⁰¹

Some metaphysicians are comfortable with a use of 'primitive' which does not take a detour through a predicate of predicates or concepts. For example, Sider (1996) considers (and argues against) a view about naturalness which he calls 'Primitivism': 'the belief that naturalness is ontologically basic, incapable of reductive analysis.' A pressing question for those who want to theorise using both 'primitive' and 'perfectly natural' as predicates of properties is whether these should be taken as equivalent, or whether they can somehow be given a separate life. Are we supposed to leave it open that some properties might be primitive but highly unnatural? Or that some perfectly natural properties are distinguished from others by their failure to be primitive? Prima facie, the remarks theorists make in introducing us to the relevant uses of 'primitive' and 'natural' aren't different enough to give us much of a grip on such suggestions.

It is relatively easy to get a sense for a view on which 'perfectly natural' and 'metaphysically primitive' fail to be coextensive—or at least fail to be definitely coextensive—because one or the other is rather vague. One thought is that 'perfectly natural' ended up vague because nothing satisfied the full role associated with it, or because of the presence in the role of vague words like 'similar' and 'refers', whereas because of the thinner role associated with 'primitive', there was nothing to resist the magnetic pull of its actual meaning. On this view, many, perhaps all, of the precisifications of 'perfectly natural' will be neither primitive nor very natural, while *primitiveness* would seem to be at least pretty natural (on all the precisifications of 'pretty natural'); a key further question is whether primitiveness is primitive. (It might alternatively be suggested that 'perfectly natural' is precise while 'primitive' is vague, but this view is a bit harder to get a grip on: if perfect naturalness is magnetic enough to be precisely expressed by 'perfectly natural', what could there be in our use of 'primitive' to prevent it from picking up on the same magnetic meaning?) But

¹⁰¹ Two-dimensionalists will presumably want to replace claims about some predicate's 'expressing a property' in the above discussion with claims about the *primary intensions* of predicates, since conceptual analyses are supposed to concern the a priori realm. Thus the question whether 'natural' is primitive will turn on the question whether its *primary intension* is maximally natural—as natural as the primary intension of any expression could ever be, remembering that primary intensions are always functions from *centred* worlds to extensions. It is not obvious that two-dimensionalists' answer to this question should be the same as their answer to the question whether *naturalness* (the *secondary intension* of 'natural') is perfectly natural.

either way, it does not seem that having both ‘metaphysically primitive’ and ‘perfectly natural’ available in the lexicon of metaphysics will open up a range of questions for fruitful debate.

It is of course conceivable that there are two or more non-coextensive, fairly magnetic properties of properties in the general vicinity of ‘naturalness’ talk, although we are not sure what would motivate such a hypothesis. Those who hold this will of course think that there is real progress to be made by introducing two or more terms associated with the different pathways to precision (though it may do more harm than good to have one of them be the old term ‘natural’). In this setting the old question ‘is naturalness natural?’ will give way to multiple successors: we can (bracketing type-theoretic worries) ask whether each of the new properties of properties has itself, and whether each has the other.

These remarks about ‘metaphysically primitive’ apply, *mutatis mutandis*, to many other bits of metaphysical jargon which might be used to raise questions about naturalness. Is naturalness *fundamental*? Is it *true in reality* that any properties are natural (Fine 2001)? Do facts about naturalness obtain *in virtue of* other facts, such as facts about similarity and reference, or do facts of those kinds obtain in virtue of facts about naturalness? The theoretical work that is supposed to be done by all of these locutions has much in common with the work that is supposed to be done by ‘natural’: it is far from clear what point there would be in distinguishing the question whether the property of being F is perfectly natural from the question whether F-ness is fundamental, or whether it is (or could be) true in reality that things are F, or whether things that are F are F in virtue of nothing. If there is no useful distinction to be made, the above questions will again collapse into the question ‘Is naturalness natural?’; which will be intimately associated with questions like ‘Is fundamentality fundamental?’; ‘Is it ever true in reality that it is true in reality that P?’; ‘Does the fact that a fact obtains in virtue of nothing obtain in virtue of anything?’. Even if there is a distinction to be made, the most likely scenario is one where only one of the relevant bits of vocabulary is precise, in which case questions articulated using both will not be especially helpful. Only on the surprising and tendentious hypothesis that there are two different pathways to precision in the vicinity will a multiplication of questions be any advance.¹⁰²

¹⁰² Some metaphysicians who are comfortable using ‘fundamental’ understand it in a way that makes it fairly easy to get a grip on the suggestion that the ranking of properties in terms of how fundamental they are comes apart from the naturalness

One might also think that there are interesting further questions concerning the explanatory power of naturalness, for example ‘Do facts about naturalness *explain* other facts, such as facts about similarity and reference, or do facts of those kinds explain facts about naturalness?’ One job ‘explains’ could be doing here is standing for some metaphysically heavyweight relation such as ‘grounding’; if so, then the above remarks about ‘in virtue of’ will also carry over here. But most ordinary uses of ‘explain’ are much more lightweight in character. Moreover, ordinary uses of ‘explain’ are also famously context-sensitive and undemanding: an enormous variety of achievements in unifying and connecting various of one’s beliefs can, in the right context, license a ‘because’ speech. In view of this, assuming that there are truths about naturalness at all, it would be absurd to deny that there are contexts where those claims can figure in true explanations of various kinds.

6. Have we missed the heart of the matter?

Consider a theorist who counts as an out-and-out naturalness-enthusiast as far as our two questions are concerned. She believes that there is a ranking of properties that plays all of the roles of Lewisian naturalness, and that ‘perfectly natural’ precisely expresses the property of coming first in this ranking. We imagine that some naturalness-enthusiasts will have a lingering feeling that despite all this, our theorist could, deep down, still be in the grip of an ‘egalitarian’ metaphysics, in a way that our tests have failed to diagnose. To bring out this feeling, imagine that our theorist makes the following speech:

Yes, there is a naturalness ranking: it is a ranking of properties whose top level constitutes an independent supervenience base for everything, and which relates in certain distinctive ways to duplication, laws, similarity, reference, and rationality. Moreover, perfect naturalness is very natural (perhaps even

ranking (as argued in Bennett MS, chapter 4). In this use, ‘fundamental’ is a predicate applicable to all sorts of entities, not just properties; the non-fundamental entities are the ‘ontologically second-rate’ ones—holes, wrinkles, smirks.... (Cf. Sider 2011, sects. 8.6 and 8.7.) For those who talk like this, it would not be considered outré to suppose that the only fundamental entities are subatomic particles, or that there is only one fundamental entity (Schaffer 2009). The view that *properties*, even perfectly natural properties, are not among the fundamental entities is thus not at all surprising. Nor is there any glaringly obvious reason to want to say that some properties are *more* fundamental than others in this ontological sense. *Sets* of fundamental things will probably be said to be all equally fundamental—all one step away from the ground floor—and some might think that properties of fundamental things are like sets in this respect.

perfectly natural), and thus easy to refer to; and we do, in fact, refer to it precisely.

But there are also many other rankings out there. For example, there is the naturalness* ranking: it is a very different ranking of properties, whose top level also constitutes an independent supervenience base for everything. It does not relate in the specified ways to duplication, laws, similarity, reference, or rationality. However, there are properties of duplication*, lawhood*, similarity*, reference*, and rationality* which relate to naturalness* exactly as duplication, lawhood, similarity, reference and rationality relate to naturalness. Perfect naturalness* is not very natural, and not very easy to refer to. But it is very natural* (perhaps even perfectly natural*), and thus easy to refer* to; and we do, in fact, refer* to it precisely.

You might suspect that in making such a speech, our theorist has unmasked herself as a closet Goodmanian. Her picture seems to be one in which the whole system of concepts including 'natural', 'similar' and so on is just spinning in the void, rather than being anchored in the world in the way true naturalness-enthusiasts suppose. This might prompt a search for some elusive further piece of doctrine which could allow the true enthusiasts to distinguish their view from the 'deflationary' view towards which the above speech seemed to gesture. But we can see no intelligible contrast in this vicinity. No-one who accepts the first paragraph of the speech quoted above should reject the second paragraph: once you Ramsify enough words out of a theory, it is inevitable that the resulting roles will be multiply satisfied if they are satisfied at all. And the speech does *not* say that naturalness and naturalness* are in any sense 'on a par'—it explicitly states that perfect naturalness is very natural, whereas perfect naturalness* is not. One might be tempted to think that there is some other sense of 'on a par' in play, such that our theorist, unlike the true naturalness enthusiasts, thinks that naturalness and naturalness* are 'on a par' in that sense. But this temptation should be resisted, since it is completely obscure what the other sense might be and how it is supposed to be different from 'equally natural'.

* * *

In the last two sections, we have surveyed a range of questions that might be thought to add further dimensions to the debate between naturalness-enthusiasts

and naturalness-sceptics. But in so far as the questions we have found make any sense, they do not seem to add much to the questions investigated earlier in the paper. We suggest that the issues of role-satisfaction and vagueness provide the most fertile territory for future debate in this area.¹⁰³

¹⁰³ We are grateful to audiences at NYU, Geneva, Oxford, Princeton, St. Andrews, and at the 2012 Metaphysical Mayhem in Rutgers. Special thanks to Ted Sider, for many helpful discussions of these issues that began many years ago, and to the editors, for their helpful comments and their patience.

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