What Humeans should say about tied best systems

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1. Introduction

The Humean best systems account (BSA) identifies laws of nature with the regularities in a system of truths that, as a whole, best conforms to scientific standards for theory-choice. The BSA provides Humeans with an attractive account of laws of nature. It avoids commitment to "primitive unHumean whatnots" (Lewis 1994: 484) by taking laws to be mere regularities. And it improves upon earlier regularity theories by identifying laws not in isolation but by how well they fit into a whole system of truths.[1]

In this paper, we address a challenge for the BSA that arises when different systems are tied for being best.[2] In §2, we briefly explain the Humean BSA. In §3, we argue that the problem of ties affects every version of the BSA because it arises regardless of which standards for theory-choice Humeans adopt. In §4, we propose a Humean response to the problem. We invoke pragmatic aspects of Humean laws to show that the BSA, despite violating some of our intuitive judgments, can account for scientific practice.

2. The Best systems account of laws

According to Humeanism, the world's fundamental metaphysical structure consists of the so-called 'Humean mosaic', i.e., the complete pattern of instantiations of perfectly natural properties at spacetime-points (or their point-sized occupants) and the spatiotemporal relations between them. The Humean element of this metaphysics is that these property instantiations are freely recombinable: No property instantiation has any modal implications for the instantiation of any other property.

Lewis's BSA is a recipe for reducing the laws to the Humean mosaic. It has two guiding ideas (see Hall 2015: 264). The first, official guiding idea has been much discussed in the literature. It says that the laws are those contingent generalizations

[1] Versions of the BSA are defended, for example, by Cohen and Callender (2009), Earman (1986), Hall (2015), and Loewer (1996, 2007). For discussion, see Roberts (2008), van Fraassen (1989) and Woodward (2014).

[2] We will draw from two cases that Hall (2015) uses to argue that Humeans cannot explain why science aims for laws that cover a wide range of metaphysically possible initial conditions. Our argument makes these cases even more troubling for Humeans since it does not make assumptions about what standards for lawhood science in fact uses.

that appear in a deductively closed system of truths that best balances strength and simplicity and whose predicates refer only to perfectly natural properties (see Lewis 1994: 478).

The second, unofficial guiding idea has received less attention. It says that "our implicit scientific standards for judging lawhood are in fact constitutive of lawhood" (Hall 2015: 264; see also Lewis 1983: 41). For anti-Humeans, the standards science uses to discover laws reveal which facts hold as a matter of law but do not determine that they have this status. What makes something a law, according to anti-Humeans, is additional metaphysical machinery, such as primitive laws (Maudlin 2007), irreducible necessitation relations (Armstrong 1983), dispositional essences (Bird 2007), or primitive subjunctive facts (Lange 2009). By contrast, according to the unofficial guiding idea, these standards are not just criteria for discovering the laws; instead, the laws are laws *because* they belong to a system that best conforms to the scientific standards for judging lawhood.

The two guiding ideas are connected. The official idea can be motivated as a specific proposal about what criteria scientists use for judging laws. Lewis (1986a: 123) argues that the "standards of simplicity, of strength, and of balance between them are to be those that guide us in assessing the credibility of rival hypotheses as to what the laws are." A version of the BSA guided by the unofficial idea is more flexible: It is non-committal about what epistemic standards scientists in fact use and merely insists that these standards, whatever they are, are constitutive of lawhood. Due to its greater flexibility, the unofficial idea is essential when assessing the plausibility of the BSA.

Interpreting the BSA in light of the unofficial idea avoids many common criticisms. For example, Roberts (2008: 8–9) and Woodward (2014) argue that science never trades strength for simplicity when choosing laws. And Loewer (2007) maintains that scientific laws do not track perfectly natural properties. These criticisms, however, do not undermine the unofficial idea. This version of the BSA can be adapted to whatever criteria science in fact employs when discovering laws and cast in whatever language it uses (cf. Loewer's 2007: 324). The unofficial idea, thus, seems to guarantee that the BSA draws the distinction between laws and non-laws exactly as science does. However, as we will argue, it faces a problem in cases of ties, where two or more systems satisfy the standards for lawhood equally well.

3. The problem of ties

Hall (2015) describes a scenario that makes the worry ties create for the BSA particularly pressing. Imagine physics has narrowed down the candidate theories about the fundamental laws to just two: 'Safe' and 'Sorry'. They make the same predictions about all actual phenomena and satisfy all theoretical virtues (e.g., simplicity) equally well. The only way to decide which theory is true would be conducting an experiment involving a powerful particle collider. Scientists calculate that if Safe is true, the experiment would go smoothly and confirm Safe; but, if Sorry is true, it would lead to a catastrophic second Big Bang. Because of this risk, the scientists decide not to perform the experiment ('better safe than sorry', they think).

Hall construes this scenario with the unofficial guiding idea in mind. Since the experiment is never performed, Safe and Sorry satisfy the criteria science uses for judging lawhood equally well and so are tied for being the best system. Whatever the standards for bestness are, two or more systems might satisfy these standards equally well. For example, according to Lewis's (1983) BSA, the laws are the contingent regularities in the systems that best balances strength and simplicity. We can then fill in the details of Hall's scenario such that Safe and Sorry balance these virtues equally well.

It is very plausible that scientists would take one of either Safe or Sorry to describe the true laws in Hall's scenario. They would reason that it is either determinately true that were they to perform the experiment, a second Big Bang would occur or it is determinately false. And, moreover, they would assume that this counterfactual is determinately true or false because one of either Safe or Sorry states the universe's true laws (see Hall 2015: 275). So, scientists would assume that one of the theories is determinately true even though knowledge of the occurrent facts underdetermines which one. However, if Humeanism is correct and the laws reduce to the Humean mosaic, it is hard to see how there could be such an epistemic gap between knowing the Humean mosaic and knowing the laws.

Indeed, no version of the BSA can correctly delineate the laws in Hall's scenario. Humeans have various options of what the laws are in cases of ties, but the following three accounts are the most plausible: First, Lewis's original BSA says that a "law is any regularity that earns inclusion in the ideal system. (Or, in case of ties, in every ideal system.)" (Lewis 1983: 367, see also Lewis 1973: 73). This account has the following consequences for ties:

> **Intersecting Laws.** If two or more systems are tied for being best, the laws are the generalizations in every best system.

Second, Lewis (1994: 478) departs from his earlier account in requiring that laws presuppose a unique best system. He now holds that a "regularity is a law iff it is a theorem of the best system." Accordingly, Lewis's more recent reaction to ties is:

> **No Laws.** If two or more systems are tied for being best, there are no laws. (see Lewis 1994: 479)

And, third, Hall (2015) maintains that the epistemic standards for lawhood are constitutive of laws, and so proposes the following account of ties:

> **Indeterminate Laws.** If two or more systems are tied for being best, it is metaphysically indeterminate what the laws are.

In the following, we will be neutral about which account Humeans should endorse. What matters is that no version can capture that one of Safe or Sorry describes the unique laws in Hall's scenario and underwrites determinate counterfactuals about the experiment.

According to Intersecting Laws, if Safe and Sorry are tied, the laws are whatever regularities are part of both systems. If the two theories only overlap very little, this proposal "could leave us with next to no laws" (Lewis 1994: 479). And in the extreme case, where there is no overlap, the world has no laws. But even if there is overlap between Safe and Sorry, the account cannot capture that either Safe or Sorry describe the unique true laws in Hall's scenario. Moreover, since Safe and Sorry make contradictory predictions about what would happen if the experiment was performed, laws determined by their intersection would neither yield the verdict Safe makes nor the verdict Sorry makes.

No Laws entails that there are no laws in Hall's scenario. This consequence is surprising because Hall describes the case such that science has successfully narrowed down the candidates for the fundamental laws to just two. So, in this world the predictive and inductive practices of science clearly work. But, according to No Laws,

this world nonetheless has no laws and so, arguably, no determinate counterfactual structure. Finally, Indeterminate Laws makes it metaphysically indeterminate whether Safe or Sorry describes the laws in Hall's scenario. It is then also metaphysically indeterminate what would happen if the experiment was performed. In sum, no version of the BSA captures our intuitive judgments.

Hall's scenario resembles familiar counterexamples to Humeanism due to Carroll (1994: ch. 3) and Tooley (1977), which can also be understood as involving ties. For example, Tooley imagines a world that contains exactly ten different types of fundamental particles. Physicists have observed 54 of the possible 55 interaction-types between these particles and have posited 54 corresponding fundamental laws. However, due to the boundary conditions at that world, no instance of the missing 55th interaction-type, namely between X- and Y-particles, occurs.

Tooley conjectures that scientists would assume that there is a unique fundamental law that determines what would happen if X- and Y-particles were to interact. However, since such interactions are not part of the pattern of non-nomic facts, "knowledge of everything that happens in such a universe will not enable one to formulate a unique axiomatic system containing theorems about the manner of interaction of particles of types X and Y" (Tooley 1977: 670-671). In other words, the scientific criteria for theory choice seem to underdetermine the relevant law. Hence, Humeans cannot capture the intuition that there are unique laws about the interaction between X- and Y-particles.

Humeans have given two types of responses to Tooley-style cases. The first response is that the anti-Humean intuitions they elicit reflect historically contingent, idiosyncratic features of our concept of a law (see Beebee 2000 and Loewer 1996). The second response concedes that these anti-Humean intuitions are relevant but says that contradicting them entails only a modest revisionism that is outweighed by the transparency and simplicity of a Humean metaphysics (see Hall manuscript: sect. 5.1).

These responses may seem equally effective for Hall's scenario. After all, Humeans can explain why scientists would not conduct the particle-collider-experiment. Even if the best systematization of the Humean mosaic as a whole entails (given that the experiment is not performed) a tie between Safe and Sorry, realistic scientists do not know the entire mosaic. Hence, scientists cannot rule out that the exact situation that would discriminate between Safe and Sorry has happened or will happen

in some distant part of the universe, and so both theories remain epistemic possibilities. For all scientists know, Sorry *might* be the unique best system, in which case performing the experiment would lead to a disastrous second Big Bang.

This epistemic possibility is enough to explain why scientists would not perform the experiment. All that Humean theories of laws leave unaccounted for are the scientists' anti-Humean judgments, and so Humeans can use the same resources as in Tooley's case to explain why this cost is bearable. We think these responses are part of the Humean answer to the problem of ties, but they are not the full story.

Hall adds a twist to his scenario that makes it more troubling than other, similar cases. Suppose again that science has narrowed down the candidate theories for laws to two: Safe and Sorry. As before, an experiment involving a powerful particle collider is the only way to decide between them. If scientists do not conduct the experiment, both theories are equally well supported by all even in principle available evidence. But this time nothing catastrophic happens if they conduct the experiment–regardless of which theory is true. The experiment would simply confirm one of the two theories. Scientists then need to decide whether they want to spend enormous resources on building the necessary particle collider.

It is very plausible that scientists would have at least some inclination to perform the experiment. As argued above, it is natural for scientists to think that there is a fact of the matter about which laws are true. But Hall argues that Humeanism has the implausible consequence that scientists would have absolutely no motivation for performing the experiment:

> [B]y your own Humean lights, it's not that you would be finding out about some basic aspect of physical reality of *which you would otherwise be ignorant*. On the contrary: if you forego this experiment, then you can be forever confident that you know *all the facts about the fundamental laws that there are to know* – namely, that they are indeterminate as between the Safe-laws and the Sorry-laws. So why spend the money? If you're rational, you won't – because you recognize *no reason whatsoever* in favor of doing so. And in that you are, I reckon, at odds with just about every one of your colleagues. (Hall 2015: 275, italics in the original)

From a Humean perspective, scientists would know everything there is to know about the world's nomic structure even if they do not perform the experiment. In the quoted passage, Hall presupposes his own Humean account of ties, viz., Indeterminate Laws. However, if either Intersecting Laws or No Laws is true, scientists who know that there is a tie between Safe and Sorry would also know everything there is to know about the world's nomic structure: that the laws are the regularities in the intersection of Safe and Sorry or, respectively, that there are no laws. So, if Humeanism is true, there appears to be no reason to perform the experiment because we would already know everything about the laws.

This practical relevance sets Hall's scenario apart from Tooley's case. It would be highly implausible if Humeanism had potentially revisionary implications for scientific practice: Telling the physicists not to conduct an experiment because Humeanism is true seems as absurd as "telling the mathematicians that they must change their ways, and abjure countless errors, now that philosophy has discovered that there are no classes" (Lewis 1991: 59). So, Humeans need a different reply to Hall's scenario.

4. A Humean response to the problem of ties

One Humean response to Hall's scenario is that realistic scientists are unlikely to find themselves in such a situation. First, if "nature is kind," (Lewis 1994: 479) there will be no tie in the first place. And, second, even if there is, scientists would have to *know* that there is a tie unless they perform the experiment. Knowing the latter requires knowing that no event in the entire history of the universe decides between Safe and Sorry. Without such knowledge, it remains epistemically possible that either one is the unique best system. Humean scientists then would have a reason to perform the experiment because in doing so they might, for all they know, discover which theory is actually true.

However, Humeans can and should say more. Even if Hall's scenario is far-fetched, it reveals something about the norms guiding scientific discovery. It is plausible that actual scientists would judge that *were* they in a situation where they know that the epistemic standards for lawhood underdetermine which theory is true, they would have reason to perform the experiment. And this fact reveals a norm implicit in scientific practice, viz., that when scientists have the option to perform a crucial experiment that decides between two theories, they should perform it. (Of course, this scientific imperative might be outweighed by extra-scientific considerations, such as the costs of

performing the experiment.) Hall's scenario would then show that Humeanism cannot account for a norm implicit in scientific practice.

We will argue that Humeans can account for the relevant norm by appealing to pragmatic aspects of laws. Moreover, our argument works regardless of which account of ties Humeans endorse. Gaining new knowledge is not the only outcome scientists hope for when conducting an experiment. Imagine an experiment that would show either that the world's fundamental laws are deterministic or indeterministic. Even if it is a Nobel-prize-winning discovery either way, scientists might still hope that the true laws are deterministic because deterministic laws are (*ceteris paribus*) practically more useful. So, scientists are not only interested in knowing the laws; they are also interested in the laws having features that make them practically useful.

As we will show, Humean scientists in Hall's scenario have a pragmatic reason for performing the experiment because doing so results in laws that have more explanatory power. This motivation fits nicely with how the BSA is frequently presented. For example, Albert (2015: 23) points out that the purpose of Humean laws is to provide information that "will serve you well, or reasonably well, or as well as possible, in making your way about in the world" (see also Beebee 2000: 547, Dorst 2018, Hicks 2018, and Jaag and Loew 2018).

In fact, there are two independent arguments for why Humean scientists have reason to perform the experiment, which presuppose different conceptions of explanation. The first argument is that if scientists perform the experiment, the world has a more determinate counterfactual structure than it has otherwise: If the experiment is not performed, counterfactuals about which Safe and Sorry disagree have no determinate truth-values (as we pointed out in §3, this consequence arises for all three Humean accounts of ties).[3] By contrast, if the experiment is performed, the relevant counterfactuals have determinate truth-values.

Many philosophers, including Humeans, hold that counterfactuals support explanations (see, e.g., Lewis 1986b: 216). Hence, performing the experiment leads to laws with more explanatory power because the laws support more determinate counterfactuals and so more explanations. Safe and Sorry make divergent predictions only about phenomena that would have to be created with a powerful particle collider.

[3] According to some Humeans accounts, counterfactual indeterminacy is much more widespread. For example, if No Laws is true, then in cases of ties there are no laws to underwrite any counterfactuals.

Counterfactuals about these phenomena, however, are still relevant for explaining actual facts. If there are determinate counterfactuals about what would have happened if such a phenomenon had occurred, its non-occurrence can be used to explain what actually happens. For example, suppose Safe and Sorry make different predictions only about systems whose energy exceeds a certain quantity *E*. As it happens no actual system's energy exceeds *E*. Nonetheless, it might sometimes be expedient to explain actual phenomena (for example, why matter is stable) by appeal to systems' energy being below *E*. If there are determinate counterfactuals about how systems behave beyond *E*, such explanations are available.

Our second argument appeals to the link between explanation and unification. Unification is the idea of having a single, compact system of basic truths from which as many other truths as possible can be derived (see Friedman 1974 and Kitcher 1989). Many Humeans think that BSA-laws explain by unifying (see Loewer 1996 and Hall 2011). Laws then have more explanatory power if they are more unifying, that is, allow us to derive more truths while "reducing the total number of independent phenomena that we have to accept as ultimate or given" (Friedman 1974: 15, see Kitcher 1989: 432).

Humean scientists then have a reason for performing the experiment because it leads to laws that are more unifying and, hence, more explanatory. If the experiment is performed, one of either Safe or Sorry states the unique laws. By contrast, if it is not performed, the laws will be some other facts that are less unifying than either system. The details depend on one's account of ties: given Intersecting Laws, the laws are the intersection of Safe and Sorry, which is less informative than either system and so allow us to derive fewer truths. Given No Laws, there are no laws and so we cannot derive any (contingent) truths. Given Indeterminate Laws, the laws are indeterminate between Safe and Sorry. We can then still derive the same truths about actual phenomena since the two systems agree about all actual predictions. However, the fundamental nomic facts now comprise that it is indeterminate which, Safe or Sorry, describes the laws. Hence, a complete description of the fundamental nomic facts must mention both theories instead of just one, and so the basic truths from which other truths are derived

are significantly more complex. So, the laws are more unifying if the experiment is performed.[4]

Let us address two worries: First, it may be objected that the resulting increase in explanatory power is too marginal to warrant conducting the experiment. How much explanatory power Humeans gain by performing the experiment depends on both which version of the BSA is true and which account of explanation is presupposed. For example, if Indeterminate Laws is true, the added explanatory power in terms of counterfactuals is arguably rather minimal. In this case, the only counterfactual determinacy we gain from performing the experiment concerns events that do not actually happen (though, as we have argued, these counterfactuals can still be relevant for explaining actual facts).

Our reply to Hall's scenario, however, works even if Indeterminate Laws is true. Most importantly, Humeans still gain *some* explanatory power from the additional counterfactual determinacy. Even if this gain is rather minimal, it suffices to rebut Hall's (2015: 275) claim that Humean scientists have "*no reason whatsoever*" to perform the experiment. Moreover, while the increase in counterfactual determinacy may be marginal, the gain in unification is substantial. It makes a significant difference for unification whether the fundamental nomic facts that serve as unexplained explainers for other facts mention only either Safe or Sorry (whichever the experiment shows to be true) or whether they need to mention both theories.

Second, it might be objected that while Humean scientists have a reason for performing the experiment, it is not the right kind of reason. Scientists who perform a tie-breaking experiment certainly would do so to find out which theory is true; they would not think of themselves as making it the case that one of them is true. So, our account does not get the scientists' psychology right.

In reply, we point out that Humeans already admit that they cannot account for scientists' judgments about the kinds of cases Carroll (1994) and Tooley (1977) describe and have provided strategies for dealing with them. If Hall's scenario creates

[4] There is a second sense in which the laws are more unifying if the experiment is performed: Doing so creates a new kind of phenomenon that falls under the laws, viz., the event taking place inside the particle collider. The resulting laws then are more unifying in the sense that they apply to more different kinds of phenomena.

any additional problems, then only because it has revisionary implications for scientific practice. Our account, however, shows that Hall's scenario has no such implications.[5]

Funding

This work was supported by Deutsche Forschungsgemeinschaft [grant number FOR 2495].

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[5] Both authors contributed equally to the paper. For helpful comments, we would like to thank David Glick, Andreas Hüttemann, Markus Schrenk and an anonymous referee for this journal.

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