Ratio (new series) XXV (2012), 387-404

Nature's Joints: a Realistic Defence of Natural Properties [1]

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Abstract

This paper attacks two contrary views. One denies that nature has joints, taking the properties we call natural to be merely artefacts of our theories. The other accepts real natural properties but takes their naturalness to come by degrees. I argue that both are wrong: natural properties are real, and their naturalness no more comes by degrees than does the naturalness of the things that have them.

1. Introduction

In 1939 G. E. Moore claimed to prove the existence of an external world by proving that he had two hands (Moore 1939 pp. 145–6). His proof is more contentious than its conclusion, despite Peter van Inwagen's claim that 'there was never any such thing as Descartes's left leg' (2001 p. 82) nor therefore, presumably, any such things as Moore's hands. Fortunately Moore's case does not rest solely on his hands. He lists several other 'things outside of us' (as he puts it): 'a shoe and sock ... a sheet of paper and a human hand ... two sheets of paper' (p. 145), and nowhere suggests that it is harder to prove that they (and many other things, including the whole organisms van Inwagen does believe in) exist than that his hands do. However, my interest here is not in the soundness of Moore's argument but in some implications of the fact that, despite an external world needing only one thing 'outside of us', all his examples are of *pairs* of things. These examples imply that a pair of hands differs from a pair of sheets of paper, that both these pairs differ from a hand and a sheet of paper, and that any of these three pairs could exist without the other two. (Proving that a pair of hands exists does not prove that a hand and a sheet of paper exist.) So Moore could have concluded, although he didn't, not just that there are two external things – hands – but that those things differ in kind from shoes, socks, sheets of paper and other things 'outside of us'.

Of course what distinguishes things of these kinds depends on what we mean by 'hands', 'shoes', 'socks' and 'sheets of paper', and that is more or less up to us. What is not up to us, as David Lewis says (1983 p. 47), is whether a thing is a hand, shoe, etc., so understood: whether, for example, things have whatever properties, known or unknown, make them sheets of paper and not hands, i.e. things we can write on but not with. It is for the reality of these properties that I shall argue, against two contrary views. One is the view that nature has no joints, and that what we call natural properties are just imaginary counterparts of our best theories' predicates. The other is that, just as, in Orwell's Animal Farm, all animals are equal but some are more equal than others, so in reality, while nature's joints are all natural, some are more natural than others. I shall tackle these

[1] My revisions of the first version of this paper, given to a Ratio conference at the University of Reading on 7 May 2011, owe much to comments on it made then and later, and especially to those of Anthony Fisher and David Oderberg.

two theses in turn, starting with the thesis that nature has no language-independent (or mind-independent) natural properties.

2. Natural Properties

Paradigms of what I mean by 'natural properties' are the sizes, shapes, masses and temperatures of planets, people, shoes, atoms, etc. – and the distances between them, since for brevity I shall call relations 'properties' too. By 'natural' I shall mean 'contingent and factual' in order to exclude necessary properties like self-identity or being a prime number, and moral and aesthetic properties like being good or being ugly.

Natural properties, so understood, are those that Lewis (1983) calls 'sparse', meaning those that 'ground the objective resemblances and the causal powers of things' (p. 12) and thereby give nature the joints that I, Plato and others say it has. In most of what follows I shall restrict the term 'property' to these, partly again for brevity but mainly to exclude Lewis's 'gerrymandered and miscellaneous' classes (p.12), which he only calls properties because they 'need not be classes of *actual* things' (my italics). (p. 10). That seems to me a poor reason to call such classes 'properties' when that term is more widely and usefully used for (what groups things into) collections that are, in some respects, *not* miscellaneous.

Take Moore's hands. Hands need surfaces, not only to give them the shapes and other properties they need in order to *be* hands, but also to give them identities, i.e. to make them countable things, distinct from their surroundings, and from each other. But surfaces can only do this by separating entities with different properties: in this case those that make hands solid and those that make their surroundings – air, water, etc. – fluid. Without the properties that give nature surfaces, there would be no countable natural particulars.

Why then are these properties more contentious than the particulars whose identities they enable? What properties there are is a good question, as is whether the answer to that question is given by microphysics alone or by all natural sciences. But neither question can arise until we admit that there *are* properties as well as the particulars to which we ascribe them. Why might we doubt that?

3. Objections to Properties

I start with Hilary Putnam's Derridean claim that 'we interpret our languages or nothing does' (Putnam 1980 p. 482), i.e. that nothing 'outside of us' constrains what our theories are about. Putnam's argument for this is that stating an external constraint on what a theory is about merely extends the theory, whose extended form we can then always interpret in order to make it come out true. If that were so, then believing '*a* is *F*' could not entail believing either in the particular *a* or in the property *F*. But it is not so, for Lewis's reason: for if it is up to us what we mean by '*F*' and '*a*', part of what we choose to mean by those terms may be, and usually is, that it is *not* up to us whether a thing satisfies '*F*', and is what '*a*' refers to. Given what we actually mean by 'Moore' and 'hand', nothing can be what 'Moore's hands' refer to that lacks the properties which make them what we call 'hands' and parts of what we call 'Moore'. The fact that we could have made the word 'Moore' mean Russell and the word 'hand' mean foot is irrelevant.

Moreover, for Putnam's 'we interpret our languages or nothing does' to mean anything, every token of its words, including those you have just read, must have whatever properties it takes to *be* a token of those words. And for any token of his sentence to mean what it does, the token first-person 'we' in it must refer to entities like us who (i) have whatever properties it takes to have a language and (ii) include whoever produced that very token. In short, we cannot both give Putnam's sentence the meaning he wants it to have and take it to be true. (Though even if we could, that would not matter here: for denying the existence of language- independent things as well as their language-independent properties will not tell us why those properties are *more* contentious than the things that have them.)

Next, before tackling more serious and specific objections to properties, I must emphasise that these do not include nominalism, in its non-Quinean sense of denying the existence of *universals*. That is because we need not, although I do, follow David Armstrong (1978) in taking properties to be universals: sets of exactly resembling tropes (Williams 1953) or particulars (Rodriguez-Pereyra 2002) can also give nature language-independent joints. And while trope theorists and nominalists have problems (i) defending the modal realism needed to distinguish actually co-extensive properties, like having a heart and having kidneys, and (ii) saying what resemblance is, if not a universal (Russell 1912; Daly 1997), these do not stop them crediting things with properties.

Still, there *are* real objections to properties, which I do need to rebut. I start with Frege's (1891) thesis that properties (which he calls 'concepts') are not 'objects', because (i) they are functions whose value, when the particulars that have them are their arguments, is the truth- value True, and (ii) 'an object is anything that is not a function, so that an expression for it does not contain any empty place' (p. 43).

So for Frege if *m* is Moore's right hand, the property *H* of being a hand is a function whose value is True when its argument is *m*. And while the name '*m*' in the sentence '*m* is *H*' is complete, the predicate '... is *H*' is not, since it has an empty place that needs filling with a term like '*m*' to complete a sentence with a truth value.

But why does calling properties 'functions' rather than 'objects' show that there are none: why not let our ontology include both functions and objects? The reason is that *any* predicate '*F*' in a true or false sentence '*m* is *F*' generates a Fregean function from *m* to a truth-value. These functions are not confined to what, for reasons given in §2, I mean by 'properties': namely contingent and factual entities that 'ground the objective resemblances and the causal powers of things'. They are also generated by predicates like '...contingent', '...prime', '...non-existent', none of which correspond to the natural properties that give nature its joints.

In short, Frege's functions are just gratuitous duplications of predicates: they tell us nothing about natural properties. They do not even tell us how properties, natural or not, differ from the particulars that have them. For if '*m* is *H*' can be decomposed into a complete '*m*' and an incomplete '... is *H*', it can also be decomposed into a complete '*H*' and an incomplete '*m* is ...'; where the singular term is what has the empty place that needs filling with a complete term like '*H*'. In other words, if *H* is a function, from particulars to truth values, *m* is also a function, from

properties to truth values. Frege's treatment of particulars as objects, and properties as functions, rather than the other way round, expresses a prejudice that his theory does nothing to justify.

The same goes for Tarski's (1944) theory of truth, which postulates no properties at all, merely particulars and the predicates they 'satisfy' (p. 63), i.e. which apply to them. But if Tarski's theory does not tell us what makes the predicate '*H*' apply to *m* and not to *mf* (Moore's right foot), at least it does not preclude the obvious answer that *m* has properties that make '*H*' apply to it and *mf* does not. (Nor does it preclude the same answer to the question of what makes the predicate 'is a token of "*H*"' apply to some linguistic tokens and not others; and similarly for tokens of names, sentences and other linguistic types.)

This lacuna in Tarski's theory is not in itself an objection to his starting with particulars instead of properties. But his theory no more justifies his doing so than Frege's does, as we can see by comparing the theory with my and Alex Oliver's (1997) tongue-in-cheek alternative, on which

'*a* is *F*' is true iff there is a ϕ such that 'is *F*' designates ϕ and '*a*' falls under ϕ, and which, as we say,

> suggests that '*a* is *F*' is only committed to F-ness, not to an entity designated by '*a*'. And why not? If we can have a primitive semantic relation, *applies to*, relating predicates to entities designated by singular terms, why not another primitive relation, *falls under*, relating singular terms to entities designated by predicates? (p. 15).

We do not of course recommend our alternative, which we give only to show that Tarski's theory, like Frege's, does nothing to justify its unargued assumption that particulars are objects and properties are not.

Then there is Quine, for whom 'to be assumed as an entity is to be reckoned as the value of a variable' (1948 p. 83). So for Quine properties (which he calls 'attributes') exist if and only if we need second-order as well as first-order quantifiers to be able to state any empirical truth without using names or other referring terms. And we do, since quantitative laws, like Newton's second law of motion, quantify over determinate values of determinables like mass, force and acceleration. These Quine will accept, but only if they are identified with their extensions, i.e. with the classes of all the things that have them. His reason is that since 'physical objects are well individuated', so are classes of them, because their 'identity consists simply in the identity of the members' (1975 p. 101). That is why he will not accept properties that are not classes of well-individuated physical objects, because they 'have no clear principle of individuation' (p. 101).

Quine is wrong, for two reasons. First, many determinate properties are in fact better individuated than the objects that have them. Take the values of temperature, pressure and density whose continuous distributions across entities like whirlpools and storms explain their behaviour. These values – degrees Celsius, pounds per square inch, grams per litre – are far better individuated than the fluid regions over which, in such cases, they are distributed.

Second, laws of nature entail that many precise temperatures, pressures, masses, etc., have no actual instances at all. Statistical mechanics, for example, implies that no spatially extended thing has an absolutely precise temperature, even when in thermal equilibrium. The only actual class we could identify these temperatures with is the null class, which would make all of them identical not

only to each other but to all uninstantiated values of every other determinable. And as Quine is an actualist – because he cannot see how to individuate merely possible fat men in doorways (1948 p. 76) – he cannot escape this implication by identifying properties with the classes of all their *possible* instances, as Lewis (1986) does. (This is also why, unlike Lewis, he cannot distinguish properties, like having a heart and having kidneys, that in our world are co-extensive.)

But could we not remove these ontological commitments of quantitative laws by reading their second-order quantifiers substitutionally instead of objectually? Perhaps we could, if there were only countably many different temperatures, masses, etc.; for then the rational numbers we use to distinguish them could give us names for all of them. But why, even if we could, should we try to do this, when Quine's only reason for rejecting properties that are not classes –that they cannot be individuated as clearly as the objects that have them – is, as we have seen, false? This way of dispensing with properties would, like Frege's and Tarski's ways, only express a prejudice against them that it does nothing to justify.

In any case, the substitutional quantification trick will not work even if it is feasible, since it will not eliminate all references to determinate properties. In particular, it will not eliminate them from sentences which say which determinables they are determinates of. For example, as Frank Jackson (1977) observes, 'Red is a colour' cannot just mean that all red things are coloured, or even that, *necessarily*, all red things are coloured: since it is also necessary that all red things are shaped, and that they are extended (pp. 89–90). Similarly for '100 grams is a mass', '100°C is a temperature', and so on. The fact is that Quine's extensional metaphysics can no more cope with the determinable properties of shaped and extended things than with the non-extensional physical probability statements entailed by sciences ranging from microphysics through genetics to epidemiology.

The only really serious problem generated by adding properties to particulars is F. H. Bradley's (1897 bk 1, ch. 2) notorious regress. For a particular *a* to have the property *F*, it cannot be enough for *a* and *F* to exist or *b*, which is not *F*, *would* be *F*. The particular *a* must also 'instantiate' *F*, which *b* does not. Yet adding an instantiation relation *I* to *a* and *F* will still not stop *b* being *F* unless *I* 'relates' *F* to *a* but not to *b*. But adding that relation will not work either, for the same reason; and so on, and so on – a seemingly vicious regress.

Whatever the answer to this regress, all I need say about it here is that each of the other theories I have mentioned generates it too. For *a* but not *b* to fall under a Fregean concept *F*, *a* and *F* must, and *b* and *F* must not, fall under the *falling under* concept; Tarski's *satisfaction* relation must relate *a* but not *b* to the predicate '... is *F*'; Quine's *class-membership* relation must relate *a* but not *b* to the class of *F*'s instances; Putnam's *interpret-as* relation must relate '*a*' and '*F*' to some pairs of entities but not to others; and so on. All theories of truth that postulate particulars generate these regresses – as indeed do theories of how 'concrete particulars and abstract universals are composed of tropes' (Williams 1953 p. 118). In short, as we are all in Bradley's boat, and will sink or swim in it together, his regress gives us no reason to replace the apparent properties of objects with functions, predicates, classes or interpretations.

4. Properties and Particulars

Assuming then that there are properties, as well as particulars, that are independent of minds and languages, how do these two kinds of entity differ? I take their independence of language to show that, as Ramsey (1925) says,

> the task on which we are engaged is not merely one of English grammar: we are not school children analysing sentences into subject, extensions of the subject, complement, and so on (p. 61),

and, specifically, that we cannot derive the distinction between particulars and properties from a subject-predicate distinction. Nor, as we have seen, can we derive it from Frege's object-function distinction, since, as Ramsey also says, a logician can

> take any type of objects whatever as the subject of his reasoning, and call them individuals, meaning by that simply that he has chosen this type to reason about, though he might equally have chosen any other type and called them individuals (p. 72).

So the real question I take to be this: why are the paradigms of what we call 'particulars' because they are what we quantify over first, i.e. take our *first*-order quantifiers to range over, what Austin calls 'moderate-sized specimens of dry goods' (1962 p. 8)? The obvious answer is that these goods, including ourselves (and our hands) have, as we have seen, causal boundaries that we can use to individuate them without having to know on *what* properties (of them and us) their boundaries, and our ability to detect them, depend.

This ability enables us to devise testable theories crediting us and other 'dry goods' with causal properties that explain how we resemble, differ from and interact with each other, properties whose distributions we can then use to mark subtler boundaries, like those of the swirling parts of whirlpools and storms. But then these particulars too, like the dry goods we start with, will occupy limited regions of spacetime – which is why we call empirical particulars 'concrete' and the properties they can share with other particulars anywhere in spacetime 'abstract'.

In short, the difference between empirical particulars and their properties lies in their different relations to space and time. Ramsey (1925) denies this, because he thinks arguing about whether a table is a continuant or a property of events is not 'arguing about how many places the table can be in at once, but about its logical nature' (p. 58). Maybe so, but whatever a table is – a sequence of causally related 'gen-identical' particulars (Reichenbach 1928 §43), a 'perduring' particular with temporal parts (Lewis 1986 pp. 202–4), an 'enduring' thing without temporal parts (Mellor 1998 ch. 8.2) or 'a maximal sum of compresent tropes' (Campbell 1979 p. 132) – it will still have the limited spacetime location that all empirical particulars have (except perhaps the whole spacetime universe, and spacetime itself, if there are such things).

This limited location is what explains why empirical particulars are less contentious than their properties. It does so because, if we are to quantify over any empirical entities other than facts, we must quantify over some entities *first*, i.e. use first-order quantifiers. And entities with spacetime boundaries are the only ones that we, as such entities, can individuate well enough to give our quantifiers definite domains without having previously individuated other entities. Whether, having

done this, we also need to quantify over their properties, i.e. to use second-order quantifiers, is therefore bound to be a more contentious matter.

5. Properties and laws

Granted, however, that we both can and should quantify over the contingent properties of empirical particulars, what properties are there for these particulars to have? Since they are independent of language, we cannot expect an actual empirical predicate to correspond to each of them (though each will of course correspond to a *possible* predicate applying to all and only those particulars with that property). But for most actual predicates, I agree with Armstrong (1978) that (replacing his term 'universal' with 'property'),

> there may be none, one or many properties in virtue of which the predicate applies [and] given a property, there may be none, one or many predicates which apply in virtue of that property (vol. 2, p. 9).

Take red things, i.e. things to which the English predicate '... is red' applies, which include red light, red paint, red-hot objects and red filters. These are made to satisfy '...is red' by quite different properties: red light by its frequency range; red paint by the chemical composition of its surface; red-hot objects by their temperature, and red filters by their molecular structure (Mellor 1997 p. 265). There is no one property that makes entities of all these kinds red. It takes empirical investigation to discover the properties that make entities of various kinds red: which and how many they are is certainly not deducible from the meaning of 'red'.

But if our predicates will not tell us what properties there are, what will? Part of the answer is given by Sydney Shoemaker's (1980) thesis that properties are what determine the causal powers of things. Thus, in his example, a thing with the property of being knife- shaped that also has the property of being made of steel 'will have the power of cutting butter, cheese and wood, if applied to these substances with suitable pressure ...'; and so on (p. 234). In other words, what fixes what properties there are is what causation there is. And that, I agree with Donald Davidson (1967 p. 160), is fixed by what laws of nature there are, with two caveats. One is that, for me, the laws of nature include the probabilistic laws that Davidson overlooks. The other is that, like Armstrong (1983), what I mean by 'law of nature' is not a kind of statement (e.g. an unrestricted universal or statistical generalisations that supports counterfactuals), but whatever it is – whether a Humean regularity or something else – that makes that statement true.

But if the laws of nature, so understood, determine what empirical properties there are, how do they do so? My answer is that these

> properties are identified *a posteriori* by scientific theories, construed as Ramsey sentences: i.e., as saying for example that there are properties *C*, *F* and *G* such that in *C*-circumstances all *F*-events have such-and-such a chance of being followed by *G*- events. If that statement is true, then there are such properties, and there is such a law, of which those properties are constituents. And being a constituent of some such laws is ... all there is to being a property. There is no more to temperatures than the thermodynamic and other laws they occur in; no more to masses and forces than the laws of motion and of motion's gravitational and other causes; and so on. In other

words, if we stated all the laws there are in a single Ramsey sentence ∑, the properties ∑ would quantify over are all the properties there are (1997 p. 260).

I call this thesis 'Ramsey's test', by analogy with 'Quine's test' for what particulars there are: namely, what our first-order quantifiers must range over to enable us to state any truth without using names or other singular terms. Similarly, by Ramsey's test, the properties that exist are those that our higher-order quantifiers must range over to enable us to state any law without using predicates.

Having defended this thesis at length elsewhere (Mellor 1995 ch. 15, §4–7), I will only make two points about it here. First, ∑ replaces *all* our theories' predicates with existentially quantified variables, not just the predicates theories introduce in order to explain observable facts we could state without using those predicates. That is because, unlike Ramsey (1929), I am not using Ramsey sentences as an alternative to defining theoretical predicates in observable terms, but to say what properties, observable or not, our theories say there are.

Second, Ramsey's test does not 'entail that we can ever know or even express ∑, merely that the properties our world contains are those which ∑ would need to quantify over if it *were* expressed' (Mellor 1995 p. 193). And this definition is not really hypothetical, any more than is Ramsey's (1928) theory of laws as what would be axioms in a deductive system of everything. For here as there, as Ramsey says, 'the ... if is only a spurious one; what is asserted is simply something about the whole world' (§14), in my case that it contains all and only those properties needed to make ∑ true.

6. Ramsey's test

Ramsey's test is controversial, partly because it rules out complex properties. These, if F and G are properties, are properties like $F \vee G$, which everything is that is *F or G*, $\neg F$, which everything is that is *not F*, and $F \wedge G$, which everything is that is *F and G*. To see why the test excludes these, take the two stable isotopes of chlorine, ^{35}Cl and ^{37}Cl, which differ physically but not chemically, and let F be the property of being ^{35}Cl and G the property of being ^{37}Cl. Now suppose there is also the complex property $F \vee G$, of being 'stable chlorine'. Then by Ramsey's test, the Ramsey sentence ∑ must quantify over $F \vee G$. So $F \vee G$ must occur in some law, e.g. in the antecedents of the laws of chlorine chemistry. But then, for $F \vee G$ to be complex, i.e. for those laws to apply to ^{35}Cl and ^{37}Cl, they must also contain F and contain G, which must then be distinguished by occurring separately in other laws, as they do in those of each isotope's distinctive physics. But then ∑ must quantify over F and over G; in which case it need not also quantify over $F \vee G$.

This is why, by Ramsey's test, there are no disjunctive properties, merely laws, like those of chlorine chemistry, with disjunctive antecedents or consequents; and similarly for negative properties. These however are not the implications that make Ramsey's a controversial test for properties which, in Lewis's words, 'ground the objective resemblances and the causal powers of things'. For if, for example, neither a nor b has the property F, say of being ^{35}Cl, this does not entail that they have another property, $\neg F$, which makes them resemble each other in some other way. They may resemble each other, e.g. if a and b are both sodium, or they may not, e.g. if a is oxygen and b is lead. This is why no one who believes in language-independent properties thinks the

existence of a property *F* makes ¬*F* a property too, even if that of the predicate '... is *F*' makes '... is ¬*F*' a predicate.

Similarly with disjunctive properties. If *F* and *G* are properties, and *a* is *F* and *b* is *G*, they may, or may not, resemble each other. They will if *F* and *G* are the same property, or are compatible, e.g. if *F* is a mass and *G* is a temperature, and *a* is *G* as well as *F*. But if *F* and *G* are *in*compatible, e.g. if they are different masses, then *a* and *b* will not resemble each other in that respect, and may not do so in any other. This is why no one thinks that satisfying the disjunctive predicate '... is *F*∨*G*' is enough to make *a* and *b* resemble each other by making them share the disjunctive property *F*∨*G*.

What makes Ramsey's test contentious is that it rules out conjunctive properties. The objection to its doing this is not that two things that share two properties F and G must also share a third, F∧G, in order to resemble each other: no one thinks that. Those who believe in conjunctive properties, as Armstrong does (1978 vol. II, ch. 15.1), have two quite different arguments for them.

Armstrong's first argument is that 'it is logically and epistemically possible that all properties are conjunctive' (p. 32), i.e. that no properties are simple. For example, just as chlorine turns out to be a mixture of atoms with different properties, not just one, so its isotopes may also turn out to be mixtures of entities with different properties, and so on indefinitely. In short, Augustus de Morgan's saying, that

> Great fleas have little fleas upon their backs to bite 'em,
> And little fleas have lesser fleas, and so *ad infinitum* (1872 p. 377),

may be as true of properties as of particulars. And if it is, then conjunctive properties will be the only properties there are.

However, this conclusion is not entailed by the mere possibility that nature is infinitely complex in this way. All that possibility shows is that there may be no limit to the number or complexity of the laws of nature, nor therefore to how many properties the Ramsey sentence ∑ must quantify over. But given the infinitely many simple volumes, masses, temperatures, etc., over which ∑ must quantify anyway, it can hardly have to quantify over conjunctions of them to accommodate a merely possible complexity that no one has shown to be actual.

Armstrong's other argument (p. 35) for conjunctive properties is that a particular *a*'s being both *F* and *G* may give it causal powers that neither property alone would give it. That is true: how cold a wind feels, for example, depends on its speed as well as its temperature.
But all this shows is that some laws of nature have conjunctive antecedents, just as some have disjunctive or negative ones. Take the gas laws that make a balloon's volume *V* depend on its pressure *P* and its temperature *T*. To infer that *V* must depend also (or instead) on the conjunctive property *P*∧*T*, is like inferring that *The Mikado* must have been written not only (or not even) by Gilbert and Sullivan, but by their mereological sum, the two-headed conjunctive particular G+S. Both inferences are equally optional and, to me, equally absurd.

In short, I see no reason to accept any of the alleged counter-examples to Ramsey's test. But I do need to say more about the properties that pass it, as I do about the particulars that pass Quine's test. Quine's test rules out complex particulars, of course, just as Ramsey's rules out complex

properties, and for same reason: Quine's first-order quantifiers need not range over them. Yet many philosophers still believe in mereological sums, not just of Gilbert and Sullivan, but of *all* particulars (Lewis 1986 p. 69). I too of course believe that many things are parts of other things, as our hands are of our bodies, leaves are of plants, wheels are of cars, and atoms are of molecules. But that does not make people, plants, cars, and molecules mereological sums, i.e. conjunctive particulars. Most if not all things with parts still pass Quine's test because, since not all truths about them are entailed by truths about their parts, our first-order quantifiers will still have to range over them. But then, since these wholes are – literally – 'more than the [mereological] sums of their parts', their existence gives us no reason to believe that there *are* any such sums, let alone sums of Gilbert and Sullivan or of any other pairs of particulars that are not both parts of some third thing. The mereological composition of particulars is a myth.

And so it is of properties. Take the claim that temperature is, i.e. is identical to, mean kinetic energy. This entails that all truths about temperatures are entailed by truths about the kinetic energies of (e.g.) gas particles. If that was so, then temperatures would fail Ramsey's test, because the Ramsey sentence $\sum$ of all laws would not need to quantify over them as well as over kinetic energies. But it is not so, for at least three reasons. First, it implies that all particles at rest are at absolute zero, and that speeding them up heats them up, which is absurd. Second, isotropic radiation need not contain particles with kinetic energies in order to have a temperature. And third, in statistical mechanics the kinetic energies of gas particles do not determine a gas's temperature T: they merely give T a high chance of lying in a narrow range.

It follows that the Ramsey sentence of all laws, including those of thermodynamics, does need to quantify over temperatures, as well as over kinetic energies and the frequencies of electromagnetic radiation. So temperatures do pass Ramsey's test, which makes them 'simple' properties, despite the causal dependence of a gas's temperatures on the kinetic energies of its particles, just as our bodies are simple particulars despite their causal dependence on their parts. In neither case does the causal dependence of a whole on its parts reduce the whole to the mereological sum of those parts. The mereological composition of natural properties is as mythical as that of natural particulars.

7. Lewis's natural joints

This brings me, finally, to Lewis's (1986 ch. 1.5) theory of properties. His theory differs from mine partly in terminology since, as I noted in §2, he calls any set of possible particulars a property, not just those whose members resemble each other. Those whose members do resemble each other perfectly Lewis calls 'perfectly natural'. The naturalness of his other properties he measures by how simply they can be defined in terms of perfectly natural ones (p. 67).

Because all Lewis's properties are sets of possible particulars, and a set's identity is fixed by its members, all his possible worlds inevitably contain the same abundant properties. What is not inevitable is Lewis's further claim that all his worlds contain the same sparse properties, i.e. the same subset of his abundant properties whose members resemble each other. This is why Lewis calls these properties 'sparse': calling them 'natural' he says

> suggests to some people that it is supposed to be nature that distinguishes natural properties from the rest; and therefore that the distinction is a contingent matter, so that a property might be natural at one world but not at another. I do not mean to suggest any such thing. A property is natural or unnatural simpliciter, not relative to one or another world (Lewis 1986 p. 60 fn. 44).

But if, as I've argued, the properties that 'ground the objective resemblances and the causal powers of things' depend on contingent laws of nature, they are bound to vary from world to world. If natural properties are those over which the Ramsey sentence $\sum$ of all laws has to quantify, there will *be* no temperatures in a world devoid of thermal phenomena and hence of laws governing them. This will be so even if properties are sets of exactly resembling possible particulars or tropes: for then what properties there are will still depend on the laws that determine which particulars or tropes *do* resemble each other. If there were no laws of thermodynamics, the resemblance that makes a set of possible tropes or particulars be the property of being 100oC – or any other temperature – would not exist.

(None of this, by the way, makes properties entail the laws they occur in, as Shoemaker (1980 §9) and Mumford (2004 ch. 10) claim. For example, in Newtonian worlds, where gravity is a force in a flat spacetime, the inertial masses of things, defined by Newton's laws of motion, are independent of their velocities, which in our world they are not. Yet our world's masses, e.g. 100 gm, can still be the same as – or be counterparts of – the properties that link forces and accelerations in Newtonian worlds.)

My Ramsey-test theory differs from Lewis's in another way too, even if, as I do, we follow Schaffer (2004) and identify Lewis's perfectly natural properties with those that occur in *any* law of nature, not just those of microphysics. For, as we have seen, Lewis also admits more or less natural complexes of these properties and Ramsey's test does not. But we need no complex properties to credit nature with complex joints, as our chlorine example shows. For all the laws of chlorine chemistry need, to explain how chlorine samples resemble each chemically, and differ from samples of other elements, are disjunctive antecedents whose disjuncts are the simple properties of being 35Cl and being 37Cl. That disjunction need not correspond to a single disjunctive property, 35Clv37Cl, of being stable chlorine, which, as we saw in §6, no one who believes in language-independent properties will believe in.

In short, Lewis's less-than-perfectly-natural properties are as superfluous as less-than-perfectly-natural particulars, like the disjunction, conjunction and negations of Gilbert and Sullivan. The naturalness of natural properties need no more come by degrees than that of the particulars whose properties they are.

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