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BEST SYSTEMS IN LAWLESS WORLDS*

Mejores sistemas en mundos sin leyes

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Abstract

David Lewis' Best System Account (BSA) finds laws of nature in lawless worlds, where there are no laws to be discovered. This suggests that BSA is at best an incomplete account of lawhood.

Key words: Laws of Nature; Best Systems Account; Theory Reduction; Counterfactual Conditionals; David Lewis.

Resumen

El Enfoque de Mejores Sistemas de David Lewis (BSA, en inglés) encuentra leyes de la naturaleza en mundos sin leyes, es decir, en mundos donde no hay leyes por descubrir. Esto sugiere que el BSA, en el mejor de los casos, ofrece una explicación incompleta de la legalidad.

Palabras clave: Leyes de la naturaleza; Enfoque de mejores sistemas; Reducción teórica; Condicionales contrafácticos; David Lewis.

1. The Big Book of Facts

David Lewis' Best System Account (BSA) is a sophisticated regularity view of lawhood that is modeled on scientific practices of theory reduction. Scientists tend to regard regularities as accidental if they can be reduced to other regularities, plus particular matters of fact. For instance, the phases of the Moon count as accidental because they follow from the principles of classical (or relativistic) mechanics, together with the initial

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locations, velocities, and masses of the Earth and the Moon. Had any of these particular facts been different then the Moon phases would have displayed a different regularity. The basic idea of BSA is to identify the laws of nature with those regularities that remain when this process of theory reduction has run its course.

In addition to the fundamental laws that form the terminus of theory reduction, one could also admit a category of derived laws that follow from the fundamental laws in conjunction with particular facts. This would allow us to distinguish the lawlike regularity that all Uranium-235 spheres are less than a mile in diameter (because they would explode) from the accidental regularity that all gold spheres are less than a mile in diameter (because nobody is that rich). For current purposes, it does not matter whether we admit derived laws. The important point is that irreducible regularities count as BSA laws.

Since any regularity admits a trivial reduction to a list of its instances, the proposal cannot be that we reduce the number of regularities as much as possible. If we eliminate all regularities then we get a list of particular facts, not a scientific theory. Lewis (1973, p. 73; 1983, p. 367) concludes that we need to strike a balance between the competing features of simplicity and strength. In our example, we increase the simplicity of our theory, by eliminating a separate Moon-phase law, but reduce its strength, by having to include particular facts about the Moon and Earth. We cannot eliminate too many regularities without losing strength, and we cannot retain too many regularities without compromising simplicity.

To illustrate this proposal, Helen Beebee (2000, sec. II) asks her readers to imagine that God wanted to reveal all the truths about the world in one Big Book of Facts. If He just listed all the particular facts then the Big Book would be too long and unwieldy to be of much use. God therefore divides the Big Book into two parts. Part A collects regularities in a compact list of general axioms ("laws of nature"); Part B provides the remaining information about the world in a long list of particular facts. In making this division, God must trade off the simplicity of His theory, which is given by the number and simplicity of the general axioms in Part A, and its strength, which is given by the number of particular facts in Part B that these axioms render redundant. As a perfect being, God finds the best balance between these competing features. BSA claims that scientific theory aspires to the ideal of God's Big Book of Facts. It aims for the best combination of simplicity and strength, and a law of nature is "any regularity that earns inclusion in the ideal system" (Lewis, 1983, p. 367).

Numerous authors complain that, as stated, BSA does not tell us (i) how to measure the simplicity of an individual regularity, (ii) how to balance simplicity with the seemingly incommensurable feature of strength, and (iii) what to say when two systems are tied.[1] Lewis hopes that these questions will turn out to be irrelevant: "if nature is kind then the best system will be *robustly* best [and] come out first under any standards of simplicity and strength and balance" (1994, p. 479). Keeping these issues in suspense clearly works in BSA's favor since it shields it from potential counterexamples. If BSA is allowed to retrofit standards of simplicity and strength, then it can always account for the verdicts of scientific inquiry. There is always some rough-and-ready story that BSA can tell, after the fact, that explains how scientists arrived at their theories by balancing strength and simplicity. In this paper, I want to raise a different problem for BSA that is insensitive to what we say about (i)–(iii). Instead of arguing that BSA fails to identify the laws of nature in worlds like ours, where there are laws to be found, I want to argue that BSA finds laws in lawless worlds, where there are no laws to be discovered.

2. Lawless Worlds

Before presenting the argument, a few clarifications are in order. By claiming that BSA finds laws in lawless worlds, I do not mean to suggest that there are BSA laws in possible worlds in which there are no BSA laws, which is clearly impossible. As I want to use the term, a lawless world is a world in which there are no counterfactual dependencies between property instantiations. In such a world, it is not the case that, if some properties had been different, some other properties would have been different as well. If we follow Lewis and analyze causation in terms of counterfactuals then there are no causal relations in such worlds. Lawless worlds are random worlds in which everything happens by accident.[2]

According to Nelson Goodman (1983), the defining feature of laws of nature is that they support counterfactual conditionals. Suppose that it is a law that all Fs are Gs and let a be an object that is neither F nor G. According to Goodman, this ought to entail the counterfactual conditional $Fa \mathrel{\Box\!\!\rightarrow} Ga$ that a would be G if it were F. Regularities that do not support counterfactuals in this way are said to be accidental. A standard example is Goodman's coin regularity (1983, p. 18):

(*) All the coins in Goodman's pocket on VE day were silver

[1] See, e.g., Carroll (1994, sec. 2.3), Woodward (2014), van Fraassen (1989, ch. 3), Roberts (2008, sec. 1.3), Cohen & Callender (2009), Hall (2015), Wheeler (2016), and Loew & Jaag (2020).

[2] "A chaotic and lawless world might have no causation" (Lewis, 1986, p. 84).

Since it is false that a copper penny would have turned silver if it had it been put into Goodman's pocket, this counts as an accidental regularity. If Goodman is right about the connection between laws and counterfactuals then there are no laws in lawless worlds, as defined above. For if there were laws in such worlds then there would be true counterfactuals about property instantiations in these worlds, and the defining feature of a lawless world is that there are no such true counterfactuals.

The coin regularity (*) also serves as a counterexample to a naïve regularity view that regards all regularities as lawlike. As Goodman puts it, the naïve regularity view fails to solve the *Problem of Law* (1983, sec. I.3). This is the task of separating the lawlike regularities from the accidental regularities so that all lawlike regularities are guaranteed to support the associated counterfactuals.

Lewis adopts a slightly different approach. For him, the defining feature of laws of nature is the logical role they play in shortening the Big Book of Facts, rather than the support they give to counterfactuals. When discussing counterfactuals, Lewis tells his readers that he doubts "that laws of nature have as much of a special status as has been thought" (1973, p. 73). But unless he is planning to use BSA to solve Goodman's Problem of Law there is no reason to bother with a sophisticated regularity view like BSA rather than adopt the naïve regularity view. If laws of nature are not needed to ground counterfactuals—as Lewis appears to suggest—then there is also no need to solve the Problem of Laws. But this would not count in favor of BSA and against the naïve regularity view.

As it turns out, Lewis' views about laws and counterfactuals are not all that different from Goodman's. Two pages after his dismissive remarks about the role of laws, Lewis offers a proof that BSA-laws do indeed support counterfactuals. Minor complication aside, his possible-worlds analysis of counterfactual conditionals is that $Fa \mathrel{\Box\!\!\rightarrow} Ga$ is true just in case a is G in the possible world most similar to ours in which a is F. This does not mention the laws, which enter indirectly, via the similarity relation between worlds. Lewis claims that BSA-laws are "highly informative" about the worlds in which they obtain, and that a difference in laws therefore makes for "a big difference between worlds" (1973, p. 75). To a first approximation, the world most similar to ours in which a is F is thus bound to be a world in which it is still a law that all Fs are Gs, which ensures that a is G in that world. Hence $Fa \mathrel{\Box\!\!\rightarrow} Ga$ is true whenever $\forall x(Fx \rightarrow Gx)$ is a BSA-law, which is what we wanted to show.

Lewis notes that this is not quite right. In a world with deterministic laws, we cannot just add the fact that a is F at some time t. If we want to keep the deterministic laws fixed then we must also change all the earlier facts, going back to the beginning of the world, that prevented a from being F at t in the first place. Since that would make for a huge difference from the actual world, Lewis (1973, p. 75) argues that the most similar world to ours in which a is F at t is one in which world history leading up to t is the same as in the actual world. Right before t, there is a small exception to the laws, a *miracle*, that turns a into an F. After the miracle, the deterministic laws hold for all future times and thus tell us what would happen if a were F at t.[3] If that is right then the closest possible world in which a is F does not have the same laws as the actual world since the miracle would be an exception to some lawlike regularity. But this does not alter Lewis' fundamental claim that BSA-laws support counterfactuals about the possible world *in which they are the laws* by being highly informative about *that* world. The miracles always happen in *other* possible worlds.

Suppose we accept Lewis' proof that BSA laws support counterfactuals. Then it follows that there are no BSA laws in lawless worlds, as defined above. For if there were BSA laws in such a world then Lewis' proof would entail that there are true counterfactuals about property instantiations in that world, and the defining feature of a lawless world is that there are no such true counterfactuals.

3. The Language Requirement

One problem with this account is that lawless world can still exhibit random regularities, which BSA would falsely classify as lawlike. Since there are no other regularities that could account for them, theory reduction would begin and end with these accidental regularities. In a lawless world, accidental regularities end up in Part A of the Big Book of Facts by default, for lack of better alternatives. BSA thus finds laws in lawless worlds with accidental regularities.

In a lawless world, there might only be *pervasive* regularities of the form $\forall x(Fx \rightarrow Gx)$ if either 'F' or 'G' is a gerrymandered predicate. Lewis notes that BSA is bound to be trivial unless we impose some constraints on the language of the Big Book of Facts. Any set of truths S can be axiomatized with a single axiom $\forall x(Fx \rightarrow Gx)$ where 'F' applies to everything and 'G' applies to all and only things at worlds where S holds.[4] To address this concern, Lewis imposes the *language requirement* that the "primitive

[3] Many authors argue that the world most similar to ours ought to be a world with *two* miracles: one right before to keep the past history the same, and one right after to keep the future history the same. Lewis responds to this *future similarity objection* in (1979, pp. 467-472). Who is right about this issue does not matter here.

[4] Lewis (1983, p. 367); see also Wheeler (2016) and Urbaniak & Leuridan (2018).

vocabulary that appears in the axioms refer only to perfectly natural properties" (1983, p. 368). This excludes gerrymandered regularities from lawhood and accounts for Goodman's example (*). Since the predicate 'is a coin in Goodman's pocket on VE day' does not pick out a perfectly natural property, Goodman's coin regularity does not count as lawlike.

However, the language requirement assumes that we already know what the natural properties are. Lewis suggests that "physics discovers natural properties in the course of discovering laws" and that the properties that feature in the laws, such as charge or mass, count as natural by default (1983, p. 365; 1994, p. 474). Barry Loewer (1996, p. 109; 2007) objects that this proposal is circular. If we impose a language requirement then we cannot determine the BSA-laws until we know what the natural properties are, but we can only tell which properties are natural once we know what the laws are. Lewis disagrees. Just as scientific theories implicitly define their own theoretical terms (Lewis, 1970), he suggests that theories provide their own notion of naturalness. In scientific inquiry, "laws and natural properties get discovered together" (Lewis, 1983, p. 368).

This might be a plausible account of laws and natural properties but combining it with BSA would prevent the language requirement from ruling out gerrymandered laws in all lawless worlds. Suppose we begin our scientific investigation of a lawless world with gerrymandered predicates that happen to deliver pervasive regularities in that world. Due to a lack of competitors, BSA would classify the gerrymandered regularities as fundamental laws and the gerrymandered properties as perfectly natural. In a lawless world, an initial choice of gerrymandered predicates never gets corrected by subsequent scientific inquiry. Rather than resolve the problem of lawless worlds, the language requirement makes matters worse. Not only do we find laws where there are none, we also run the risk of classifying gerrymandered properties as natural.

In any case, the language requirement would not prevent lawless worlds from randomly exhibiting *minor* regularities that involve perfectly natural properties. Suppose that F and G are natural properties and that our lawless world contains only a handful of Fs, all of which just happen to be Gs. Then the accidental regularity $\forall x(Fx \rightarrow Gx)$ has few non-trivial instances, but even a minor regularity is a regularity. And since there are no other regularities in our lawless world to which it can be reduced, BSA would again count this minor accidental regularity as lawlike.

One might insist that this is the correct result, and that our "lawless" world is not lawless after all. BSA is inspired by Frank Ramsey's remark that "even if we knew everything, we should still want to systematize our knowledge in a deductive system, and the general axioms in that system would be the fundamental laws of nature" (1928, §12). The regularities in lawless worlds might be sparsely instantiated, but they do what Ramsey claims laws do: they shorten the Big Book of Facts. If no other system does a better job at systematizing truths then these minor regularities do qualify as BSA-laws.

This might take care of the problem at hand but it would wreak havoc with Lewis' proof that BSA-laws support counterfactuals. Minor regularities are equivalent to small clusters of particular facts and fail to be "highly informative" about their worlds. If that feature is needed for a regularity to support counterfactuals, as Lewis suggests, and if these minor regularities qualify as BSA-laws, then some BSA-laws do not support counterfactuals, and thus fail to satisfy a necessary condition for lawhood.

4. The Strength Threshold

Rather than focus on how regularities in lawless worlds are described, one might take issue with the fact that they are *minor*. The simplicity-cost of counting a regularity as a law is always the same: it increases the number of axioms in Part A of the Big Book of Facts by one. The strength-benefit, on the other hand, depends on how pervasive the regularity is. For the same simplicity-cost, a minor regularity only offers a modest increase in strength, by rendering a small number of particular facts redundant. This suggests that some regularities do not have enough instances to justify the simplicity-cost of counting them as laws.

Such a *strength threshold* is suggested by Jonathan Cohen and Craig Callender (2009, p. 5), who argue that it is not a law that all the students in their small metaphysics seminar are seated. Counting this minor regularity as lawlike is not worth the simplicity-cost. By excluding minor regularities, a strength threshold would eliminate the challenge that these regularities pose to Lewis' proof. Minor regularities do not support counterfactuals because they are too uninformative to qualify as laws. Indeed, one might argue that the real issue with Goodman's coin regularity (*) is not its use of gerrymandered predicates but the fact that it fails to clear the strength threshold.

However, a strength threshold would also prohibit lawlike regularities with very few instances. Suppose that, in the actual world, it is a law that all *F*s are *G*s. Consider another possible world w_1 that contains nothing but two *F*s that are both *G*s. In w_1, the regularity would count as accidental just because it falls below the strength threshold. Adopting the strength threshold would thus commit us to the peculiar view that some possible worlds cannot possess any laws because too little is happening in them.

Even though the regularity in w_1 is of tiny absolute size, one might be impressed by the fact that it is *maximally* large relative to the size of its equally tiny world. By relativizing the strength threshold to the size of the world under consideration, one could obtain the result that w_1 does indeed exhibit a lawlike regularity that all *F*s are *G*s. But consider the possible world w_2 that we obtain from w_1 by adding a huge number of "alien" objects that do not share any properties with the two *F*s, and do not interact with them, either. The alien objects make no difference to the two s, but their presence would ensure that the regularity $\forall x(Fx \rightarrow Gx)$ in w_2 fails to satisfy a size-relativized threshold for lawhood.

Beebee complains about opponents of BSA who appeal to their prejudiced intuitions about what the laws would be in some "barren and very distant possible world" (2000, p. 586). But some barren worlds are not exotic at all. Anybody who has taken an introductory physics course knows that physicists routinely consider law-governed worlds that contain nothing but (i) two point-sized masses, (ii) one ball on an inclined plane, (iii) one electron in a box, (iv) one hydrogen atom, and so on. These barren worlds are not idle playthings of philosophers but are of central importance to scientific theorizing. They are the only models for which we can find precise solutions to our theories of motion.

Even the actual world is "barren" in some respects. Many philosophers believe that any account of lawhood must admit *vacuous laws* that have zero actual instances (Loewer, 1996, p. 111). Take Newton's law of gravitation, which is about continuum-many properties of mass. If the universe has a finite total mass, or if everything in it is composed of atoms with a fixed finite mass, then most mass properties are uninstantiated. No matter how low we put the strength threshold, vacuous regularities involving uninstantiated mass properties will never cross it, yet physicists still think that they are lawlike. We thus face a dilemma. Without a strength threshold, BSA finds laws in lawless worlds; with a strength threshold, it overlooks sparsely instantiated laws. BSA cannot admit both lawless worlds that only have accidental regularities, and law-governed worlds with sparsely instantiated laws.

But perhaps physicists are just mistaken about what the laws would be in barren worlds. As Marc Lange (2009, sec. 2.4) emphasizes in his discussion of nested counterfactuals, regularities that are lawlike in one world can be accidental in others. It might be an actual law that all *F*s are *G*s but that does not mean that this regularity is also lawlike in w_1 and w_2, where it has too few instances to pass the strength threshold. The advocates of BSA could just bite the bullet and deny that there are any sparsely instantiated laws. If physicists think otherwise, then they are just wrong about this. I am not sure that this is a plausible view but let me pass over this here. I now want to argue that BSA has a problem with lawless worlds even if we accept both the language requirement and the strength threshold.

5. Equations of Motion

Like many other accounts of lawhood, BSA takes it for granted that laws of nature are about co-instantiations of natural properties, and that they manifest themselves in regularities of the form $\forall x(Fx \rightarrow Gx)$.[5] The reality is that *none* of the fundamental laws of physics describe regularities of this type. When physicists are asked to provide an example of a law of nature, they invariably mention fundamental force laws. Richard Feynman (1967) cites the example of Newton's law of gravitation. Given masses m_1 and m_2 at locations $\vec{x}_1$ and $\vec{x}_2$, respectively, Newton's law claims that the acceleration $\vec{a}_{12}$ of m_1 towards m_2 is given by the following formula, where G is the gravitational constant.

$$\vec{a}_{12} = G \frac{m_2}{|\vec{x}_2 - \vec{x}_1|^3} (\vec{x}_2 - \vec{x}_1)$$

If Newton's law is indeed a *law*, and if BSA is right about laws being pervasive regularities, then Newton's law ought to have many non-trivial instances. But it doesn't. The problem is not just that we live in a relativistic world rather than a Newtonian one. As Nancy Cartwright (1983, ch. 3) notes, Newton's law is false in any possible world that contains masses other than m_1 and m_2. Due to the gravitational influence of these other masses, m_1 would never exhibit the precise acceleration $\vec{a}_{12}$ specified by Newton's law. If the other masses are very small, or very far away, then their gravitational effects might fall below the margin of error of our measurement apparatus, but an approximation of a regularity is not a regularity. The only worlds in which Newton's law can describe an exceptionless regularity are *barren* worlds that only contain two masses.

The obvious reply to Cartwright is that the accelerations in multi-particle systems are given by vector addition. Suppose that masses $m_1, \dots, m_k$ are at locations $\vec{x}_1, \dots, \vec{x}_k$. Then Newton's law tells us about the acceleration $\vec{a}_{ij}$ that m_j would cause in m_i if these were the only two masses in the universe. (If $i = j$ then $\vec{a}_{ij} = 0$.) If there are k masses then

[5] Armstrong admits that "it does not seem very likely that many laws have this form" (1983, p. 7) but then proceeds to offer an account of lawhood that takes it for granted that they *all* do.

the acceleration experienced by the i-th mass m_i is given by the vector sum $\vec{a}_i = \vec{a}_{i1} + \vec{a}_{i2} + \cdots + \vec{a}_{ik}$ of these individual accelerations, each of which is given by Newton's law. The situation gets more complicated if the masses have other dynamically relevant properties, such as electric charges, which require additional terms to account for non-gravitational interactions. But physicists have developed a rigorous method for taking all these factors into account. For any physical system, this procedure delivers *equations of motion* that describe how the spatial distribution of physical properties at one time constrains their spatial distribution at another time. In a simple example, the equations of motion might claim that whenever properties F_1, …, F_k are instantiated at $\vec{x}_1$, …, $\vec{x}_k$ at an earlier time then properties G_1, …, G_n will be instantiated at $\vec{y}_1$, …, $\vec{y}_n$ at a later time:

(†) $$(F_1@\,\vec{x}_1 \wedge \ldots \wedge F_k@\,\vec{x}_k) \rightarrow (G_1@\,\vec{y}_1 \wedge \ldots \wedge G_n@\,\vec{y}_n)$$

Since the equations of motion make similar claims about other possible property distributions, we can think of them as a long conjunction of conditionals of the form (†). The reality is, or course, a little bit more complicated. The number of possible property distributions is usually infinite, and (†) does not yet account for the fact the two property distributions would obtain at different times. A comprehensive account of equations of motion would need to be given in the language of the calculus, as differential equations with an infinite-dimensional solution space. Let us not worry about these complications here.

One might argue that the underlying force laws still count as *laws* because they serve as logical building blocks of the equations of motion. This might well accord with what physicists think about laws, and it might even be the correct way of thinking about laws, but it would mean abandoning BSA in favor of some other account of laws. BSA is a regularity view of lawhood that identifies the laws of nature with actual regularities, rather than with underlying features that "generate" or "govern" these regularities. Since the force laws do not describe regularities in worlds with multiple objects, they are not BSA laws. Unless the advocates of BSA want to adopt Cartwright's view that there are no laws in the actual world, which is clearly not what they had in mind, they must accept the equations of motion as laws of nature in many-particle worlds. Any regularity view of lawhood must identify the actual laws with some actual regularities, and the equations of motion are the only regularities that could plausibly play this role.

6. Frankenstein Regularities

The equations of motion describe how the spatial distribution of properties at one time constrains the distribution of properties at another time. They are about patterns of instantiation involving multiple objects and multiple properties, rather than about the co-instantiation of pairs of natural properties by single objects. The properties mentioned in the equations of motion might well be natural, but there need not be anything natural about the way they are distributed. Neither the antecedent nor the consequent of the conditional (†) need to pick out natural properties. If the equations of motion in the actual world qualify as BSA-laws then we can find similar regularities in lawless worlds. Instead of gerrymandering predicates, which is prohibited by the language requirement, we can find pervasive regularities in lawless worlds by gerrymandering the *distribution* of natural properties.

Suppose we are in a lawless world and it happens to be the case that, whenever some natural properties $F_1, \ldots, F_k$ are instantiated at locations $\vec{x}_1, \ldots, \vec{x}_k$, the natural properties $G_1, \ldots, G_n$ are later instantiated at locations $\vec{y}_1, \ldots, \vec{y}_n$. This gives us one conditional of the form (†). Since there is no upper limit on how many properties we can include in the antecedent and the consequent of (†), we can find numerous gerrymandered conditionals of this type, by exploiting the random peculiarities of our lawless world. Once we have collected all these conditionals, we take their conjunction to produce a pervasive *Frankenstein regularity* that has the same logical form as equations of motion.

It might turn out that none of the conditionals in this long conjunction has more than a single non-trivial instance. To gerrymander conditionals of the form (†), we might have to consider very complex property distributions that occur only once in the history of our lawless world. But that is not a peculiar feature of Frankenstein regularities. It is very likely that most of the momentary property-distributions in the actual world also occur only once in world history. In a deterministic world without eternal recurrence, *every* momentary property-distribution is guaranteed to be unique. This means that we cannot impose a strength threshold on individual conditionals of the form (†) without running the risk of ending up with a lawless actual world, by excluding equations of motion from lawhood. Yet if only the long conjunction of these conditionals needs to have enough non-trivial instances then also Frankenstein regularities can satisfy the language requirement and still surpass any strength threshold.

If we use an absolute strength threshold for lawhood, rather than one that is relativized to the size of the world under consideration, then we might need to consider a lawless world that is large enough to yield a Frankenstein regularity of the appropriate size. But we are only trying to show that BSA finds laws of nature in many lawless worlds, not that it finds laws in all of them.

The equations of motion are unified by the systematic way in which they are generated by the underlying force laws. One might argue that it is because of this *systematic unity* that the equations of motion count as BSA-laws. Even though the force laws themselves are not BSA-laws (they do not describe actual regularities, as noted by Cartwright) they are part of the reason why the equations of motion, which the force laws generate, are part of the best system in the actual world.

Considerations of systematic unity can also be used to address the issue of vacuous laws mentioned earlier. The force laws generate numerous conditionals of the form (†) that are concerned with property distributions that are never realized in the actual world. These vacuously true conditionals might not add any strength to our system but they do contribute to its systematic unity, which is arguably a key part of what makes the equations of motion the best system in the actual world.

By contrast, the Frankenstein regularities in lawless worlds are stitched together from unrelated conditionals and lack the systematic unity that characterizes the equation of motion in the actual world. But such trans-world comparisons do not matter for determining the best system in a particular world. Frankenstein regularities do not compete with systems in the actual world; their rivals are other regularities in their own lawless world and none of these local competitors are unified by force laws, either. In lawless worlds, Frankenstein regularities can only be defeated by other Frankenstein regularities. The best Frankenstein system in a lawless world might lack systematic unity, but that does not change the fact that it is the best system in its world, and that its axioms count as BSA-laws.

So even if we adopt both the language requirement and a strength threshold, BSA still runs into problems with lawless worlds. Either BSA fails to find any laws of nature in the possible worlds described by our best physical theories (because it does not admit equations of motion as laws), or it finds laws in some lawless worlds (because it must admit some Frankenstein regularities as laws).

7. Laws and Counterfactuals

The advocates of BSA might claim that the argument cuts the other way and that it shows that the best Frankenstein regularity in a "lawless" world is indeed a BSA-law. We already considered this move at the end of Section 3, when discussing minor random regularities. Back then, we rejected the proposal because the minor regularities in lawless worlds are not "highly informative" and thus fail to support counterfactual conditionals via the mechanism outlined in Lewis' proof. What is different in the present case is that Frankenstein regularities are not minor. They are designed to clear the strength threshold, which is our standard for being "highly informative" about a world. However, since we obtained the pervasive Frankenstein regularities in lawless worlds by stitching together minor accidental regularities, they still do not support the associated counterfactuals, as laws of nature ought to do.

As a simple example, suppose that the best Frankenstein regularity in a lawless world w has Goodman's coin regularity (*) as a conjunct. Then the entire Frankenstein regularity might be "highly informative" about w, but the coin regularity on its own is still no more informative than a small cluster of particular facts. Breaking this minor regularity would still only make for a tiny difference between worlds. Suppose that is a copper coin in w. Presumably, the world most similar to w in which a is in Goodman's pocket is a world in which (*) is false and a is still made of copper. The pocket does not acquire the ability to turn copper into silver just because we conjoin (*) with numerous unrelated conditionals. It is still false that a would have been made of silver had it been in Goodman's pocket.

Like Frankenstein regularities, equations of motion are conjunctions of conditionals of the form (†) that often have very few non-trivial instances. The difference is that these conditionals are generated in a systematic manner from the underlying force laws. Breaking even a minor conjunct of the equations of motion would upset this systematic unity, and that would arguably take us to a very different possible world. If that is right then the equations of motion do support counterfactual conditionals, but they do so thanks to the systematic unity they derive from the force laws and not because of their informational content, as Lewis' proof suggests.

Suppose we wanted to know what would happen if the Moon had half its actual mass. The equations of motion seem to provide an easy answer to our question. We just need to find the conjunct of form (†) where the antecedent describes our counterfactual situation and then extract the answer to our question from the consequent. But the conditional that supports the counterfactual is vacuously true in the actual world, where the Moon has a larger mass, and we only included this conditional because it contributes to the systematic unity of the equations of motion. The equations of motion thus support counterfactuals thanks to their *vacuously true* conjuncts, which provide no information about the world that we are in.

This points to a crucial flaw in Lewis' proof that BSA-laws support counterfactual conditionals. Any attempt at maximizing both strength and simplicity is bound to generate a small number (simplicity) of pervasive regularities (strength), thus guaranteeing that BSA laws are "highly informative" about their worlds. While this feature might be necessary to support counterfactuals, it is not sufficient. The best Frankenstein regularities in lawless worlds can be as informative about their worlds as the equations of motions are about ours, yet only the latter seem to support the associated counterfactuals.

Since Lewis is clearly more interested in the logical role of laws in shortening the Big Book of Facts than in the support that they give to counterfactuals, he might be tempted to abandon his proof and conclude that only some lawlike regularities support counterfactuals. We are lucky to live in a possible world with laws that do support counterfactuals. But we already noted in Section 2 that this would undermine the motivation for developing a sophisticated regularity view like BSA in the first place. If we are willing to accept that only some laws support counterfactuals then there is no reason to abandon the naïve regularity view that all regularities are lawlike.

Moreover, if only some regularities support counterfactuals then we should want to know what it is about these special regularities that gives them the power to support counterfactuals. To solve the problem of lawless worlds, this would need to be some feature in addition to the language requirement and the strength threshold. Once we have identified this extra feature, there would be irresistible pressure to reserve the term 'law of nature' for those regularities that possess this feature, especially if this would finally allow us to classify Frankenstein regularities in lawless worlds as accidental. In light of the discussion of equations of motion, an obvious proposal would be to require the best system to be unified by underlying force laws. But that would restrict lawhood to systems that are broadly similar to Newtonian mechanics, and it is not clear that BSA could adopt such a requirement without ceasing to be a regularity view of lawhood.

The problem of lawless worlds suggests that, as presented by David Lewis, BSA is at best an incomplete account of lawhood. While laws of nature might indeed play a purely logical role in shortening the Big Book of Facts, this cannot be turned into a sufficient condition for lawhood. In the actual world, the best system might include equations of motion unified by underlying force laws that support counterfactual conditionals. But there are no systems unified by force laws in lawless worlds, where even the best system lacks the power to support counterfactual conditionals.

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