Laws of Nature and Individuals

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Abstract
Individuals (like the Earth or a biological species) are often the subject of generalizations of various special sciences. The traditional argument is that there can't be laws about such individuals, since the law statements would have to contain local predicates (refer essentially to a particular time, place, object, or event). Marc Lange argues that, despite local predication, there can be laws about individuals. This paper argues, on the contrary, that there can be no such laws – not because of local predication, but because the laws would discriminate among material systems on non-qualitative grounds. I rely on the principle that qualitatively identical systems under one set of laws must evolve in the same manner. If there could be laws about individuals, nothing would guarantee that the principle is satisfied. My argument is illustrated by a thought experiment inspired by Strawson's massive reduplication argument.

Philosophers may be forgiven for thinking it settled whether or not laws of nature can be about individuals. The position that laws can't be about individuals – that laws can only be about kinds of things – is generally assumed, as when Smart (1963) argues that the regularities concerning biological species aren't laws since a biological species is a historically extended individual, or when Griffiths (1999) argues that biological species must not be individuals since there are laws about them. But this popular view has seen surprisingly little argumentative support.

In contrast, the opposing position, that there might well be laws about individuals, has received some attention and argumentative support. In particular, Lange (1995, 2000) argues that there is nothing in the concept of a law that forbids there being laws about individuals, and that there are perfectly good examples of laws that are about individuals.

In this paper I defend the popular position that laws can't be about individuals. First, I think Lange's criticism is best understood as an argument not against the position that laws can't be about individuals, but rather against the classic characterization of that position, *i.e.*, that lawlike sentences can't have local predicates (can't refer essentially to a particular time, place, object, or event). I will therefore introduce a new characterization that I argue defuses Lange's criticism: a law has to be falsified by any system

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that fits some qualitative description.[1] I will then make a positive argument in favour of this position, relying on the claim that qualitatively identical material systems under one set of laws must evolve in the same manner. Since laws about individuals cannot guarantee that qualitatively identical systems evolve the same way (up to a well-defined statistical variation), such laws cannot exist. The plausibility of this claim will be illustrated by a thought experiment inspired by Strawson's (1959) massive reduplication argument for identifying references.

What makes this issue interesting, beyond bare philosophical curiosity, is that various special sciences and other areas of study appear to have laws about individuals. Already mentioned is biology, where a species is often taken to be an individual even though there are lawlike regularities about them. Hempel and Oppenheim (1948), and thus Lange, consider by way of example the regularity that all robins' eggs are greenish-blue. Since a given species is 'picked out by its position in the evolutionary tree of life' (Lange, 1995, p. 432), phenotypically (and even genotypically) similar animals that evolved at a different time or on a different planet would not be robins, and the purported law would not be about them. Geology and ballistics, both of which make essential reference to the Earth, also appear to discover regularities about an individual. And all but the most general laws of history would be about individual times or places. Once we begin looking, purported laws about individuals appear everywhere.[2]

My primary concern is therefore whether regularities about individuals in the special sciences can be laws, and the modal strength of my argument should be read with this in mind. In other words, it doesn't have to be *metaphysically* impossible for there to be laws about individuals in order to say that special science regularities are either not about individuals or not laws. A secondary concern is that it *is* in fact metaphysically impossible for there to be laws about individuals. I won't argue for this directly, but I will have some remarks towards the end of the paper about extending my argument in that direction.

[1] Systems, in the sense used in this paper, are nomologically isolated, so that how a system evolves depends only on the laws of nature and its own characteristics.

[2] See Martin (1986). He argues that non-fundamental laws can be about individuals, but only if the individuals in question satisfy the predicates of a law statement with at least nomological necessity. He does not distinguish between law statements and statements of nomological necessity, however.

By way of argumentative context, consider the following preliminary remarks about laws of nature. Statements of laws are usually taken to be particular sorts of universal generalizations, of the form 'all *P*s are *Q*', where *P* is the subject class and *Q* is the predicate class. Furthermore, I'll take for granted that the laws of nature are *complete*, that the totality of laws give the objective chances for every possible evolution of all material systems. We have good empirical reasons for believing the laws of the actual world (and so worlds like ours) are complete, and some reasons to believe the same of the laws of any metaphysically possible world.[3]

I'm also assuming a modest realism about laws, for two reasons. First, talking about lawlike sentences and law statements seems to obscure what I think is the more interesting issue of laws about individuals. Taking laws to be out there in the world is a helpful way to keep laws and their statements distinct. Second, it is implicit in my argument that laws of nature govern the evolution of material systems; they have to influence the way things turn out. The governing conception of laws arguably implies realism about laws.[4]

[3] See Lange (2009) for an account of the completeness of natural laws, and for an argument that the totality of laws of any world must be so. Whether there are laws about individuals doesn't depend on the partial lawlessness of the individuals in question, so the completion assumption is harmless here.

[4] See Beebee (2000). I'm not going to argue for or against the governing conception of laws. But see Schneider (2007).

The two principal non-governing conceptions of laws are Humeanism (as in Lewis (1973)), according to which laws are just certain types of regularities, and (maybe) dispositional essentialism (as in Bird (2005)), according to which laws arise *from* the metaphysically more fundamental dispositions possessed by properties.

All dispositional essentialist accounts appear to build in a requirement that laws not be about individuals. Properties have dispositions essentially, and it is these dispositions that both give rise to the laws and determine the behaviour of particulars. It appears to follow that laws are about kinds as characterized by the dispositions, not about individuals. Whether an account can be constructed that allows token dispositions to give rise to laws, so that laws would be about individuals bearing those tokens, remains to be seen. If it can, then, with minor modifications, the argument presented in this paper might apply.

It's an interesting question whether Humeans about laws of nature should accept that there can't be laws about individuals. Lewis (among other Humeans) thinks it's good not to forbid such laws *a priori* (Lewis, 1986b), though it's unlikely that the actual world has them. While I doubt they would accept the argument presented in this paper, they may readily

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Finally, I will help myself to the assumption that laws of nature are contingent, and that we can talk freely about metaphysically possible worlds that are nomologically impossible. This is just a convenient way to engage in the counterlegal reasoning that is central to several parts of the paper, like considering how systems would have evolved had the laws been a little different. Philosophers who believe that natural laws hold with metaphysical necessity can translate the counterlegal reasoning as they see fit.[5]

1. Laws about individuals

In more nominalist times, the position that laws can't be about individuals was characterized in terms of restrictions on lawlike sentences. For example, Hempel and Oppenheim demanded that fundamental lawlike sentences 'contain no essential – *i.e.*, ineliminable – occurrences of designations of particular objects' (Hempel and Oppenheim, 1948, p. 155), so that their predicates are 'purely qualitative' (Hempel and Oppenheim, 1948, p. 156).[6] As is typical, they give

accept the conclusion for other reasons. For example, suppose the laws of nature of a given possible world are the axioms of the scientific theory of that world that best balance strength and simplicity. Now consider a sentence that describes how an individual behaves. There are two cases. On the one hand, suppose the behaviour is described by some more general law. Then adding the sentence to the axioms of the theory adds no strength but reduces simplicity. On the other hand, suppose the behaviour is not described by any other generalization. Even still, plausibly, the sentence adds almost no strength to a theory, but greatly reduces its simplicity, so it's unlikely to optimize the balance of the two. This second case is very much the sort of situation where Humeans (like Lewis) would want to say that the fact is not covered by any law; the reasons they would give for this are exactly the reasons for accepting that there can't be laws about individuals. This decomposition of the issue into two cases prefigures an argumentative strategy I use in this paper.

The distinction between these conceptions of laws is not always as clear as presented above. For a quasi-Humean governing conception of laws, see Roberts (2008).

[5] See, for example, Handfield (2004) and Kimpton-Nye (2020), who discuss how dispositional essentialists and a modal necessitarians, respectively, can make sense of counterlegal reasoning.

[6] A predicate is purely qualitative if and only if 'a statement of its meaning does not require reference to any particular object or spatio-temporal location' (Hempel and Oppenheim, 1948, p. 156).

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no argument for this demand, though the suggestion is that a lawlike sentence can't truly be universal or general if it refers essentially to an individual.[7]

Lange describes characterizations like these (all of which roughly agree) as a local predicate restriction: lawlike sentences can't refer essentially to a particular place, time, object, or event. Generalizations with local predicates, it is suggested, might prevent them from being necessary instead of accidental, genuinely general, or universal. Lange argues against this restriction, first by questioning the coherence of the concept of a local predicate, second by providing examples of purported laws with local predicates in perfectly respectable sciences, and finally by arguing that it is not part of the concept of a law of nature that it not have local predicates, since we can imagine laws that require them. Lange's criticism has some force against forbidding sentences with local predicates from describing laws, but (I argue) it has far less force against forbidding laws about individuals. In other words, I think that we took a wrong turn when we started to talk about local predicates. Concerns about how to express laws in language are separate from the question of whether laws can be about individuals. I think the problem with having laws about individuals is that they would distinguish among qualitatively identical systems.

Below, I explain how laws about individuals would distinguish among qualitatively identical systems. I will then argue that Lange's criticism succeeds against forbidding lawlike sentences with local predicates, but not against forbidding laws about individuals.

Ayer (1963) argues (falsely) that any mention of an individual is eliminable, by replacing it with a coreferential description. Martin (1986) replies that replacing proper names and indexicals with coreferential descriptions alters the counterfactual implications of the sentence. (But why not add a rigidifying operator?) It seems to me the real problem, following Strawson, is that it's possible for there to be no qualitative description that picks out the object unambiguously, and I'll be exploiting this observation below.

[7] Hempel and Oppenheim do mention that requiring only qualitative predicates allows the lawlike statement to satisfy their non-limited scope requirement: that the sentence must apply to a potentially infinite number of objects. But the non-limited scope requirement is itself unargued, though the suggestion again is that this is part of what it is for the sentence to be universal.

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1.1. Characterizing laws about individuals

We want a better characterization of laws being about individuals than lawlike statements having local predicates. To avoid the complications of talking about the meaning of predicates, we will talk instead about the laws themselves, and the sorts of classes that can be associated with laws.

Recall our concern over laws about robins. If the species robin is an individual, then laws about robins would not govern relevantly similar creatures that (say) evolved on another planet. The law would be about *that* thing, not things *like* it. This is the sense of laws being about individuals at issue, and the one that likely concerns philosophers taking sides in the debate over whether such laws are possible.

Let us attempt a somewhat more precise characterization of laws about individuals. There are two sorts of classes of possible material systems. Some classes are closed under qualitative identity, *i.e.*, the qualitative duplicates of any member is also a member, using the broadest sense of 'qualitative' that still contrasts qualitative identity with numerical identity.[8] Qualitatively closed classes are those that contain all and only those systems that share some set of qualities, and unions of such classes. All other classes are open under qualitative identity. Each has at least one member with a qualitative duplicate outside the class, and thus requires non-qualitative grounds to distinguish members from non-members.

For example, if robins are a kind whose members all share certain qualities, then every qualitative duplicate of a robin is a robin. That would make the class qualitatively closed. On the other hand, if robins are a particular lineage of organisms that evolved on Earth, then qualitative duplicates that evolved on other planets would not be robins. That would make the class qualitatively open.

We can relativize this definition to a restricted domain of possibility: a class is qualitatively closed in a domain if and only if its subclass in the domain is closed under qualitative identity with respect to all material systems in the domain; otherwise, it is open in the domain. Since we're talking about laws and kinds, one domain type of interest to us is the domain of nomological possibility with respect to some possible world. We'll say a class is nomologically closed in a given world if it is qualitatively closed across all possible worlds that are

[8] One way to understand this sort of qualitative identity is in terms of having all the same natural properties in common. See, for example, Lewis (1986a, pp. 60ff).

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nomologically possible with respect to that world, and nomologically open in the world otherwise. The class of robins is nomologically closed in the actual world if every nomologically possible qualitative duplicate of a robin is a robin. Otherwise, it is nomologically open in the actual world.

Let P and Q be arbitrary classes of metaphysically possible material systems. The purported law is that all Ps are Q. We want our characterization of laws about individuals to say something like this: a law is about an individual if and only if the class that it governs is qualitatively open. But it is a non-trivial matter to specify the class governed by the law. Without taking a metaphysical position on the nature of laws, neither P nor Q (nor indeed any nomologically possible combination of P and Q) can straightforwardly serve as the class governed by the law. This is because any generalization (including those that describe laws) is logically equivalent to other generalizations with distinct subject and predicate classes.

Indeed, let P_1 and P_2 be arbitrary classes whose intersection is P, and let Q_1 and Q_2 be arbitrary classes whose union is Q. The generalization 'all Ps are Q' is logically equivalent to any generalization of the form 'all things that are both P_1 and non-Q_1 are either non-P_2 or Q_2'. The limiting cases, 'all non-Qs are non-P' and 'all things are either non-P or Q', are familiar from discussions of the paradox of the raven – 'all ravens are black' is logically equivalent to 'all non-black things are non-ravens' and 'all things are either non-ravens or black'.

What's worse, since the classes are arbitrary, it is always possible to gerrymander the subject and predicate classes so that they are qualitatively open. For example, consider the law that all robins' eggs are greenish-blue, and suppose that both the class of robins' eggs and the class of greenish-blue things are qualitatively closed classes. Now consider the following gerrymandered classes: grobins' eggs (the class composed of robins' eggs and eggs eaten by only Robin Gibb) and wrobins' eggs (the class composed of robins' eggs and eggs eaten by only Robin Williams). Both these classes are qualitatively open (though their intersection, the class of robins' eggs, is qualitatively closed). 'All robins' eggs are greenish-blue' is logically equivalent to 'all grobins' eggs are either non-wrobins'-eggs or greenish-blue'; if one describes the law, then so does the other. A modest realism about laws should not privilege one description over another when characterizing what the law is about, so we have to be careful about specifying which class being nomologically open makes a given law one that is about an individual.

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Fortunately, we can provide a criterion for laws being about individuals by considering nomologically impossible (but metaphysically possible) combinations of P and Q. The falsifying class of the generalization 'all Ps are Q' is the class of all the Ps that are not Q, or $P\backslash Q$.[9] The falsifying class of 'all robins' eggs are greenish-blue' is the class of robins' eggs that aren't greenish-blue. All logically equivalent generalizations of the form 'all things that are both P_1 and non-Q_1 are either non-P_2 or Q_2' (where the intersection of P_1 and P_2 is P and the union of Q_1 and Q_2 is Q) have exactly the same falsifying class: $P\backslash Q$ and $(P_1 \cap \text{non-}Q_1)\backslash(\text{non-}P_2 \cup Q_2)$ are the same class. The class of robins' eggs that aren't greenish-blue and the class of grobins' eggs that aren't greenish-blue wrobins' eggs are the same class. By appealing to the falsifying class, the class that we associate with the law is independent of how we describe the law.

Thus we arrive at a characterization for laws being about individuals. The purported law is about an individual if and only if the falsifying class is nomologically open in at least one possible world. Otherwise, the falsifying class is nomologically closed in every world, and the purported law is not about an individual. If the law that all robins' eggs are greenish-blue is about an individual, then there is at least one possible world with material systems that falsify the law (non-greenish-blue eggs of robins or their counterparts) and qualitatively identical systems that are nomologically possible with respect to them that don't (non-greenish-blue eggs of robinish creatures). Otherwise, the law is not about an individual.

This makes sense: any law about an individual would be falsified by something to do with that individual, not with things just like it. A purported law with a nomologically open falsifying class is incompatible with a world owing not only to the kinds of systems in the world, but also to which particular systems they are. In other words, such laws would require of worlds different things depending on the individuals in question. At the limit, they will distinguish among qualitatively identical systems, even those nomologically possible relative to one another. A law about an individual would either direct such systems to behave differently, or, more relevantly, govern some but be silent on others.

[9] If the generalization describes an irreducibly statistical law, then Q will be the objective chances of the Ps evolving a given way. In that case, the falsifying class will have as members those Ps with objective chances that are distinct from Q, however they end up evolving.

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1.2. Contrasting local predicates and laws about individuals

There are advantages to avoiding language-based accounts of laws about individuals (like law statements having local predicates). For one, it sidesteps the question of how laws are described. We can ignore how lawlike statements refer to classes in favour of the makeup of the classes themselves. Furthermore, as described above, by using the falsifying class, the characterization presented above is independent of the formulation of the law statement, as all logically equivalent generalizations have the same falsifying class.

Extensionally, the contrast between law statements having local predicates and laws about individuals is best seen in the way they treat qualities that must (or even happen to) be satisfied by only one individual. Suppose it is purportedly a law that the centre of the universe has a temperature of 3 Kelvin. A lawlike sentence that states this law contains an essential reference to a particular spacetime region; therefore it has a local predicate. However, the purported law is not really about an individual, it's just that (typically) at most one individual can have the quality of being the average of all spatial positions. We may be referring necessarily to at most one spacetime region, but we are doing so via the qualities it has. Happily, the purported law has a nomologically closed falsifying class, which reflects this interpretation.

1.3. Lange against local predicates

We're now in a position to defuse Lange's (1995, pp. 432–36) criticisms of forbidding laws about individuals, and show them to be directed mostly at forbidding law sentences from having local predicates.

In his first set of criticisms, Lange problematizes the concept of 'local', with grue-like concerns, concerns about what counts as an object, and general concerns about stating the meaning of a predicate (Lange, 1995, pp. 432–33). These concerns are overstated.[10] Still, it's clear that these are not problems with forbidding laws about individuals *per se*, but rather with characterizing the restriction with local

[10] Problems associated with meaning and reference are far too general to require a solution from an account of laws. Furthermore, clearly the objects in question are broadly scientific objects, and if there are problems specifying these, they are again more general than should concern us here.

predicates. As stated earlier, better to avoid talking about predicates at all when talking about laws and individuals.

Lange's second set of criticisms is an argument from scientific practice: there are perfectly good examples of purported laws that have local predicates. For example, a law (proposed by Dirac) with a gravitational constant that varies with the age of universe; references to a metre in the proportionality constants of various laws (when the length was defined by a particular object); and all of Aristotelian physics (which mention particulars like the centre of the universe and the path of the moon). Any statement of such laws would clearly have local predicates, but this doesn't seem to touch the issue of laws not being about individuals. References to individuals like the centre or the beginning of the universe are (plausibly) done via their qualities, so laws about them are not about individuals.[11] Likewise with references to a metre, since the law deals with the length of the stick, not the stick itself.

The third set of criticisms is a burden of proof argument. Lange argues that there is nothing in the concept of a natural law that prevents it from being about an individual: laws don't have to be universal, and forbidding laws about individuals doesn't help to differentiate laws from accidents or fundamental from derivative laws.[12] I think Lange is correct to separate the issue of laws being about individuals from the issue of contrasting laws and accidental generalizations, as well as the issue of local predicates underwriting derivativeness. But intuitively, laws *are* supposed to be universal, and laws not being about individuals does seem to have something to do with their universality.

The example Lange uses to deny this is Tooley's (1977) apple-only garden: a unique garden in which all the fruit are apples, but not accidentally (oranges become elephants and bananas become apples as they pass into the garden, and pears are excluded from it by an irresistible force). As described, this is, finally, a clear and unambiguous case of a law about an individual. Fortunately (for me), it's also fictional, and I think our intuitions about such cases are misleading.

Many philosophers will accept the metaphysical possibility of a unique garden that exhibits such lawful behaviour. However, as we

[11] Implicit in such laws is a reference to the structure of the universe rather than to the individuals primitively: the center of the universe to the spatial distribution of matter, and a varying gravitational constant to the structure of spacetime, itself a result of the distribution of matter and energy.

[12] The thought that local predicates might underwrite a law's derivativeness seems entirely unmotivated.

should by now recognize, this says less about the possibility of genuine laws about individuals, and more about laws about systems that merely happen to be instantiated only once. Philosophers thinking about such cases likely haven't been particularly sensitive to this distinction, and their initial plausibility as laws about individuals comes from adopting the intuitive force of the latter in service of the former. I suspect that they would naturally take the garden to behave as it does because it has some quality or configuration that other gardens don't have, so that a qualitatively identical garden would also exclude non-apple fruit.[13] This accords with the law's universality.

Finally, Lange's positive proposal is to adjudicate lawfulness according to the difference between the way scientists treat lawlike statements and accidental generalizations (their relations to counterfactuals, scientific explanations, and inductive confirmation). Since the functions to which scientists put lawlike sentences demand no special relationship to local predicates, Lange argues, laws are allowed to be about individuals. Below, I present a reason for believing that scientists do in fact require that laws not be about individuals in order for law sentences to do the work that they do. In particular, laws are what guarantee that qualitatively identical systems evolve in the same manner. I will argue that, if laws are about individuals, they can't fulfill that function.

2. Why laws can't be about individuals

My thesis is that a law of nature cannot be about an individual. So there may be laws about electrons, but there are no laws about my sweater. At least there are no laws about my sweater *qua* my sweater, *this* thing; only (possibly) laws about sweaters that fit a certain description. This is also why 'all robins' eggs are greenish-blue' cannot be a law, if the species robin really is an individual.

The argument for this thesis begins with the observation that laws determine the *manner* in which a system evolves, which is to say, they determine the various ways it *could* evolve. Thus, the laws establish

[13] In this way, it is similar to laws that include proportionality constants that vary from item to item. There might be an object whose constant is unique, but not because the law with that particular constant is about the object, rather from the improbability of repeating the structure of the object somewhere else. Had the structure been repeated, the law would have applied to the new object.

the counterfactual profile of a system's evolution. In the most general case, this means that the laws give us the objective chances of the system to evolve in various ways. In the special case of determinism, the absence of irreducibly statistical laws means the laws completely determine the state into which the system evolves.

The thesis hinges on the following claim: qualitatively identical systems under one set of laws must evolve in the same manner. They must have the same objective chances to evolve in various ways; under determinism, this means they must evolve into qualitatively identical states. Laws are about individuals precisely when they distinguish qualitatively identical objects in qualitatively identical contexts. So if such laws existed, each system would (at best) have its own numerically distinct law. If two qualitatively identical systems are governed by two numerically distinct laws, nothing guarantees that they will evolve in the same manner.

To illustrate this argument, and pump intuitions about the plausibility of the claim that qualitatively identical systems evolve in the same manner, I'm going to suggest a thought experiment, based on Strawson's massive reduplication argument.[14] Since statistical laws are (mostly) an unnecessary complication,[15] and since it makes the illustration clearer, I will assume determinism for the thought experiment. I will thereafter return to the general case to present the argument, and argue for each of the premises. Finally, I will discuss the metaphysical possibility of laws about individuals.

[14] Strawson argues that all identifying references to material objects have a demonstrative component. However much the object and its environment are described, a purely descriptive reference might fail to pick out an individual, since it is always possible that, in some other sector of the universe, a second object satisfies the description.

My thought experiment is a radicalization of this. It posits a universe in which every object has a qualitative duplicate in a qualitatively identical environment. So a law about an individual always distinguishes between it and a qualitatively identical object in that universe.

[15] Nothing about the issue of there being laws about individuals depends on there being statistical laws. If laws about individuals are possible, then such laws are possible under determinism. The special case is especially salient given the primary concern of this paper: the actual world is effectively deterministic at the level of the special sciences, the special sciences are largely insensitive to the irreducibly statistical nature of the microscopic world, and the examples of purported laws about individuals from the special sciences have nothing to do with spontaneous events as understood in physics.

2.1. Duplicate universe

Suppose the universe has two symmetric halves:[16] they have qualitatively identical initial conditions, and share the same laws. Assuming determinism, we have a very strong intuition that the halves would evolve the same way, and indeed that the halves would remain qualitative duplicates throughout history. This intuition underlies the belief that qualitatively identical systems under one set of laws must evolve in the same manner.

So suppose, because the halves had the same initial conditions and share the same laws, that they are duplicates of one another.[17] Note that it is one universe, not two: the halves are not causally isolated, but if, say, a photon leaves one half for the other, a complementary photon returns, and symmetry is maintained. Since they are qualitatively identical, there is no way to distinguish them descriptively. The half that we live in is this side, the other half is that (or the other) side.

Consider generalizations about robins. When we say 'robins', we mean the creatures we know and love, here on Earth. For clarity, call them these-robins. By hypothesis, we know there are qualitatively identical creatures on the other side of the universe, in a qualitatively identical context with qualitatively identical causal histories. Call them those-robins.

Our purported law is that all robins' eggs are greenish-blue. By this, we mean that it is a law that all these-robins' eggs are greenish-blue. But, again by hypothesis, the eggs of those-robins are also greenish-blue. Yet they are not governed by the law in question. Thus, we have numerically distinct laws, a these-robins law and a those-robins law, that govern qualitatively identical systems. Even though the laws are numerically distinct, all the eggs of both these-robins and those-robins are greenish-blue. So the halves evolved the same way, but the laws that govern the two systems don't make it so, since it's an accident that unconnected laws conspired to achieve the result.

[16] We can implement this any way we like. Probably the best way to imagine it is to consider an arbitrary distribution of matter and energy as half the universe. Some distance away from this half, we can place the origin of Cartesian axes. Then we can map the matter and energy from (x,y,z) to $(x,-y,-z)$ to generate the other half. This is a 2-fold rotationally symmetric universe about the x-axis, and avoids issues involved in mirror-symmetry.

[17] Thought experiments about a symmetric universe were considered in the mid-twentieth century. See Burks (1951), Black (1952), and Wilson (1953).

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Or at least not these two laws. In order to guarantee that both these-robins and those-robins lay greenish-blue eggs, perhaps there is a further law, that the eggs of all robin-ish things are greenish-blue. But given that such a law exists, it becomes unparsimonious to posit three numerically distinct laws when fewer will suffice to guarantee the halves evolve the same way.

It is worth looking more closely at how this thought experiment works. The thought experiment exploits Strawson's observation that it is always possible that descriptions are ambiguous, and appropriate demonstrations are required to distinguish qualitatively identical (but numerically distinct) objects in qualitatively identical contexts. Laws of nature govern the evolution of natural systems, and qualitatively identical systems must evolve in the same manner. The only way this is guaranteed is if the laws are not about individuals. The thought experiment is not about some other part of the universe. It works because it is really about how we think about our universe, even the local universe, and how statements about our universe are universal in the relevant sense.

2.2. The argument formalized

In this section I'll argue more formally that laws can't be about individuals, and attempt to defend each of the premises. The argument is this:

(1) Qualitatively identical systems under one set of laws must evolve in the same manner.
(2) If laws could be about individuals, then two qualitatively identical systems (under one set of laws) could be governed by numerically distinct laws.
(3) If qualitatively identical systems (under one set of laws) could be governed by numerically distinct laws, then nothing guarantees that they will evolve in the same manner.

∴ (4) Laws cannot be about individuals.

All the modal terms in (1)–(4) have the same strength: something less than metaphysical necessity but more than nomological necessity, importantly including counterlegal circumstances in which the laws are arbitrarily (but not utterly) different.[18] This is enough to establish

[18] Two notes on the strength of the modal terms in the argument. First, the use of 'under one set of laws' is set apart, and consistently implies systems that are nomologically possible with respect to one another.

conclusions about the special science laws that are the principal concern of this paper. A stronger reading, with a modal strength of metaphysical necessity, would be required to deny the metaphysical possibility of laws about individuals. I'll discuss the stronger reading in the next section.

2.2.1. Support for premise (1)

Premise (1) states that qualitatively identical systems under one set of laws must evolve in the same manner. If the laws give a system an objective chance to evolve into some state, they have to give qualitatively identical systems the same chance. Under determinism, this reduces to the claim that qualitatively identical systems evolve the same way, *i.e.*, into qualitatively identical states. But in the more general case in which irreducibly statistical laws determine the evolution of the systems up to a well-defined statistical variation, all we can say is that the two systems evolve a given way with the same probability.

Premise (1) has intuitive appeal, and is consistent with the way philosophers (and, for that matter, laypeople) treat laws of nature. We take a system to evolve not because of which *particular* objects constitute it, but because of which *kinds* of objects, or the qualities of those objects, or the underlying structure of the system. Indeed, even those who argue that there can be special science laws about individuals don't seriously doubt it.

Beyond this, an argument from scientific practice can also be made in support of premise (1). If a scientist encounters a new system that is apparently qualitatively identical to a previously known system, she assumes the new system will evolve the way the old system does. If it does not, she will try to find some qualitative difference between the systems. If there is no qualitative difference, she may take the relevant laws to be statistical, so that each system has the same chance to evolve a given way.[19] She may even decide that she has discovered that something not previously taken to be a quality is in fact one. She will *not* conclude that the two systems evolve

Second, the strength of the remaining modal terms is probably best captured by quantifiers that are restricted to a domain composed of nomologically possible worlds, nearby nomologically impossible worlds, and worlds nomologically possible with respect to the latter.

[19] For example, a large number of qualitatively identical particles are measured to decay at different times after production. The scientist determines a pattern in the distribution of decay times, and discovers a statistical law that governs the decay of all the systems.

differently merely because they are numerically distinct, as if there were no expectation that they should do otherwise; she could be seen as unwittingly entering empirical evidence into what is essentially a metaphysical debate on what constitutes an individual.

That qualitatively identical systems must evolve in the same manner is deeply embedded in the practice of science. It underwrites inductive reasoning and the extension of conclusions from one system to another. It is the reason that the evolution of systems can be described in terms of transformations from one state to another.[20] It is the basis for frequentist interpretations of irreducibly statistical laws, in which the probability of an event occurring in a system is interpreted as the frequency of events of the same type occurring among an arbitrarily large number of qualitatively identical systems (an ensemble). It explains why scientists are not concerned with the numerical identity of experimental systems (except as a guarantee of qualitative identity) when they leave their labs at night, or why they trust commercial companies to produce and reproduce exhaustible components of their experiments, or why the failure to reproduce the results of an experiment counts as disconfirming it and not as discovering a law about an individual. It is why special scientists whose practice is supposedly about an individual (as geology is about the Earth) apply their principles to qualitatively similar systems without a second thought (as in planetary geology).

Furthermore, that apparently qualitatively identical systems evolve differently (in a way that can't be accommodated by a statistical interpretation) is itself sufficient ground for positing a new quality. An interesting example comes from the history of chemistry.[21] In 1820, Charles Kestner, while manufacturing tartaric acid, accidentally and irreproducibly manufactured a sample of apparently qualitatively identical acid that exhibited very different behaviour. As discovered by Jean-Baptiste Biot, tartaric acid rotated the polarization angle of polarized light passing through it, while the new acid did not. Thought to differ in some thitherto unknown quality, it was designated a new kind: racemic acid. Twenty-eight years passed before Louis Pasteur discovered that tartaric acid is chiral (left-handed in

[20] Indeed, I believe that this is a more promising account of laws than as certain sorts of universal generalizations: laws are abstract entities that govern the transformation of systems from one state to another. For a related view, and a convincing argument on the centrality of the *temporal* evolution of physical states, see Maudlin (2007).

[21] See Ihde (1984, p. 322).

this case), while racemic acid is not.[22] We have every reason to believe that this example is typical of scientific practice.

Nothing in the scientific practice detailed above depends on the actual laws. Indeed, it presupposes an ignorance of the actual laws. It is not a cosmic accident that qualitatively identical systems must evolve in the same manner. They would under any set of laws remotely like ours.

2.2.2. Support for premise (2)

Premise (2) states that if laws could be about individuals, then two qualitatively identical systems (under one set of laws) could be governed by numerically distinct laws. If a law is about an individual, then it distinguishes among qualitatively identical systems (nomologically possible with respect to one another). The law can't specify that they evolve in a different manner, for this would directly violate premise (1). So the law must be silent on the manner of evolution of at least one of them. Therefore, there must be another, numerically distinct law that specifies the manner in which that system evolves.

2.2.3. Support for premise (3)

The third premise states that if two qualitatively identical systems could be governed by numerically distinct laws, then nothing guarantees that they will evolve in the same manner. It can be argued as follows.

Consider two qualitatively identical systems s_1 and s_2 that are governed by numerically distinct laws described by 'all P_1s are Q_1' and 'all P_2s are Q_2', respectively. Suppose further that s_1 is a member of P_1 but not P_2, and s_2 is a member of P_2 but not P_1. In this case, if s_1 and s_2 evolve in the same manner (for convenience, say $Q_1 = Q_2$), neither of the laws governing s_1 and s_2 guarantee it. Had their laws been just a little different, realized perhaps by slightly (but

[22] Fortunately for Pasteur, the chirality of tartaric acid molecules has macroscopic chiral effects, *i.e.*, the shape of the salt crystals of the left-handed molecules are mirror images of the shape of the salt crystals of the right-handed molecules. Natural tartaric acid has left-handed crystals exclusively. Racemic acid, it turns out, has an equal mixture of the left-handed and right-handed crystals. What Pasteur noticed was that some of the crystals of racemic acid resembled those of tartaric acid, while others were their mirror images.

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independently) varying their parameters, their manners of evolution could have come apart. Thus, either they evolve in the same manner by some cosmic accident (that $Q_1 = Q_2$), or some other law governing both guarantees that they evolve in the same manner.

For example, suppose these-robins are governed by a law that has them lay greenish-blue eggs, and suppose qualitatively identical those-robins are governed by a numerically distinct law that has them lay greenish-blue eggs as well. Now consider the neighbourhood of (nomologically impossible) possible worlds where these-robins and those-robins are still qualitatively identical and nomologically possible with respect to one another. Because the two laws are independent of one another, some of those worlds are worlds where the laws governing the two systems come apart; perhaps these-robins lay green eggs and those-robins lay blue eggs. In that case, unless there is a law governing both these-robins and those-robins, these-robin systems and those-robin systems can evolve in a distinct manner despite being qualitatively identical.

Consider then a third law described by 'all Ps are Q', such that P has both s_1 and s_2 as members. It is then necessary (in the sense required for the argument) that $Q_1 = Q_2 = Q$, and the P-law explains why s_1 and s_2 evolve in the same manner. (For example, perhaps there is a further law that governs all robin-ish things that has them lay greenish-blue eggs. Then it is not a cosmic accident that these-robins and those-robins both lay greenish-blue eggs.) In this case, we should revisit the nomological status of the purported laws about P_1 and P_2. We already have a general law that specifies the manner of evolution of both s_1 and s_2. Their only apparent metaphysical significance is that they instantiate the general law. Anyone committed to using mere instantiation as grounds for lawhood has no reason to deny as many laws in a world as there are particulars (individuated as finely as the token states of each system), since all particulars would be governed by more general laws. Even worse, if nomological possibility is to be couched in terms of worlds with a common set of laws, then she would be committed to as many laws in a world as there are nomologically possible particulars. Thus, while it is possible to resist the argument here, the cost of doing so is sacrificing parsimony.[23]

[23] There is logical room here for some other entity that is not a natural law, but that connects the P_1-law and the P_2-law, requiring that $Q_1 = Q_2$. Perhaps it is some sort of meta-law. This move, while not forbidden, seems undermotivated, and would result the multiplication not of laws but of the types of relations in which laws stand.

Contrast this line of reasoning with arguments about the existence of special science laws at all, as distinct from physical laws. The grounds presented for the existence of special science laws are frequently metaphysically significant: for example, being about properties that are multiply realizable or causally autonomous, or standing in various complex relationships with physical laws (including transcending them). None of these grounds are available to a law about an individual with respect to a more general law that also specifies its manner of evolution. And in any case, as there would be far fewer special science laws about kinds than about individuals, the sacrifice in parsimony would be much less demanding.

2.3. Extending the argument

Recall that statements (1)–(4) of the previous section's argument can be read with two different modal strengths. The weaker reading, sufficient to address the special science cases that are the primary concern of this paper, is supported by the considerations of the previous section. In order to *metaphysically* forbid laws about individuals, the modal strength of the premises has to be increased to metaphysical necessity. In this section, I have some remarks about this stronger reading of the argument, and though I won't argue for it, I will provide an argumentative sketch.

The second and third premises are largely unaffected by the stronger reading. However, it is at least controversial that an argument from scientific practice would be enough to support the first premise under the stronger reading. So we would need to look elsewhere to support this premise.[24] The natural place to start would

[24] We can support premise (1) controversially by an appeal to metaphysical 'best practices'. An account of laws should be neutral with respect to whether a counterpart of an actual object in another possible world is numerically identical to the object. But if qualitatively identical systems under one set of laws could evolve in a different manner, it would be difficult to determine sensibly the truth of certain modal or counterfactual claims about it *unless* its counterparts were numerically identical to it. If they were merely qualitatively identical, and nomologically possible (thus under the same set of laws), we appear to have very little information by which to determine their evolution, and hence the truth of counterfactual statements about the actual object. It would needlessly complicate modal reasoning to deny that qualitatively identical systems under one set of laws must evolve in the same manner, unless the object was numerically identical to its counterparts.

perhaps be to argue that qualities either are or ground dispositions, so that you can't have a dispositional difference without a qualitative difference.[25] But I don't think this is the right strategy. At root, the argument presented in the previous section is more general than that, and this can be reflected in a more general first premise. We do not require *qualitative* identity; we just require something that accounts for a difference between systems that (nomologically) must evolve in the same manner by cosmic accident, and systems that must evolve in the same manner in a stronger sense.

The following example illustrates this difference. Consider a Newtonian world in which the only forces operating are Newtonian gravity and the electrostatic force following Coulomb's law. A system consisting of an electron and a positron has (and indeed nomologically must have) the same kinematic evolution as a system with two neutral point-like masses of about 3.8 billion tonnes each in the same configuration.[26] But it is only by a conspiracy of variables that it does: several independent parameters, the magnitudes of the masses and charges of the various bodies in relation to the relative strengths of the Coulomb and gravitational forces, had to be in just the right proportions. In contrast, a second electron-positron system in the same configuration has the same kinematic evolution as the first electron-positron system, but not by some high-order accident.

This conclusion can be extended to comprehensive (as opposed to just kinematic) evolutionary identity as well. Consider an electron-positron system in the same configuration, but in a possible world with different laws.[27] In this new world, the magnitudes of the Coulomb and gravitational forces are re-jigged in such a way that the change washes out in the electron-positron system. Perhaps the new gravitational force has the same magnitude at the electron/positron mass as the old Coulomb force did for their charges, and

[25] See, for example, Martin and Heil (1998) and Tugby (2012).

[26] An electron/positron has mass 0.511 eV/c^2 and charge 1 e. Each sees an attractive force of about 2.3×10^{-28} N times the inverse square of their separation (in metres). This corresponds to an acceleration towards one another of about 250 m/s^2 times the inverse square of their separation (in metres). Two neutral masses of 3.8×10^{12} kg each see an attractive force of about 9.6×10^{16} N times the inverse square of their separation (in metres). This also corresponds to an acceleration towards one another of about 250 m/s^2 times the inverse square of their separation (in metres).

[27] Again, those who might object to property-identity or kind-identity across worlds with different laws already concede a connection between laws and properties strong enough to support some version of premise (1).

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vice-versa. Such a system would evolve in exactly the same way as the original electron-positron system, by nomological necessity.[28] But again, it is only by a conspiracy of variables that it does.

It's not clear to me how to argue that there metaphysically must be systems (not necessarily in the same world) that nomologically must evolve in the same manner, and not by cosmic accident. But most metaphysical accounts consistent with (or interpreted in light of) a governing conception of laws are committed to this, whether they connect properties and laws necessarily, or have laws contingently relate universals, or have properties acquire dispositions contingently according to the laws.[29] Accounts that deny it without simultaneously denying the governing conception of laws (perhaps involving instances of bare dispositions that do not fall under types) appear at first glance to have very little to work with, and to my knowledge such accounts have never been advanced.

Once it is accepted that for every material system there is another possible system that must evolve in the same manner (and not by cosmic accident), the rest of the argument follows. It doesn't matter if they do so because they share qualities, or because their dispositions are type-identical, or what have you. If laws govern the evolution of material systems, then however the laws hook onto systems, it is the laws that make the systems evolve in the same manner. If laws could be about individuals, then such systems might be governed by numerically distinct laws. But if so, then it is a mere cosmic accident that they evolve in the same manner, unless some further law governed both. Since this would imply an unacceptable explosion in the number of laws, the only way to guarantee they evolve in the same manner is to forbid laws about individuals.

Besides denying that systems have possible partners that must evolve in the same manner (but not by cosmic accident), the obvious way to resist the argument would be to deny that parsimony is a guide at all to the nature of laws, or more generally to deny the

[28] Both systems nomologically must evolve the way they do, so there is a sense in which they nomologically must evolve the same way, although we are not quantifying over the same worlds.

[29] Indeed, even dispositional essentialist accounts that deny the governing conception of laws accept it. Nothing in the electron/positron examples changes if the Coulomb and gravitational forces *arise from* the dispositions of the constituents of the system. The type-distinct dispositions and stimulus conditions can conspire to ensure two systems have the same evolution, but systems with type-identical dispositions and stimulus conditions must have the same evolution (and not by cosmic accident).

governing conception of laws.[30] But such strategies are not special to the strong reading of the argument.

3. Conclusions

Laws can't be about individuals. If they could, then nothing would guarantee that qualitatively identical systems evolve in the same manner, since being about individuals is precisely what allows numerically distinct laws about qualitatively identical systems. If, for example, a species is an individual, then it is a qualitatively open class, and so there can't be laws about it.

This needn't be a disastrous conclusion. For example, any treatment of the generalization 'all robins' eggs are greenish-blue' that counts qualitatively identical creatures (like those-robins) as honest-to-goodness robins will not be excluded by my argument. All we have to do is provide some criteria for being a robin, or at least assume that some exist, that do not discriminate against relevantly similar creatures. Maybe we define robins phenetically, or by their ecological role. Or we could say that robins instantiate the natural kind of robinhood.

This generalizes: special science laws that are purportedly about individuals are better interpreted as being about kinds, and so are not forbidden by my argument. Perhaps these sciences are positing a new kind (instantiated in that individual only). But more likely, they are implicitly about things with a given underlying structure and standing in certain relations. So, however statements about them are constructed, the laws discovered by geology are not really about the Earth, they are about *things like* the Earth, even if the Earth is the only such thing. Again, it is a vanishingly small step for a special science to move from purportedly talking about an individual (as in geology or terrestrial biology) to talking about kinds (as in planetary geology or astrobiology).

Furthermore, other laws traditionally taken to be about individuals were, in my view, mistakenly taken to be so. Some laws are about kinds that only happen to be instantiated once, like laws with

[30] The two denials are related, in that it would be difficult to construct an account of laws in which a law genuinely governs the evolution of material systems with such massive redundancy. Similar remarks are made by Bird (2006). It should also be noted that even non-governing conceptions of laws often accept a distinction between laws and nomologically necessary facts. See note 4. In contrast, see Lange (2000).

proportionality constants that vary from item to item. These are local only by the improbability of repeating the material structure. Other laws are about kinds that can be instantiated at most once, like laws about the centre or the beginning of the universe. These are local only because at most one object can satisfy the relevant descriptions. Either way, the law applies universally to the structure, even if the structure happens to be (or even must be) instantiated only locally. They don't discriminate on non-qualitative grounds, so they are permitted to be laws.

The only purported laws that are excluded by my argument are those that are genuinely about individuals. If, say, species are individuals, then there can be no laws about them.[31]

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