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Humean Laws in an unHumean World

ABSTRACT: *I argue that an* unHumean *ontology of irreducibly dispositional properties might be fruitfully combined with what has typically been thought of as a* Humean *account of laws, namely, the* best-system account, *made popular by David Lewis (e.g., 1983, 1986, 1994). In this paper I provide the details of what I argue is the most defensible account of Humean laws in an unHumean world. This package of views has the benefits of upholding scientific realism while doing without any suspect metaphysical entities to account for natural law. I conclude by arguing that the Humean laws-unHumean ontology package is well placed to provide an account of objective, nontrivial* chances, *a famous stumbling block for the Humean laws-Humean ontology package developed by Lewis.*

KEYWORDS: chance, dispositions, laws, modality, ontology

Introduction

Contemporary debates about laws of nature have centered on a disagreement between two camps: the neo-Humeans and the anti-Humeans. Here I consider the option of combining some elements of the Humean view with some elements of the anti-Humean view. I suggest that we can be Humean about the laws, in the sense of having a metaphysically thin view of what it is for some proposition to constitute a law of nature, while also embracing a form of scientific realism according to which the world is irreducibly modal. The position is partly motivated by a desire to uphold scientific realism, which many have argued leads naturally to a view of the world as imbued with objective, irreducible modality, for example, Blackburn (1990) and Bird (2007). The position is also motivated by the belief that a thin view of laws is all that is needed once certain *unHumean* ontological elements are admitted (see Demarest 2017). Interestingly, then, the best account of laws might turn out to be one that combines elements of the Humean and the anti-Humean views that have for a long time been in fierce disagreement.

My discussion shall proceed as follows:

Section 1 provides some background on *Humean* laws and ontology in contrast with *unHumean* laws and ontology.

Section 2 anticipates a concern according to which it would be ill-motivated to combine Humeanism about laws with an unHumean ontology, and this in turn

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allows me to identify two desiderata for an account of laws deserving of the name '*best-system account*'.

Section 3 discusses Heather Demarest's excellent pass at combining a Humean account of laws with an unHumean ontology. I will argue, however, that Demarest's potency-BSA risks making the laws epistemically inaccessible to us.

Section 4 suggests a revision to Demarest's potency-BSA that, as I will argue, avoids skepticism *and* satisfies the desiderata identified in section 2.

Section 5 discusses a potential further benefit of my revised potency-BSA according to which it might evade the 'Big Bad Bug' (Bigelow et al. 1993) that afflicts Lewis's Humean laws-ontology package.

1. Background: Laws and Ontology

1.1 Humean Laws and Ontology

David Lewis made famous the combination of a neo-Humean ontology he called 'Humean Supervenience' and the best-system analysis of laws (BSA). I will briefly discuss these elements in turn.

> Humean Supervenience is named in honor of the greater [*sic*] denier of necessary connections. It is the doctrine that all there is to the world is a vast mosaic of local matters of particular fact, just one little thing and then another. (Lewis 1986: ix)

Lewis refers to the 'vast mosaic of local matters of particular fact' as the *Humean Mosaic*, and I shall use this terminology in subsequent discussion.

The basic properties countenanced by Humean supervenience are *categorical*, which means that no causal role is essential to them. The property *charge*, in our world, occupies a certain role; it confers upon its bearers a disposition to exert a force on other charged bodies in accordance with Coulomb's law. However, according to the categoricalist about properties, this role occupancy is thoroughly contingent. There are worlds in which *charge* confers no causal role at all and worlds in which it plays the role that we at the actual world associate with *mass*. It is these *categorical* properties of, or instantiated at, points and their spatiotemporal relations that make up Lewis's neo-Humean ontology.

Now imagine that God wanted to convey to us all the facts about the Humean Mosaic. To this end he might give us a big book that listed the spatiotemporal location of every fundamental property instance. But this would not be very useful for us insofar as we were interested in having the information readily accessible to our finite intellects. A better option might be to provide us with fewer, more general statements about the distribution of qualities throughout the Humean Mosaic, from which we could *deduce* additional information not explicitly given. Such a more informative systematization will have more basic statements, more *axioms* if you like. A simpler systematization will have fewer axioms but will sacrifice informativeness. Hence, the virtues of informativeness and simplicity of a system

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compete. According to the BSA, the fundamental laws are the axioms of this system that strikes the optimal informativeness-simplicity balance.

Balancing the virtues of informativeness and simplicity in this way will involve a collective consideration of the mosaic *as a whole*: 'An adequate analysis must be collective. It must treat regularities not one at a time, but rather as candidates to enter into *integrated* systems' (Lewis 1983: 367, my emphasis).

Adding to the system a statement such as 'all electrons are negatively charged' might increase complexity at little to no informative gain if this *regularity* followed from some more general statement of, say, quantum theory. The point is that the BSA treats regularities collectively as candidates to enter into an *integrated* system because matters of fact far beyond those concerning any given regularity or the participants in a regularity, considered in isolation, will be relevant to that regularity's status (or lack thereof) as a *law*. This is an important feature of the BSA to which I shall return in section 2 when I consider how a best-system account of laws in an *unHumean* world might be deserving of the name 'BSA'.

1.2 unHumean Laws and Ontology

Any ontology that admits modal properties or necessary connections that do not reduce to some nonmodal features of the ontology is unHumean. To illustrate the idea, I will briefly consider two quite different examples of unHumean ontologies: dispositional essentialism, for example, Bird (2007), and the nomic necessitation view, for example, Armstrong (1983).

According to dispositional essentialism, at least some fundamental properties are not categorical because they are *constituted* by their causal roles. The property *charge*, for example, just is, in all possible worlds, the disposition to exert a force on other charged objects in accordance with Coulomb's law—there is no possibility of *charge* switching roles with *mass* on this view. Hence, dispositional essentialists maintain that at least some properties are irreducibly modal.

Another quite different way in which Humean supervenience has been rejected is by Armstrong (1983; see also Dretske 1977; Tooley 1977), who maintains categoricalism about fundamental properties but introduces primitive necessitation relations between universals to account for laws. On this account, laws of the form 'all *F*s are *G*s' are analyzed in terms of a necessitation relation, *N*, that in this case holds between the universals *F* and *G*. The fact that the higher-order universal, *N*, connects the universals *F* and *G* is what makes it a *law* that all *F*s are *G*s, on this account.

In each case, giving up Humean supervenience is closely connected to the provision of a non-Humean account of laws. Dispositional essentialism grounds the laws in irreducibly modal properties and the nomic necessitation view analyses the laws in terms of primitive necessary connections between universals.

Among the positions outlined, two broad conceptions of natural law have been employed: a *governance* conception and a *codification* conception. Armstrong's nomic necessitation view is a governance conception. It conceives of the laws as imposed 'pushers and pullers' of the *stuff* in the world. By contrast, the BSA conceives of the laws as merely codifying matters of fact. The laws, according to the

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BSA, have no prescriptive power over events, rather they describe, in a particularly efficient way, what goes on in the universe. Dispositional essentialism might also be understood as a codification conception; on this view, the laws *describe* the dispositional essences of properties and what this implies for the behaviors of their bearers.

2. A Concern About Motivation

To uphold the thesis of Humean supervenience is to maintain that *everything* supervenes on the arrangement of categorical properties at points and the spatiotemporal relations between them. Within the scope of 'everything' in the previous sentence are facts about the laws of nature. The BSA is plausibly understood as Lewis's attempt to reconcile the appearance of necessity in nature, in the form of natural laws, with the claim that all facts, including those about laws, supervene on a sparse base that is absent any necessary connections or primitively modal properties. Lewis develops Ramsey's idea that the laws are: 'consequences of those propositions which we should take as axioms if we knew *everything* and organised it as simply as possible in a deductive system' (Ramsey 1990: 150, my emphasis). Lewis modifies Ramsey by replacing 'everything' with 'as much of everything as admits of simple organization', otherwise everything would count as a law (Lewis 1994: 478). The crucial idea is that, according to the BSA, the laws take into account facts about the mosaic considered collectively so that they may *describe* it in a way that best balances the virtues of simplicity and informativeness.

If, however, one were to admit primitive modalities into one's ontology, then it might seem unclear why one would—or indeed how one *could*—also defend a *Humean* account of laws, like the BSA.

There are two distinct strands to this motivation concern:

1. Why *bother* with the BSA once primitive necessary connections are admitted, which seem capable of doing the work of accounting for laws?
2. Why think that the laws should form parts of an *integrated* systematization of the mosaic once primitive modalities are admitted?

Regarding (1), the objector I have in mind here is one with the intuition that laws *govern*, as opposed to codify, matters of fact in the universe. That this is a widespread intuition is evidenced in Beebee's (2000) survey of certain critiques of the BSA, which she argues miss the mark by failing to understand that the BSA is a *non*-governance conception of law. Furthermore, Mumford (2004) takes the lack of a governance role for laws as evidence for the claim that there are no laws. The nomic necessitation view of Armstrong (1983) is a paradigm governance view of laws. Armstrong sacrifices Humean supervenience and provides the laws with a governing role with the introduction of necessitation relations between universals. Now if one were of the belief that the laws governed, then

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it might seem odd to admit happily unHumean *whatnots* (to use Lewis's phrase) but not the right *whatnots* to yield a governing role for laws. In other words, the proponent of governance might wonder why, if Humean Supervenience is surrendered, Armstrongian 'pushers and pullers' would not be admitted to account for the laws. Now this would constitute a significant departure from the BSA, which is a codification conception, but the motivation concern is a challenge to say why or how the essence of the BSA should be preserved given an unHumean ontology.

The thought behind (2) is that once irreducibly modal properties are admitted, there would be no need (or scope) to think of the laws as forming parts of an *integrated* system because they would follow from particular property instances considered in *isolation* from the rest of the universe. Recall that dispositional essentialism gives up Humean supervenience by admitting properties with a dispositional essence. The laws, on this view, then hold in virtue of these dispositional essences. Very roughly, the property *charge*, for example, will imply certain conditionals. For example, a charged object will be such that *if* it were in close proximity to another charged object (stimulus), then it would exert a force that is proportional to the magnitude of the two charges and inversely proportional to the square of the distance between them (manifestation). Since this generalizes, that is, *for any* individual x, if it is charged, it will yield a certain manifestation given a certain stimulus condition, the result is a universal statement of *law* that is grounded in the dispositional essence of the property charge (Bird 2007: 46). As it is the essential nature of the property *charge* that is doing all the work here, it follows that any particular instance of charge, considered in isolation, will suffice to ground the associated Coulomb's law. Coulomb's law just says that the property *charge* is such that *P,* and this fact about the nature of charge means that no more than the instantiation of a single instance of charge is required for Coulomb's law to prevail.

Armstrong gives up Humean supervenience with the introduction of necessitation relations between universals—primitive necessary connections. An account of laws is then given in terms of *these* unHumean whatnots according to which if it is a law that all *F*s are *G*s, then there is a higher order universal that *connects* the *F*s and the *G*s, that is, one that makes it the case that if something is F, then it is also G. But again, the unHumean elements of the ontology seem apt to account for the laws independently of much else of what goes on in the universe. The necessitation relations, the *N*s, considered in isolation suffice to account for the laws.

On both the dispositional essentialist and the nomic necessitation account, the unHumean elements of the ontology suffice to account for the laws independently of vast swathes of the mosaic. The laws, on these accounts, are thus not *integrated* in the BSA sense.

The motivation concern for an account of Humean laws in an unHumean world is a challenge to say how to understand the laws such that they form an *integrated description* of the unHumean mosaic so that the view can be deserving of the name 'BSA'.

To allay the concerns expressed in (1) and (2), I suggest that a Humean account of laws ought to satisfy the following desiderata:

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> **C**(odification): The laws should be understood as descriptive, not prescriptive.
> **I**(ntegration): The laws should form an integrated systematization of the *mosaic* in the sense that *as much of everything as admits of simple organization* should be relevant to any given law's status as a law.

Any account of laws that failed to satisfy **C** and **I** would not really deserve the name 'BSA' because it would stray too far from the letter of Lewis's development of Ramsey's idea that the laws are 'consequences of those propositions which we should take as axioms if we knew *everything* and organised it as simply as possible in a deductive system' (Ramsey 1990: 150, my emphasis).

C is satisfied quite naturally given an unHumean ontology of properties with dispositional essences. The laws might be understood as *codifying* the behaviors produced by dispositions. All of the explanatory work done by a governance conception of laws can be done by the dispositional properties themselves. And since the dispositions are not *themselves* laws, the laws are best thought of as summaries of the behaviors produced by the dispositional properties. For this reason, insofar as I am interested in defending an account of Humean laws in an unHumean world, I am justified in confining my attention to the type of unHumean ontology posited by the dispositional essentialists as opposed to that posited by Armstrong. The former ontology, but not the latter, lends itself quite naturally to a codification conception of natural law and, as discussed, for an account of law to deserve the name *Humean*, it ought at least be a codification conception.

Whereas **C** seems quite easily and naturally satisfied, the real thrust behind the motivation concern is in the difficulty of satisfying **I**. I will talk more about satisfying the desiderata in section 4, but as a prelude I turn to a discussion of Heather Demarest's potency-BSA, which shall form the basis for my revised potency-BSA. It might appear that my work has been done by Demarest. I will argue, however, that Demarest's account requires modification because it risks rendering the laws completely epistemically inaccessible. With the additional details of my revised potency-BSA I will be able to overcome the concern raised for Demarest and I will be in a better position to say in more detail how the desiderata identified above can be satisfied.

3. Demarest's Potency-BSA

Demarest's unHumean ontology is similar to the dispositional essentialist's in that it consists of *potencies—fundamental* properties with a dispositional essence (see Bird 2007: 45). Potencies can be understood as modal analogues of Lewis's 'perfectly natural' properties. Central to Demarest's potency-BSA is the idea that the laws at a world, w, systematize actual and *possible* distributions of those potencies instantiated at w:

> **Potency-BSA:** The basic laws of nature at w are the axioms of the simplest, most informative, true systematization of all w-potency-distributions, where a w-potency-distribution is a possible distribution of only potencies appearing in w. (Demarest 2017: 49)

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Demarest argues that systematizing *possible* potency distributions constitutes no additional cost because primitively modal properties have already been admitted into the ontology (2017: 49). Furthermore, she argues that by systematizing other relevant possible worlds, the potency-BSA avoids the *impoverished world objection*.

According to the impoverished world objection, the traditional BSA yields counterintuitive results about the laws of nature at 'impoverished' worlds. The objection considers a world, call it *i*, whose sole inhabitant is a single massive particle travelling inertially for all time. Now according to the BSA, it is a *law* at *i* that all massive particles always travel inertially. But this seems wrong, so the objection goes, because intuitively it is *not* a law that all massive particles always travel inertially at the impoverished world because *if* there were a second massive particle, then the two would accelerate toward each other.

Setting aside concerns about how convincing the impoverished world objection is, I note for now just that *one* of the reasons Demarest offers in favor of her potency-BSA is that it can offer a response to this objection. Furthermore, the details of Demarest's response shed additional light on her view:

> Consider, again, a world with a single massive particle, traveling inertially for all time. The laws of this world will systematize not just this world, but all worlds that contain mass. Therefore, it will be a law that all massive particles attract each other, and NOT that they always travel inertially. (2017: 51)

Inhabitants of an impoverished world would be unable to *arrive* at a correct account of the laws because they would be in a kind of skeptical scenario. Similarly, if our world turned out to be impoverished, we too would be in a skeptical scenario and so unable to know the laws. But this is acceptable, Demarest suggests, because there should be no guarantee that the laws are epistemically accessible. I argue, however, that the potency-BSA faces a more pressing skeptical worry.

3.1. A Skeptical Worry

Call a world, *w**, *relevant* to the laws at a distinct world, *w*, iff some element of *w** partly determines *w*'s laws. Thus, if the distribution of, say, *mass* at a world *w1* is systematized by the laws of *w2* because *mass* is instantiated at both, then *w1* is relevant to the laws at *w2*.

To highlight the skeptical worry, I will consider *which* worlds Demarest's potency-BSA deems relevant to the laws at a given world. Consider a simple world, *w0*, at which just *mass* and *charge* are instantiated. I will denote the situation like this: *w0*(mass, charge). According to the potency-BSA, the laws of *w0* systematize all *w0*-potency distributions, where a *w0*-potency distribution is a possible distribution of only those potencies appearing in *w0* (Demarest 2017: 49). The laws of *w0* are thus partly determined by the distributions of *mass* and *charge* at worlds other than *w0*. Hence, worlds other than *w0* are *relevant* to *w0*'s laws. For all that has been said, *four* options for the range of worlds relevant to the laws of *w0*(mass, charge) can be discerned:

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Option 1: worlds with *all* the potencies found at *w0*. This would include worlds with some potencies *alien* to *w0* and would omit worlds lacking potencies instantiated at *w0*. For example, *w1* would be included *w1*(mass, charge, schmass), but not *w2*(mass).

Option 2: Worlds with *only* the potencies found at *w0*. This would rule out worlds with alien potencies and include worlds absent some potencies instantiated at *w0*. For example, *w2* would be included, but not *w1*.

Option 3: Worlds with *all and only* those potencies found at *w0*. This rules out worlds with potencies that are alien to *w0* and worlds absent any potencies instantiated at *w0*. For example, *w3* (which has the same potency instances as *w0*, though those potency instances might be differently distributed) would be included *w3*(mass, charge), but *w2* and *w1* would not.

Option 4: Worlds with *some* of those potencies found at *w0*. This just rules out worlds that are absent all of the potencies instantiated at *w0*. For example, *w1, w2,* and *w3* would be included, but not *w4*(schmass, schmarge).

I suggest that Demarest may be interpreted as endorsing either option 2 or option 4. Option 4 seems to follow from Demarest's explicit statement of the potency-BSA (2017: 49) as well as perhaps from her response to the impoverished world objection (2017: 51). Saddling Demarest with option 4, however, might seem less charitable, since radical skepticism about the laws quickly follows from this option. Hence, the potency-BSA could at least benefit from clearer articulation to avoid this interpretation. As it happens, however, option 2 also faces a skeptical worry via a subtler route. I will discuss these different interpretations (and the skeptical threat to each) in turn before proposing a revision to the potency-BSA that avoids these problems and satisfies the desiderata identified in section 2.

Demarest is clear that the laws of a world, *w*, are unconcerned with possible distributions of potencies *alien* to *w*: 'The basic laws of nature at *w* are the axioms of the simplest, most informative, true systematization of all *w*-potency-distributions, where a *w*-potency-distribution is *a possible distribution of only potencies appearing in w*' (2017: 49, my emphasis). However, it cannot be inferred from this that only those worlds containing just the same potencies as *w0*(mass, charge) are relevant to *w0*'s laws because among the possible distributions of *mass* are those distributions of mass at worlds where, for example, *schmarge* is instantiated too.

Moreover, consider Demarest's response to the impoverished world objection: 'Consider, again, a world with a single massive particle, traveling inertially for all time. *The laws of this world will systematize not just this world, but all worlds that contain mass*' (2017: 51, my emphasis). Relative to the impoverished world, potencies found at the actual world: charge, spin, etc., are alien, but Demarest seems to imply that the laws at the impoverished world nonetheless concern the distribution of mass at the actual world because 'the laws of this world will systematize . . . all worlds that contain mass' and the actual world contains mass. On this reading, it seems that for Demarest all worlds with at least *some* of the potencies found at a world, *w*, are relevant to the *laws* at *w*, which is option 4.

Skepticism about the laws quickly follows because inhabitants of *w0*(mass, charge) could not possibly know how *alien* potencies, like *schmass*, would affect the

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distribution of *w*o-potencies, namely, *mass* and *charge*, so they could not possibly come to know all *w*o-potency-distributions, the best systematization of which determines the *laws* at *w*o. The problem generalizes and makes the actual laws unknowable too. In essence, the problem is this: at worlds with alien potencies, familiar potencies, like *mass* and *charge*, might behave very differently. We, at the actual world, cannot know how alien potencies will affect the distribution of, for example, *mass* and *charge*, so if the actual laws concerning *mass* and *charge* are supposed to systematize their distributions in the presence of alien potencies, we cannot know the laws. It is plausible, however, that we possess all sorts of knowledge about natural laws, or are at least in theory capable of acquiring such knowledge, so we are justified in rejecting any metaphysical view that would imply otherwise.

Alternatively, Demarest's definition of a *w*-potency distribution as 'a possible distribution of only potencies appearing in *w*' might be interpreted to mean a distribution of *all* the potencies at some possible world, *w**, where the only potencies found at *w** are potencies that are also found at *w*. On this reading, the distribution of *mass* at a world containing *schmass* would not be a *w*o-potency distribution, where *w*o(mass, charge). But distributions of *mass* at worlds with just *mass*, for example, as well as other possible distributions of *mass* and *charge* at worlds with no other potencies besides, would count as *w*o-potency distributions. On this interpretation, Demarest goes for option 2. Accordingly, when Demarest writes, regarding the impoverished world: 'The laws of this world will systematize . . . all worlds that contain mass', she must be read as speaking elliptically for 'all worlds that contain only mass'. If this were the intended interpretation, I would suggest the following modification to the definition of the potency-BSA:

> **Potency-BSA*:** The basic laws of nature at *w* are the axioms of the simplest, most informative, true systematization of all *w*-potency-distributions, where a *w*-potency-distribution is the distribution of all the potencies at a world, *w**, where *w** contains no potencies alien to *w*.

However, just as the distribution of *mass*, for all we know, might be radically unfamiliar at worlds where *schmarge* is instantiated, for all we know, the distribution of *mass* might be radically unfamiliar at worlds *absent*, say, *charge*. We inhabit a world where both *mass* and *charge* are instantiated (as well as other potencies), and in our world *mass* is distributed as it is, and we can make certain inferences about the possible distributions of *mass*. What we cannot know, I suggest, is how the absence of *charge* at a world would affect the behavior of masses, and this imposes a restriction on the range of possible *mass* distributions that we are able to know.

This concern is driven, in part, by reflection on the apparent fine-tuned-ness of the universe. It is often suggested that had certain fundamental physical constants been even slightly different, a radically different universe would have resulted; one without any carbon-based life or even any coalesced matter, perhaps:

> If the strength of gravity were smaller or larger by an estimated one part in 10^{60} of its current value, the universe would have either exploded too

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> quickly for galaxies and stars to form, or collapsed back on itself too quickly for life to evolve. (Collins 2009: 215)
>
> Had the boundary conditions in the initial seconds of the big bang, and the values of various fundamental constants differed ever so slightly, we would not have had anything like a stable universe in which life could evolve. (White 2000: 260)

But if minor tweaks to physical constants would result in such a radically different universe, it seems plausible that a *big* change—the omission of a ubiquitous fundamental potency, such as *charge*—might result in a world that is utterly unrecognizable. These considerations might reasonably inspire a distinct lack of confidence in our ability to *know* much at all about what such worlds would be like, including with respect to, say, how *mass* is distributed. It is better, then, not to allow those likely *unknowable* possible distributions of *mass* in such radically different worlds to be relevant to the actual laws.

It might be responded that given the success science has enjoyed when it comes to isolating potencies from each other, we, at the actual world, *can* be confident in our ability to make inferences about the possible behavior of, say, massive bodies in the absence of charges. But aside from the physical implausibility of the idea that we might completely isolate mass from charge, we cannot ever make it the case that *mass* is instantiated in a *world* where *charge* is uninstantiated and that we are there to observe the results. The skeptical concern is not that masses might behave oddly when isolated under lab conditions from the effects of *charge* at a world in which *charge* is nonetheless instantiated. The worry is that masses might behave oddly when instantiated in a world at which *charge* is *nowhere* instantiated—call this an *S*-type hypothesis. No lab can create these conditions; we are all world-bound.

There may be a temptation to dismiss *S*-type hypotheses as no more problematic than run-of-the-mill external world skepticism. However, *S*-type hypotheses are of a very different kind from run-of-the-mill skeptical hypotheses. A typical run-of-the-mill skeptical attack on knowledge argues that since I cannot know I am not a brain-in-a-vat (BIV), I cannot know all sorts of things about the *actual world*, such as that I have hands, because having hands is inconsistent with being a BIV. *S*-type hypotheses, by contrast, do not threaten our knowledge of the actual world; they threaten our *modal* knowledge. The fact that I cannot rule out the hypothesis that *mass* is distributed very strangely in worlds absent *charge* limits what I can know about other possible worlds. Furthermore, reflection on the apparent fine-tuned-ness of the universe provides *S*-type hypotheses with at least some prima facie plausibility not enjoyed by, say, the run-of-the-mill skeptical hypothesis that I am a BIV.

Given these differences, responses to run-of-the-mill skepticism should not be expected to be effective against the skeptical threat posed by *S*-type hypotheses. Consider, for example, a typical externalist response to run-of-the-mill skepticism (e.g., Nozick 1981), according to which a belief counts as knowledge just in case it is true and it tracks the truth at nearby worlds. Assume that I inhabit the actual, non-BIV-world and that I have a true belief that I have hands. This belief counts as *knowledge* because in nearby worlds in which I am handless (perhaps due to some

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unfortunate accident) I do not believe that I have hands and in nearby worlds where I do have hands I believe that I do. Sure, my belief would fail to track the truth at the BIV-world, but knowledge does not require truth-tracking at such *distant* worlds, on this account. This type of response justifies the dismissal of run-of-the-mill skeptical hypotheses by showing them to be *compatible* with much of my knowledge as well as by emphasizing the fact that run-of-the-mill skeptical hypotheses themselves enjoy no prima facie plausibility for being so *distant*.

No such response is available to the threat posed by *S*-type hypotheses. It is consistent with my having hands that, say, *mass* is distributed very strangely in worlds absent *charge*. Thus, it does nothing to quell the skeptical threat of *S*-type hypotheses to show that everyday knowledge of the actual world is consistent with our inability to rule them out. Furthermore, and as mentioned above, *S*-type hypotheses enjoy at least some prima facie plausibility once we reflect on the fine-tuned-ness of the universe. Unfortunately, I lack the space here to survey all possible responses to run-of-the-mill skepticism. But plausibly the point will extend to other responses given the very different kind of threat posed by *S*-type hypotheses compared with that posed by run-of-the-mill skeptical hypotheses and given the fact that the former, but not the latter, enjoy at least some prima facie plausibility. I thus take these considerations to show that *S*-type hypotheses should not be immediately dismissed as on a par with run-of-the-mill skepticism.

On the other hand, it might be argued that the skepticism ushered in by *S*-type hypotheses, if accepted, proves too much; for ought we, at the actual world, not also think that we cannot know how *mass* would behave at a world absent, say, Bill Clinton (BC)? The obvious response is that we have lots of evidence to suggest that the distribution of *mass* is completely independent of BC, and hence it seems reasonable to infer that the distribution of mass would be unaffected by his absence. Of course, we cannot rule out the logical possibility that BC's existence plays some key role in the law concerning *mass*, but this hypothesis deserves being taken no more seriously than Russell's teapot.

So why not employ a similar answer when *charge* is substituted for BC? (Of course, to do so would undermine my argument above.) Well, I note first there is a weak sense in which BC *is* relevant to the law concerning *mass*. Insofar as BC is composed of massive particles, he is relevant to the overall cross-world distribution of *mass* and hence the mass-law. But BC's negligible contribution to the distribution of *mass* is plausibly far from pivotal to the *robustly* best system of which the law concerning *mass* is an axiom. Whereas worlds absent BC would differ negligibly from the actual world, worlds absent any instances of *charge* whatsoever would be radically different from actuality. It seems at least plausible that in such a radically different world the distribution of *mass* would be significantly affected, and it is this prima facie plausibility that is lacking in the cases of hypotheses about BC and Russell's teapot. *Charge* is a ubiquitous, *fundamental*, potency. The concern is really that the possible distributions of ubiquitous fundamental potencies might be more tightly entwined than we could ever know. It would be a quite different matter to claim that any individual whatsoever might have some crucial, yet unobservable, impact on the possible evolution of the universe. BC is not a ubiquitous fundamental potency and so cannot be substituted for '*charge*' in, for example, the hypothesis

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that we cannot know how *mass* would behave in a world absent *charge* without significantly altering the claim.

Thus, I suggest taking option 3, which avoids the skeptical problems by rendering only those worlds instantiating all and only the potencies instantiated at *w* relevant to *w*'s laws. But if for all that has been said you remain unconvinced, I offer one final consideration in favor of this option. Either *S*-type hypotheses pose no skeptical threat, for whatever reason, so we can embrace option 2: worlds with *only* those potencies found at *w* are relevant to *w*'s laws. Or *S*-type hypotheses are a threat and to ensure the epistemic accessibility of the laws we should go for option 3: worlds with *all and only* those potencies found at *w* are relevant to *w*'s laws. In a Pascal's Wager-type move, I suggest that unless we can be completely certain that *S*-type hypotheses pose absolutely no threat, we should go for option 3. This is because we stand to lose relatively little, perhaps even nothing, by choosing option 3 over option 2—maybe the laws of a world, *w*, will be slightly less informative than they might have been because they will systematize fewer possibilities. However, if we go for option 2 and it turns out that *S*-type hypotheses are problematic in the way described, we lose all epistemic access to the laws (which would plausibly count as *infinitely* bad in the context of an analysis of laws!). We cannot be absolutely certain that *S*-type hypotheses pose no threat whatsoever; we can only have perhaps a relatively high degree of *confidence* that they are unthreatening, and therefore option 3 is best.

In the next section I suggest a revision to the potency-BSA that guarantees to avoid skepticism about the laws and that, as I shall argue in 4.1, can satisfy the desiderata set out in section 2.

4. The Revised Potency-BSA

Demarest's potency-BSA makes the innovative leap of systematizing a range of possible worlds. The skeptical concern arises, however, because *too many* worlds are systematized. My suggestion is thus to systematize *fewer* worlds.

Of the four options for the range of worlds deemed relevant to the laws at a given world, *w*, I suggest option 3: just those worlds at which all and only the potencies instantiated at *w* are instantiated. Hence, I propose the following:

> **Revised Potency-BSA:** The basic laws of nature at *w* are the axioms of the simplest, most informative, true systematization of all *w*-potency-distributions, where a ***w*-potency-distribution** is a distribution of only potencies appearing in *w* **at a world instantiating all and only those potencies instantiated at *w*.**

By truncating the range of worlds deemed relevant to the laws at a given world, *w*, in this way, the skeptical concern is avoided. We cannot know how actual potencies, such as *charge*, will be distributed in worlds instantiating alien potencies or how they will be distributed in worlds that are absent actual potencies, but

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according to the revised potency-BSA such possibilities are irrelevant to the actual law concerning *charge*.

4.1 Satisfying the Desiderata

The laws at *w*, according to the revised potency-BSA, are a function of the *modal profiles* of all and only the potencies instantiated at *w*. In this subsection I shall say more about how to understand the term 'modal profile' in the course of gesturing at how the revised potency-BSA might be thought to satisfy the desiderata outlined in section 2.

I will define the modal profile of a potency, *P*, as the range of properties with which *P* is possibly *coinstantiated* by a property-bearer. In possible worlds talk, the modal profile of *P* will determine, for any property *X*, if there is a world, *w*, at which some individual, *x*, instantiates *P* and *X*. Since the definition does not specify that *X* is fundamental or *sparse*—*X* could stand for a conjunctive property—it captures the idea that the modal profile of *P* has to do with possible *combinations* of properties with which *P* is coinstantiated by a property-bearer. Furthermore, since the definition does not rule out that the *X*s with which *P* is possibly coinstantiated are *extrinsic* properties—they might be relational—it captures that *P*'s modal profile determines how instances of *P* might possibly be *distributed* in space and time. A particular brick, for example, might coinstantiate *toughness* and *redness*, but the brick might also instantiate such extrinsic properties as *being in a wheelbarrow* or *forming part of the foundations of a house*. In other words, the property *toughness* is possibly coinstantiated with the extrinsic property *forming the foundations of a house*. The modal profile of the property *toughness* allows for such possibilities. Similarly, the potency *electric charge*, in virtue if *its* modal profile, is possibly coinstantiated with the property of *partially constituting an atom of carbon*—electrons, for example, instantiate electric charge and can also instantiate the extrinsic property of *partially constituting an atom of carbon*.

The laws at *w* are thus a *function* of the modal profiles of all and only those potencies instantiated at *w*, according to the revised potency-BSA. The laws are efficient summaries of the facts about possible distributions of those potency instances, where the possible distributions of potencies at *w* are determined by those potencies' modal profiles. I propose an explanation of what it is for a potency to figure in some *distribution* in terms of the properties, including extrinsic properties, with which it is coinstantiated. For a given world, *w*, we thus have a hierarchical grounding structure at the base of which we find the potencies, with their irreducible modal profiles. These modal profiles then ground the possible distributions of the *w*-potency instances, which in turn ground the laws because the *w*-laws are summaries of the possible distributions of the *w*-potency instances that best balance the virtues of informativeness and simplicity.

I can now articulate more precisely how the revised potency-BSA satisfies **C**. Given a world of potencies, fully capable of 'pushing and pulling' things around, or *determining their own distributions*, in accordance with their *modal profiles*, there would seem to be no need for additional governing laws. The revised potency-BSA satisfies **C** because it says that the laws at *w* are the axioms of the system that

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best balances the virtues of informativeness and simplicity in its effort to convey all of the information about the distributions of the *w*-potencies in all possible worlds at which all and only *w*-potencies are instantiated. The potencies themselves might be thought to do some 'pushing and pulling' because their modal profiles metaphysically *determine* their possible distributions, but the potencies are not laws; the laws are features of a *description* of the possible distributions of those potencies that best balances the virtues of informativeness and simplicity.

The tougher task faced by any account of Humean laws in an unHumean world is that of satisfying **I**. Recall that according to dispositional essentialism, *dispositional essences* have an irreducible modal character that suffices to ground the laws *independently* of swathes of the fundamental mosaic; desideratum **I** is not satisfied by dispositional essentialism.

In order to satisfy desideratum **I**, the revised potency-BSA must understand the laws *not* as codifying the essences of particular potencies considered in isolation, as dispositional essentialism would have it, but as codifying the possible *distributions* of all potency instances. As we have seen, it is the potencies' modal profiles that carry implications for their possible distributions because a potency's modal profile determines the range of properties with which it is possibly coinstantiated, including the distributions in which it can (metaphysically possibly) feature. Thus, talking in terms of modal profiles, as opposed to dispositional essences, facilitates discussion of the present account of laws according to which the *w*-laws are parts of an efficient integrated description of the possible arrangements of the *w*-potencies.

Crucially, the possible distributions of *w*-potencies across worlds instantiating all and only the *w*-potencies will have to do with the *w*-potencies considered *collectively*. The distribution of *w*-potencies across possible worlds will be determined by the various possible *interactions* between potency instances. The thought can be illustrated with a macroscopic example. Consider a vase encased in formaldehyde. Among the possible distributions of the stuff in a world, $w1$, that included vases and formaldehyde, there might be very few possibilities in which a vase encased in formaldehyde at one time, $t_{earlier}$, is then shattered at a later time, t_{later}, but in which there is no time between $t_{earlier}$ and t_{later} at which the vase is not encased in formaldehyde. Put more simply, the point is that the possible *interaction* between the vase and the formaldehyde restricts how those things could possibly be distributed in space and time. In very few possibilities does an unbroken vase become broken in a time span in which it is encased in formaldehyde. Plausibly, fundamental potencies, *charge*, *mass*, etc., will exhibit analogous interactions. The *w*-laws of the revised potency-BSA thus respect desideratum **I** by summarizing all the information about possible configurations of *w*-potency instances in a manner that accounts for the various possible interactions between the *w*-potencies. To capture this information best, we need to 'zoom out', so to speak, to understand how the various potencies at a world, with their modal profiles, can possibly interact. No potency, or indeed cluster of potencies, considered in isolation from the entire distribution of potencies at a world could suffice to ground the laws on this view; hence **I** is satisfied.

I have said that potency instances will interact in various ways determined by their modal profiles. One way in which potencies might interact is by *masking* each

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other. The modal profile of the potency *charge* is such that distinct instances of charge can exert a force on each other. But this ability to exert a force conferred on an instance of charge, *e*, might be masked if extrinsic factors conspire to make it the case that *e* never manifests this ability. This is supposed to be analogous to the way in which wrapping a vase in bubble wrap *masks* its disposition to break. It would seem to follow that there is at least one possible world at which all and only those potencies instantiated at the actual world are instantiated and at which the instances of charge have their ability to exert a force on other instances of charge in accordance with Coulomb's law consistently masked. At this world, it so happens that distinct instances of charge never instantiate the property of exerting a force on each other in accordance with Coulomb's law because something always gets in the way, so to speak. Why, then, should Coulomb's law be an *axiom* of the best systematization of the possible distributions of all and only the potencies at the actual world? The answer comes, I suggest, from reflection upon the *ceteris paribus* nature of laws. It is implicit in the formulation of Coulomb's law (and other laws) that intervening factors are absent. All Coulomb's law says *explicitly* is that separated charges exert a force on each other proportional to the magnitude of their charge and inversely proportional to the square of the distance between them. What is left *implicit* is that this is only the case in the absence of, say, a nearby black hole or indeed of anything else that may negate the tendency of charged individuals to interact in accordance with Coulomb's law. What Coulomb's law tells us, on the current conception, is that in the absence of intervening factors, that is, *ceteris paribus*, charged bodies will interact in this and that way. Coulomb's law so conceived seems like a good candidate for entering into a strong, simple systematization of the possible distribution of all and only the potencies in the actual world, and hence it seems to be a good candidate for a *law* even given its *ceteris paribus* nature. Indeed, it really should count as a *benefit* of the present account that it accommodates the *ceteris paribus* nature of natural laws.

The laws, on this account, form parts of an *integrated description* of possible potency arrangements; desiderata **C** and **I** are satisfied. No potency instance considered in isolation can suffice to ground any law because the laws at a world, *w*, are the axioms of the best systematization of the possible interactions *between* the totality of potency instances at *w*. Possible arrangements of all and only the potencies at *w*, which are *systematized* as part of the revised potency-BSA, depend not on potency instances considered in isolation, but rather on the potency instances at *w* considered *collectively*.

5. Chance

Finally, I want to consider how the revised potency-BSA might handle objective chance—a notorious stumbling block for the Humean laws-ontology package. In a nutshell, the problem is that the traditional BSA assigns nontrivial chances to futures that would undermine those very chances. In this section, I will look in more detail at how this odd result arises before discussing how the revised potency-BSA might do better.

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According to the *Humean* best systems analyst, facts about *chances*, like all other contingent facts, must be made true by some feature(s) of the Humean mosaic. What is more, by Lewis's Principal Principle (PP), which says that an individual's credence in a proposition given the chance of that proposition and any *admissible* evidence ought just to equal the chance, these 'chancemaking' features must be the sorts of things that, if known, could constrain rational credence (Lewis 1994). After considering, and dismissing, symmetries and frequencies as the fundamental chancemakers (symmetries can be defeated by frequencies, but frequencies cannot account for single-case chances of a unique kind, nor can finite frequencies yield irrational chances), Lewis suggests that single-case chances follow from general probabilistic *laws of nature* (Lewis 1994: 478).

Just as 'charged bodies exert a force on all other charged bodies' may be an axiom of the best system and hence a law, so might 'tritium has a half-life of 12.3 years'. The latter 'law' is probabilistic in the sense that it implies, for any given tritium atom, that it will have a 50 percent chance of decaying in a 12.3-year time interval. Where previously the BSA was just concerned with trading off strength and simplicity, with the introduction of probabilistic laws comes a new criterion that must be balanced: fit. A systematization will fit a world, w, better to the extent that it assigns a higher chance to the entire history of w.

The BSA treatment of chance simply says that the chances are what the laws of the system that strikes the best balance between strength, simplicity, and fit say they are. Assuming 'tritium has a half-life of 12.3 years' is a law, given these criteria, it will also be true that a particular tritium atom has a 50 percent chance of decaying in a 12.3-year time interval, and this fact will be made true by the Humean mosaic in the desired way.

Chances thus supervene on the entire 4-D mosaic of matters of particular fact, past, present *and future*. This means that different futures will determine different present chances. To see the 'bug', reconsider the law that says tritium has a half-life of 12.3 years and the associated single-case chances that this law projects. This probabilistic law and the single-case chances projected are consistent with a future in which vastly more tritium atoms come into existence than have existed thus far (maybe due to a cataclysmic colliding of galaxies or something) and where these atoms all decay in well under 12.3 years. In this case, the mosaic would make it true that the half-life of tritium is far *less* than 12.3 years. Now there is a sense in which this alternative future could come to pass: it is assigned a nonzero chance by the actual probabilistic laws, but in another sense it could not come to pass because if it came to pass, that would contradict the fact of the matter about present chances (Lewis 1994: 482).

This odd result can be shown to yield a flat contradiction, given the Principal Principle (PP). PP says that our credence, Cr, in a proposition, A, given the chance, x, of A and all admissible evidence, E, ought to just equal x, the *chance* of A.

$$PP\colon Cr\,(A|x\&E) = x$$

Now take A to be the alternative future history in which vastly more tritium atoms come into existence than have ever existed so far, each of which decays within, say, five years. And take E, our admissible evidence, to include the whole

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truth about the present actual chances. The present chance of this future obtaining, according to the best system, is > 0. Therefore, by PP, our credence in this *A* ought to be > 0. However, we also know that this future is inconsistent with *E*, because if this future came about, our present chances would have been different from what they actually are. And so it seems that our credence in *A* ought to be 0. Thus, we have a contradiction: *(Cr>0) & (Cr=0)*.

Lewis offers a solution to the bug whereby he claims that admissibility admits of degrees, relative to the proposition our credence in which is at stake. He argues that in the above instance of PP, the evidence about the present actual chances is not fully admissible, and hence the derivation of the contradiction is spurious (see Lewis 1994 for details). Even if one were convinced that this strategy successfully blocked the contradiction, the very fact of present chances undermining themselves remains, and this seems very strange indeed. So let us see if a potency-BSA can do any better.

5.1 Revised Potency-BSA Chances

The revised potency-BSA can account for nontrivial chances in much the same way as that suggested by Lewis: by showing them to follow from general probabilistic laws. However, as I will show, the revised potency-BSA blocks the credence=0 side of the contradiction because it is consistent with the chances of a world, *w*, that the entire history of *w* diverges dramatically from what we would expect given those chances.

Consider again the distribution of tritium decay events throughout the actual world, @. Now, if we were to systematize all actual tritium decay events, we might find that close to 50 percent of tritium atoms decay within 12.3 years of coming into existence. Indeed, the traditional BSA might offer this sort of fact as part of an analysis of the probabilistic law according to which the half-life of tritium is 12.3 years—the candidate law will increase the *fit* of a system. But as has been shown, this probabilistic law assigns nonzero chances to futures that are such that the actual present chances would be different; the bug bites.

According to the revised potency-BSA, however, it is not enough just to systematize @. The laws of @ systematize tritium decay events across all worlds at which all and only those potencies instantiated at @ are instantiated. If, and only if, according to the *best* systematization of potency distributions across *all* relevant worlds, 'tritium has a half-life of 12.3 years' is an axiom, then this fact will analyze relevant objective chances at @.

The bug does not bite this account. The @-law according to which tritium has a half-life of 12.3 years is consistent with an @-future in which vastly more tritium atoms than have ever existed previously come into being and all decay in well under 12.3 years—call this a recalcitrant future. It would not suffice to undermine the actual probabilistic law if a recalcitrant future were realized in @. This is because, according to the revised potency-BSA, the probabilistic law, which says that tritium has a half-life of 12.3 years, is grounded in a relevant range of possible worlds and their entire histories. Accordingly, while in @ it may turn out that most tritium atoms decay in well under 12.3 years, it can still be true that 'tritium has a half-life

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of 12.3 years' is an axiom of the best systematization of the potency distributions across *all* relevant worlds and hence a law at @. Since it does not follow that one's rational credence in a recalcitrant future coming to pass conditional on the relevant probabilistic law must be zero, the credence=0 side of the contradiction is blocked. It can be consistently maintained that one's credence in a recalcitrant future ought to be > 0.

At this point, the reader might wonder about the criterion of *fit*. The revised potency-BSA presents the following picture: all possible worlds are split up into equivalence classes under the relation 'contains all and only the same potencies as'. Hence, to each world, w, there corresponds one such equivalence class, the w-class. The laws of w are then the axioms of the best systematization of potency distributions across all worlds in the w-class. Until now I have said that the best such system is the one that strikes the optimal strength/simplicity trade-off. However, with the introduction of probabilistic laws, fit must be maximized too. Furthermore, just as strength and simplicity of competing systems are evaluated at the interworld level, so too fit should be evaluated at the interworld level.

If fit were evaluated on a world-by-world basis, different systems would be best according to different w-class worlds; hence w-class worlds would differ with respect to their laws and chances, and the bug would still bite. Assuming that fit is to be evaluated on a world-by-world basis, consider two worlds in a given w-class, $w1$ and $w2$, and assume that $w1$ and $w2$ have different chances because different systems fit best in each case. Furthermore, assume that some initial segments of the histories of $w1$ and $w2$, H_{w1} and H_{w2}, match perfectly and that $w2$ contains finitely many chance events according to the laws of $w1$. Now let F be the proposition specifying the history of $w2$ after initial segment H_{w2}. As there are only finitely many chance events occurring in F, the chance of F according to the laws of $w1$ is > 0. Accordingly, a subject in $w1$ whose evidence includes the $w1$-laws and hence the $w1$-chances ought to have a > 0 credence in F. But if F were to come to pass, the $w1$-chances would be different because, by hypothesis, $w2$, whose entire history is given by $H_{w2}+F$ (where H_{w1} and H_{w2} match perfectly), has different chances from $w1$. It also follows that the agent in $w1$ who knows the $w1$ chances should have 0 credence in F. The bug bites again. The only way out is to evaluate fit not on a world-by-world basis but at the interworld level such that all w-class worlds agree with respect to their laws and hence with respect to their chances.

How, then, is the fit of a system to be evaluated at the interworld level? Sure, the law 'tritium has a half-life of 12.3 years' may fit the history of the actual world, @, well, but there are many worlds in the @-class for which this law will be a very poor fit indeed. There may well be worlds in which all tritium atoms decay within a nanosecond and others in which no tritium atom decays in under a million years and everything else in between and more extreme. The hope must be that a system including the law 'tritium has a half-life of 12.3 years' fits the overall distribution of tritium decay events across all @-class worlds better than any competing system. Thus, it seems that some weighting function over possible worlds is required. This is a problem faced by any account of chance in terms of possible worlds. What the revised potency-BSA does, then, is shift the problem of chances undermining themselves onto the problem of devising a weighting function

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over possible worlds. Assuming that the prospects of solving the latter problem are brighter than the prospects of solving the former, this constitutes progress, but I leave further treatment of this issue for another time.

6. Conclusion

I have argued that an account of laws in an unHumean world that deserves the name 'best-system account' must conceive of the laws as descriptive and that those laws must form parts of an integrated systematization of the information about a world. To this end I propose the revised potency-BSA, which I have also argued overcomes the threat of skepticism raised for Demarest's potency-BSA. Finally, the revised potency-BSA is poised to provide a better account of objective chances than the old *Humean* BSA, on the assumption that the prospects of devising an appropriate weighting function over relevant worlds are brighter than the prospects of overcoming the undermining problem.

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