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Published in:
Erkenntnis

DOI:
10.1007/s10670-022-00567-1

Publication date:
2024

Document Version
Publisher's PDF, also known as Version of record

Erkenntnis
https://doi.org/10.1007/s10670-022-00567-1

ORIGINAL RESEARCH

The Necessity of Naturalness

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Received: 27 May 2021 / Accepted: 16 April 2022

Are properties perfectly natural (or not) relative to worlds, or are they perfectly natural (or not) *tout court*? That is, could there be a property P that is instantiated at worlds w_1 and w_2, and is perfectly natural at w_1 but not at w_2? Here, we offer an original argument for the non-world-relativity of perfect naturalness. Along the way, we reply to a *prima facie* compelling argument for the contingency of perfect naturalness, based upon the connection between natural properties and laws of nature.

According to Lewis, we can draw a distinction between perfectly natural properties and other, less-than-perfectly natural properties, where the former are simple, intrinsic, non-gerrymandered, and serve to 'carve nature at the joints' in a way that the latter do not (1983: 346).[1] Lewis used this perfectly natural/less-than perfectly natural property distinction in a variety of ways, including in his analyses of causation, intrinsicality, similarity, duplication, induction, supervenience, reference, physicalism, and laws of nature.[2] Some have been skeptical about perfect naturalness, claiming that it is the worst sort of 'spooky' metaphysics (see, e.g., Witmer et al. 2005). But, because of this extensive utility, numerous philosophers have adopted Lewis's distinction, modifying, extending, and applying the notion of perfect naturalness in various ways.[3]

[1] We, following Lewis, take the distinction to apply equally well to relations as well as monadic properties. For ease of expression, throughout we use 'property' to include both properties and relations.

[2] See e.g. Lewis (1983: 351–355 and 366–368; 1984; and 1986: 59–61 and 123–124).

[3] For example, Brown (2016) uses natural properties to develop a theory of natural objects, and to address questions about the nature of mereology. Meanwhile, Wildman (2013) appeals to natural properties to defend a modal account of essence. Finally, Sider (2009, 2011) extends the notion of naturalness to quantifier meanings and deploys it to argue, *contra* ontological deflationists that (at least some) existence questions are substantive.

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Published online: 19 May 2022

Despite this broad uptake, much about perfectly natural properties needs clarification. One open question here concerns the modal status of perfect naturalness.[4] Specifically, it is not clear whether properties are perfectly natural (or not) relative to worlds, or are perfectly natural (or not) *tout court*. That is, could there be a property P, instantiated at both world w_1 and world w_2, that is perfectly natural at w_1 but not at w_2? If so, perfect naturalness is world-relative, and is a contingent feature of (at least some of) the properties that have it; if not, then perfect naturalness is non-relative, and the perfectly natural properties are all necessarily so.

Addressing this question is in fact important for the Lewisian. If perfect naturalness is to do the work Lewis wants it to, then it must be a necessary feature of the perfectly natural properties. For example, Lewis's accounts of supervenience theses, formulations of materialism, similarity relations, counterfactuals, and causation all require cross-world comparisons, and hence require that what is perfectly natural remains stable across worlds. If perfect naturalness is contingent in the manner specified above, then these accounts all fall apart. So, it is imperative that the Lewisian provide an argument for the necessity of naturalness—otherwise, much of the Lewisian project is doomed to fail.

There has been some discussion concerning this modal status question in the literature: Lewis (1986: 44, 61) explicitly takes perfect naturalness to be a non-world-relative feature of properties, a sentiment that Dorr and Hawthorne (2013), Borghini and Lando (2015: 104), and Thompson (2016: 382) endorse. Cameron, meanwhile, says that he is 'more sympathetic than many' to naturalness facts being contingent (2010: 284), though he explicitly does not 'take a stand' on the issue.

However, little in the way of *argument* has been given for either conclusion. Perhaps the closest are Dorr and Hawthorne, who profess to not having a 'sense of how to steer a disciplined path through [the] garden of decision points' concerning denying the necessity of naturalness, though they do briefly sketch some apparent difficulties facing contingent naturalness (2013: 33).

Here, we aim to make some headway in this matter. We will do so in two steps. First, we offer an argument for the necessity of perfect naturalness. We then address a potential argument for contingency, which turns on the apparent tight connection between perfect naturalness and laws of nature. With an eye towards circumventing this latter argument, we clarify these connections, concluding that the link between naturalness and natural laws is not as intimate as one might think—and, most importantly, does not support contingency.

To be clear, the following is tightly focused: we only explicitly address whether a property might be perfectly natural in some worlds but not others, and only consider one argument each for necessity and for contingency. That said, the argument for necessity of perfect naturalness we develop readily generalizes to other, less-than-perfect degrees of naturalness. Further, the pro-contingency argument that we undercut is, to our minds, the most plausible argument in favour of perfect

[4] Other unsettled questions include whether the perfectly natural properties only occur at the fundamental level (Schaffer 2004), and whether perfect naturalness is itself perfectly natural (Thompson 2016).

naturalness being world-relative. In this way, while our discussion is not exhaustive, it is substantive (and potentially even decisive).

Similarly, it is worth noting that while we are here arguing for the 'standard view'—i.e., the idea that perfect naturalness is non-relative is the default assumption—we are *arguing* for it. One could simply *stipulate* that naturalness is necessary, and try to justify this stipulation by insisting that perfect naturalness is intended to, for example, explain similarity across worlds.[5] But it would still be useful to have an argument justifying or explaining this stipulation—and this is what we hope to here supply.

Before we get started, a few quick preliminaries. First, we make two assumptions—one substantive, one merely convenient, both due to Lewis (1983)—about properties. The convenient assumption is that properties are (perhaps cross-world) sets of objects. This identification of properties with sets can be dropped and the arguments of the paper recast, though thinking of properties this way makes it much easier to formulate things.

The substantive assumption is that properties are abundant—*every* set of objects is a property. The perfectly natural properties, meanwhile, are an elite proper subclass of the properties. Some of what follows crucially depends on the abundance of properties. If we drop the convenient assumption, we can still retain the substantive assumption, as it only requires that, for any set of objects, there is a property had by all and only the members of that set.

Finally, for succinctness, when talking about perfectly natural properties in the following we will tend to drop the 'perfectly'.

1 The Case for the Necessity of Naturalness

Suppose, for (informal) *reductio*, that P is a contingently natural property. Let P be instantiated in worlds W_P, perfectly natural in worlds W_{P+}, and not perfectly natural in worlds W_{P-}. The worlds in W_{P+} are those in which P grounds objective similarities and causal relations, plays a role in the fundamental laws, etc.; the worlds in W_{P-} are those in which P does not.[6] W_{P+} and W_{P-} are disjoint, non-empty, sets of worlds whose union is W_P.

Consider now the property P^*, which is the union of the extensions of P in the worlds of W_{P+}; the substantive assumption about the abundance of properties guarantees that there is such a P^*. By definition, P^* is a sub-property of P, one that is instantiated exactly where P is both instantiated *and* natural. In light of this, it seems obvious that P^* is a more natural property than P. So, P^* is natural and P is not.

[5] Hildebrand (2016) discusses a version of this point with regards to universals.

[6] Natural properties raise a host of epistemological questions—most pressingly, how do we discover which properties are natural? See Lewis (2009), Dorr and Hawthorne (2013), and Borghini and Lando (2015) for some discussion of this and related issues. Here we set the epistemology of naturalness aside and assume a god's-eye view in distinguishing the perfectly natural properties from less natural ones. In any event, we're not ultimately committed to being able to draw a line between W_{P+} and W_{P-}—or, rather, we think it can be done trivially. For we conclude that all perfectly natural properties are necessarily so; thus, on our view, for every such property P, $W = W_{P+}$, and W_{P-} is empty.

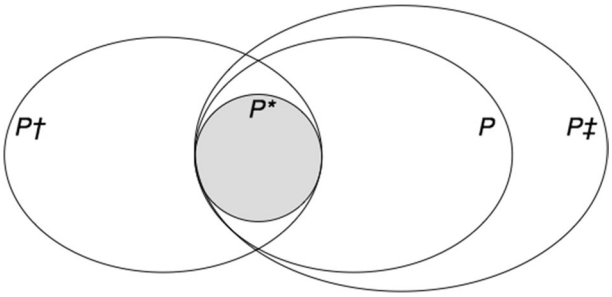

Fig. 1 The (cross-world) extensions of P, P^*, $P\dagger$ and $P\ddagger$. P is a putative contingently natural property; P^* is instantiated just where P is both instantiated and perfectly natural. Are $P\dagger$ and $P\ddagger$ contingently natural?

Further, since, by stipulation, P^* is natural in every world in which it is instantiated, it is natural *tout court*—and is *necessarily* so.

Of course, 'it seems obvious' is often just a paraphrase for 'we don't have an argument.' So we'd like to do better than that if we can.

With that in mind, consider properties $P\dagger$, a super-property of P^* distinct from P, and $P\ddagger$ a super-property of P—and hence also of P^* (see Fig. 1). Are $P\dagger$ and $P\ddagger$ contingently natural properties? The only grounds we can see for thinking they are contingently natural is that $P\dagger$ and $P\ddagger$ have a necessarily natural property—i.e., a property that is perfectly natural in every world in which it is instantiated—P^*, as a sub-property. But this means that the notion of necessary naturalness is doing all the work. Further, on such a view, the supposedly natural properties are not sparse enough to do the work required of them, as any two objects will share uncountably many contingently 'natural' properties—and that doesn't seem to be tracking objective similarities! Consequently, we ought to reject the claim that $P\dagger$ and $P\ddagger$ are relatively-natural properties. But there is no principled reason for taking some extensions of P^* to be contingently natural while insisting that others are not. Therefore, we ought to take naturalness to be a necessary feature of the properties that have it.

Here's another way to come at the argument. Suppose that *having mass* is a natural property, but that it is contingently so.[7] Let us then consider some world, w, where there are massy objects, but where *having mass* isn't natural. What is the extension of *having mass* at w? Which objects are the massy ones? If *having mass* were natural at w, we could answer: the objects that are objectively similar (in a certain way) to the massy objects in *our* world and to those in other worlds where *having mass* is natural. But we've stipulated that *having mass* isn't natural at w—so there is no guarantee that the massy objects at w are objectively similar to the actual massy objects. Indeed, the massy objects at w need not even be objectively similar to *each other* in virtue of all having mass. Likewise, at w, the property of *having*

[7] If you don't think *having mass* is perfectly natural—maybe because, *contra* Wilson (2012), you don't think that determinable properties can be fundamental, or because you are convinced by the sorts of considerations raised by Brown (2016: 259–260)— then pick *having mass of 125.18 GeV/c*^{2}, or some other property you *do* take to be perfectly natural.

mass doesn't figure in the natural laws, doesn't ground causal relations—in short, it doesn't carve *w* at its joints. Thus, the collection of massy objects at *w* may well be arbitrary and miscellaneous—and any similarities that *do* obtain between the massy objects, any regularities they exhibit, etc., must be in virtue of *other* properties they share.

Now consider a different property, the property had by exactly those massy objects at worlds where *having mass* is natural. Call this property *having natural mass*. The naturally massy objects—no matter which world they are at—are all objectively similar to each other in virtue of having natural mass, and no *other* objects are objectively similar to them in just the same way. Furthermore, this objective similarity figures in natural laws and grounds causal relations (though see below for more discussion on this point). Thus, *having natural mass* appears better suited to play the theoretical role of perfect naturalness than does *having mass*. And since *having natural mass* is, per hypothesis, natural at every world in which it is instantiated, it is *necessarily* natural.

The above argument rules out a property being perfectly natural in some worlds and perfectly non-natural in others. But perhaps there is another way for naturalness to be contingent: a property could be perfectly natural at some worlds and imperfectly, though still highly natural at other worlds. Consider: in the actual world, the theory of relativity is fundamental, and the laws of Newtonian mechanics are non-fundamental, derived laws. However, a Newtonian world, one in which Newton's laws are themselves fundamental, is metaphysically possible. So the property *having Newtonian (inertial) mass*[8] is perfectly natural (because fundamental) in some worlds, but less-than-perfectly natural (because non-fundamental) in others, including ours. If this is right, then a property's degree of naturalness can be contingent after all.[9]

This argument for contingency rests on two substantive—and contentious—metaphysical theses. The first is structuralism about properties: properties are individuated by their nomological roles.[10] The second claim is (weak) contingentism about laws of nature: a given set of laws may be fundamental in some worlds and non-fundamental (though still operative) in others. We could, of course, respond by rejecting either of these two theses. Lewis (2009) himself rejects structuralism in favor of *quidditism*, the view that structurally indiscernible properties may nonetheless be distinct. If quidditism is right, then the laws of Newtonian mechanics may work on

[8] Newtonian mechanics employs two conceptually distinct mass properties, inertial mass and gravitational mass. As a matter of empirical fact, an object's inertial mass and its gravitational mass are always equal, though nothing in Newtonian mechanics itself requires this. For an account of the relation between inertial and gravitational mass, see Weatherall (2011). In what follows, we consider only Newtonian inertial mass, and henceforth drop the qualifier 'inertial.' (Thanks to an anonymous reviewer for the reference and for suggesting we clarify this point.).

[9] Thanks to two anonymous referees for pushing us to address this argument.

[10] See, e.g., Swoyer (1982), and Kistler (2002). Some structuralists—e.g., Shoemaker (1998)—take properties to be individuated by causal roles, or a mix of causal and nomological features—Berenstain (2016). As far as we can see, our argument can be modified to apply to those versions of structuralism, too.

different properties in relativistic worlds than in Newtonian worlds. We note, too, that structuralism and contingentism are odd—even uncomfortable—bedfellows: Swoyer (1982) and Kistler (2002), for example, both argue from structuralism to the claim that natural laws are metaphysically necessary. But there is also a response that lets us side-step debates about structuralism and contingentism: we contend that there is no common nomological role for Newtonian mass across both Newtonian and relativistic worlds; thus, even if we assume both structuralism and contingentism, there's no one property—*having Newtonian mass*—that's fundamental/perfectly natural in some worlds and non-fundamental/less-than-perfectly natural in others.[11]

In the actual world, the theory of relativity governs (non-Newtonian) rest mass. Newtonian mechanics is valid only in the low-energy limit (viz., in the presence of only weak gravity and at velocities much lower than the speed of light), where rest mass is approximated by Newtonian mass. In the actual world, then: (i) Newton's laws, the laws 'directly' governing Newtonian mass, apply only in particular, circumscribed conditions, and (ii) Newtonian mass is nomologically connected to (non-Newtonian) rest mass. Furthermore, (iii) relativistic effects show up even in the Newtonian limit: a spring will have higher Newtonian mass when stretched than when relaxed, a sealed container of gas will gain mass as it is heated, etc. To be sure, these changes are small—so small that they can, for most purposes, be neglected—but they are, nonetheless, there. In contrast, in a Newtonian world, none of (i)–(iii) hold: Newton's laws apply universally; Newtonian mass has no nomological connection to some more fundamental property; the Newtonian mass of a composite system will not change as energy is added to it—a spring will have the same mass whether stretched or relaxed. 'Newtonian mass,' then, has a very different nomological profile in Newtonian worlds than it does in relativistic worlds.[12] So, by the structuralist's own lights, the worlds must contain *different* properties. Thus, structuralism fails to support the claim that one and the same property may be perfectly natural in some worlds, but less-than-perfectly natural in others.[13]

This concludes our argument for (perfect) naturalness being such that every property that possesses it in one world must possess it in every world in which it is instanced—i.e., for the necessity of perfect naturalness.

[11] Note that this is different from the quidditistic response. The quidditist can accept that there is a common nomological role, defined by Newton's equations, that is filled in both Newtonian and relativistic worlds—she just insists that it is filled by different properties.

[12] Here's another difference between 'Newtonian mass' in relativistic and Newtonian worlds. Weatherall (2011: 429–32) argues that the observed equality between Newtonian inertial mass and Newtonian gravitational mass is, in fact, a law-like generalization that is explained by how Newtonian mechanics emerges as a limit case of General Relativity—gravitational mass, it turns out, just is inertial mass. Thus, in relativistic worlds, an object's inertial mass and gravitational mass *must* be equal because there's really only one property there. However, nothing in Newtonian mechanics itself entails this identity, or even that an object's inertial mass and gravitational mass be equal. And so, in worlds in which Newtonian mechanics is fundamental, the relationship is not constrained in this way, and the ratio of an object's inertial mass to its gravitational mass need not equal one.

[13] Cf. Hildebrand (2019: 166).

2 The Nomic Argument for Contingent Naturalness

The proponent of world-relative naturalness is likely to respond to the argument of §1 with the following—which is, to our minds, also the best argument going for contingent naturalness. Per Lewis, natural properties are intimately bound up with laws of nature.[14] Further, laws vary from world to world.[15] Finally, it seems possible that property P could be instantiated in both world w_1 and world w_2 while figuring in laws of the former but not the latter. Then, given the link between (perfect) naturalness and figuring in the laws, this suggests that it is possible for P to be natural with respect to w_1 but not w_2. Consequently, naturalness is in fact contingent.

This seems like a *prima facie* appealing case for the contingency of (perfect) naturalness. But consider a different, albeit related, question: do natural properties figure in the laws in every world in which they are instantiated? Reasoning roughly parallel to that in the previous section suggests that the answer is 'yes.' Let P be some supposedly natural property instantiated in worlds W_{P+} where it figures in the laws, and in worlds W_{P-} where it does not figure in the laws. Consider P^*, the union of the extensions of P in the worlds of W_{P+}. Arguably, P^* is a better candidate for (perfect) naturalness than P; after all, P^* figures in the natural laws everywhere it is instantiated, while P does not. If this is right, then, since P^* is natural in every world in which it is instantiated, naturalness isn't contingent after all.

This reply to the argument for contingency faces a question: which of P and P^* do the laws of worlds in W_{P+} *really* work on? The defenders of world-relative naturalness might simply insist that, though P and P^* are coextensive at every world in W_{P+}, only P is nomically relevant in those worlds. Alas, we are beginning to get mired in the issues of quidditism and Ramseyan humility that we tried to side-step above.[16] Before we're sunk too deeply, we'd like to offer a line of thought that might keep us out of this quagmire. One function of the natural properties is to serve as grist for the laws. But this isn't their *only* function. Importantly, natural properties also serve to ground objective similarities between objects—and not just intra-world similarities, but *inter*-world similarities, too. Recognizing this, the following seems possible: two objects, o_1 in w_1 and o_2 in w_2, are intrinsic duplicates and so share all of their natural properties, yet the laws of w_1 and w_2 differ such that some property (had by o_1 and o_2) figures in the former but not the latter. To accommodate such a possibility, we must allow natural properties to be instantiated even in worlds at which they do not figure in the laws.

Lewis (2009: 213) presents more-or-less the same argument just given, and calls natural properties that are instantiated at a world but aren't grist for its laws *idlers* at that world. Idlers pose all sorts of epistemological challenges—e.g., how are we to discover natural properties idling at our world if they don't exhibit law-like regularities?—but that does not speak against their metaphysical possibility. And the

[14] See Lewis (1973: 73–4; 1983: 366–8; 1984) and cf. Sider (2011: 16–7).

[15] Some philosophers argue that the natural laws are metaphysically necessary—see, e.g., Swoyer (1982) and Bird (2007). We are unconvinced, but those who are can simply accept the argument in §1.

[16] See Lewis (2009), as well as Locke (2012) and Baysan (2019).

possibility of idlers undercuts the above argument for the contingency of (perfect) naturalness. For if idlers are possible, then the link between naturalness and figuring in the laws is not tight enough to warrant the claim that the contingency of the laws entails contingency of naturalness. This is a happy result, given the conclusions of the previous section.

Of course, natural properties ought not be *completely* divorced from the laws. Allowing a natural property P that figures in the laws of no world whatsoever—i.e., that it is *impossible* for natural laws to operate on P—seems a bridge too far. It is difficult to conceive of an objective similarity—a joint in reality—that is not just nomologically inert but nomologically *immune*. Taking this into consideration, we tentatively endorse the claim that a property is natural if and only if it features in the natural laws of *some* world.[17]

Notably, Borghini and Lando (2015) raise an objection to a version of this proposal. Suppose that we have two perfectly natural properties G and F which are instantiated in worlds w_1 and w_2, and that F is idle in both worlds. Further, suppose that object o_1 has both G and F in w_1, while in w_2 object o_2 has G and F and o_3 just has G. Then, o_1 and o_2 are duplicates, though o_1 and o_3 are not, since they do not share all their perfectly natural properties—o_1 has, but o_3 lacks, F. But this result is, per Borghini and Lando, 'counterintuitive from the point of view of the natural sciences… since [F] does not play any role in the workings of these worlds. … intuitively, [o_1] and [o_3] should be duplicates…' (2015:111).

We must confess to not sharing this intuition: the two objects differ in their properties, so they are not duplicates. It is, of course, a big epistemic challenge to come to *know* they aren't duplicates. But this is just yet another epistemic issue thrown up by allowing for idlers, rather than a particular problem for our proposal. Since this epistemic issue does not by itself undermine the metaphysical picture, we do not feel overly threatened by this quirk.

The upshot is that accepting (a) that there is a link between (perfect) naturalness and appearing in the laws and (b) that laws are contingent, does not undermine the necessity of (perfect) naturalness. Together with the result from the previous sections, this suggests that we've got good reason for thinking that perfect naturalness is non-world-relative—just as Lewis needs it to be.

Acknowledgements Thanks to Bredo Johnsen, Jim Garson, Jessie Petricka, and the participants in the May 2019 *Modality and Fiction Workshop* at the University of Graz for helpful comments and discussion. Thanks, also, to our anonymous referees, whose feedback greatly improved the paper.

[17] Brown (2016: 257–258) has argued that some haecceities are perfectly natural. If this is right, our claim needs qualification: a *non-haecceitistic* property is natural if and only if it features in the natural laws of some world. A haecceitistic property is a unit class, a property had by exactly one object. Since haecceities are unit properties, they can't be the subjects of general laws.

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