

Generalizing the Problem of Humean Undermining

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Abstract:

For Humeans, many facts—even ones intuitively “about” particular, localized macroscopic parts of the world—turn out to depend on surprisingly global fundamental bases. We investigate some counterintuitive consequences of this picture. Many counterfactuals whose antecedents describe intuitively localized, non-actual states of affairs nevertheless end up involving wide-ranging implications for the global, embedding Humean mosaic. The case of self-undermining chances is a familiar example of this. We examine that example in detail and argue that popular existing strategies such as “holding the laws fixed as laws” or “holding the laws fixed as true” are of no help. Interestingly, we show how a new proposal that draws on the resources of the Mentaculus can yield the right results—but only on the assumption that the Humean can make cross-world identifications. We go on to argue that the Humean cannot make such identifications. We conclude that the root of this trouble is deeper, and its reach broader, than the familiar cases suggest. We think it is very much an open question whether the Humean has sufficient resources to properly conceptualize macroscopic objects or to analyze these “local” counterfactuals.

Generalizing the Problem of Humean Undermining

1 Introduction

For Humeans, all facts about the world supervene on a global mosaic of local qualities, the distribution of fundamental intrinsic, categorical properties arrayed in spacetime. It follows that many facts—even ones intuitively “about” particular, localized macroscopic parts of the world—turn out to depend on surprisingly global fundamental bases.¹ For instance, the fact that this chunk of salt is soluble in water depends on facts about special science kinds that reflect, or arise from, patterns in fundamental local qualities spread across all of space and time. We investigate some counterintuitive consequences for such a Humean picture.

To get a feel for the problem, suppose there were a perfect microphysical duplicate of this chunk of salt in a world that shared our microphysical dynamical laws, yet (perhaps due to strange initial conditions) did not contain any other samples of salt (or, more dramatically, any other macroscopic solids at all). In such a world, on the standard Humean account, there would be no simple, informative systematization that included the special science kind *salt*, nor the special science causal process of *dissolving*, and thus no disposition of *solubility*. It seems the Humean is committed to implausible counterfactuals such as: “If the initial conditions had been thus-and-so, then a microphysical duplicate of this chunk of salt would not have been soluble.”

The result is similar in form to better-known self-undermining counterfactuals such as, “If this coin had landed heads each time, its chance of landing heads would have been closer to one than it actually is.” Some Humeans have suggested that the laws “need to be

¹ For a more thorough explanation of this, see Miller (2019).

held fixed” when evaluating these counterfactuals, but it is often unclear how exactly this ought to be implemented and motivated. We show how the resources of the Mentaculus can be used to develop a precise account of counterfactual chances, and in so doing, provide a satisfying Humean account of some self-undermining counterfactuals about chances—but only on the assumption that the Humean can make cross-world identifications of objects such as coins. We go on to argue that the Humean cannot make such identifications. We use the Mentaculus to explore what, in broad outline, a Humean solution to our more general challenge from self-undermining counterfactuals would need to look like. We conclude that it is very much an open question whether a Humean account can meet this challenge.

2 Humean Supervenience

Here, we briefly summarize the key bits of Humean metaphysics for our project.

According to the standard, Humean picture, fundamentally, all that exists is the Humean *mosaic*.

The mosaic includes:

- points of space-time (or small regions of space-time) and perhaps concrete occupants of these points (or regions);
- local,² intrinsic, categorical “perfectly natural”³ properties of those points or occupants;⁴ and
- external spatiotemporal relations between the points or occupants.

² We set aside entanglement worries. For more on this, see Miller (2014) and Bhogal and Perry (2017).

³ For the canonical exposition of perfect naturalness, see Lewis (1983). Note that perfectly natural properties, or their bearers, need not be robustly fundamental in a sense that commits Humeans to the thesis that these elements are, for example, *metaphysically prior grounds* of the global mosaic.

⁴ These perfectly natural properties may turn out to be magnitudes with further structure. See Hall (2015), Wilson (2012), Eddon (2013), and Eddon and Meacham (2015).

The familiar, macroscopic properties and kinds, in addition to the familiar notions of modality (including laws of nature, causation, counterfactuals, dispositions, etc.) are not part of the fundamental mosaic, they supervene on these more fundamental features. Metaphysically possible worlds with the same Humean mosaic also have the same laws, dispositions, etc.

3 Local Dependence on the Global Mosaic

Chance is a familiar example of a property that is attributed locally, but that depends on the global mosaic. Consider a typical simplified example: if a coin has a fifty percent chance of landing heads on its next toss, this is in virtue of the fact that its microstructure and environment are part of a global pattern of tosses in which roughly half of those coins land heads and roughly half land tails.⁵ Thus, the local fact about the coin toss's chance depends on the global distribution of features. In order for the toss to have the chance it does, the rest of the universe has to exhibit certain patterns. The very same coin toss, embedded in different patterns, would have a different chance of landing heads.

Dispositional properties are also locally attributed properties that depend on the global mosaic. For example, to say that a chunk of salt is soluble is to say that it has a causal profile: in certain kinds of environments, given the right circumstances, it will dissolve.⁶ But, for standard Humeans, this causal profile is determined by the patterns in the global mosaic; it is only because the laws of nature systematize patterns of dissolving that the intrinsic character of *this particular chunk of salt* can be ascribed the dispositional property of being soluble. This local dependence

⁵ We assume the coin is fundamentally chancy. If the coin's chances are explained in terms of further microstructure and further, more fundamental laws and chances (rather than by the global pattern of heads-lands), the argument may not go through (it will depend on the details of that further structure). Sequences of "fundamental" coin flips are paradigmatic examples in discussions of undermining chances, but we could just as well be considering, say, sequences of stochastic decay events among fundamental particles.

⁶ We bracket the issue of chance—salt is not guaranteed to dissolve. We assume that if the Humean has a satisfactory theory of chance and a satisfactory theory of dispositions, they can be unproblematically combined.

on the global can be extended further. Consider, for example, Ned Hall’s (ms) observation that nothing prevents the Humean from taking the seemingly fundamental property of charge as arising from a simple, informative systematization of particle positions.⁷

The important point is that the Humean takes some things as metaphysically fundamental and takes everything else as (ultimately) derived from patterns instantiated by those fundamental things.⁸ The upshot is that those further features—be they non-fundamental properties, chances, causes, dispositions, functions, etc.—while they may be instantiated locally, nevertheless depend on the global distribution. Thus, all non-fundamental properties—including special science kinds like being a predator, or being a rabbit, or being ill, or being a mother—depend on the global patterns of the Humean mosaic. For instance, if there are not enough predators in a world, then the predator-patterns in the mosaic will not be strong enough to justify their inclusion in a simple law-systematization.⁹

On the Humean picture, then, even a perfect intrinsic duplicate of an actual predator *is not* a predator—it does not belong to a class that earns the status of such a kind—in a world without robust predator-prey patterns.¹⁰ We think this has far-reaching implications for the Humean view, particularly its approach to counterfactuals.

⁷ Miller (2014) suggests applying this sort of strategy to quantum states, particularly in the context of Bohmian mechanics; Bhogal and Perry (2017) discuss the strategy’s general prospects for accommodating quantum entanglement in a Humean framework.

⁸ More carefully: the *truthmakers* for claims about, say, the expected outcome of this chancy event or this pellet’s solubility include patterns collectively instantiated by all elements of the Humean mosaic.

⁹ Certainly, there is also *some* sense of “depend” in which *anti*-Humean laws also depend on the occurrent decoration of space-time. After all, anti-Humeans can endorse claims of this sort: if that decoration were different in such-and-such ways, then the laws would be (would have to have been) different. For anti-Humeans, though, any (true) counterfactuals like this direct us to worlds in which the laws are different because they *have* to be, in this sense: the such-and-such decoration specified in our antecedent is *inconsistent* with (even the truth of) our actual laws. Crucially, though, Humeans don’t need our antecedent’s such-and-such categorical decoration of space-time to be prohibited by our laws in order for a world with that decoration to have laws that *differ* from our own—and so, it seems, various different (“local”) “non-fundamental” facts as a result.

¹⁰ Lewis explicitly endorses the dependence of some local properties on their embedding global distributions. In the case of pain, he writes, “The madman is in pain in one sense, or *relative to one population*. The Martian is in pain in another sense, or *relative to another population*” (1980, p. 221; italics added).

4 Counterfactuals

Counterfactuals are ubiquitous in science. They state how things *would have gone* if something *had been different*. For instance, “If there had been an additional charged particle, then the attraction on the test particle would have been stronger.” While many philosophers who work on counterfactuals are concerned with truth conditions for ordinary utterances,¹¹ we set aside the linguistic concerns and focus on the causal and scientific uses of counterfactuals.¹² We also set aside counter-nomic counterfactuals that ask how things would go, say, had gravity attracted according to an inverse cube law.¹³

Counterfactuals present some well-known problems for the Humean account. We survey some of those below. We go on to show that these problems turn out to be much broader than previously noted. Recall that, according to the Humean, many different things—ranging from dinner parties to solubility and from predation to currencies, etc.—depend on the laws. And since the laws, in turn, depend on the existence of robust patterns, the existence of, say, a chance event, or a dinner party, depends on a lot more than a single coin or a collection of people. Essentially, the Humean is unable to consider counterfactuals that specify only “local” states of affairs in these cases.

¹¹ See, for instance, the large literature on the semantics of counterfactuals in dynamic contexts, including Gillies (2007), Lewis (2018), and Starr (2014).

¹² As Loewer notes, “English counterfactuals are expressed in a number of grammatically different ways, there are many kinds of conditionals, counterfactuals are vague, they are plausibly context relative, they have Gricean implicatures and so forth. The semantics and pragmatics of ordinary counterfactuals is a messy matter. Lewis’s approach, which I will follow, is to ignore most of these difficulties” (2007, p. 308).

¹³ Thus, our project is orthogonal to the suggestion of Bhogal and Perry (2017, p. 93, fn 12) that Humeans need two kinds of modality. More generally, counter-nomic counterfactuals ask what would be the case if some of our actual physical laws were violated. But the cases we are considering here plausibly do not involve any explicit violation of our actual fundamental physical laws, but only antecedents that posit “local” facts that have implications for what the Humean laws of the world can be, such as, “Had only one particle been massive.”

The standard Lewisian way to evaluate a counterfactual, $A \square \rightarrow C$, is to consider the closest world in which the antecedent, A , obtains.¹⁴ If the consequent, C , also obtains in that world, then the counterfactual is true; if not, the counterfactual is false. The closeness of the world is determined contextually, but with an emphasis placed on avoiding “miracles” or violations of natural law. Lewis also thought it was important for the closest world to match the actual mosaic as much as possible. Well known problems for this standard account have led many philosophers to propose modifications of various sorts, most significantly, requiring the mosaic to match the actual world’s past but not its future.¹⁵ Here, we focus in on this idea of violations of law. Specifically, we are interested in cases whose antecedents direct us to worlds with mosaics not systematized by the laws of our actual world.

We first consider the case of chances, since the problem of undermining chances for Humeans is familiar and interestingly different from the cases we address later. Consider a world that has only one coin which will be tossed exactly one thousand times. Now consider the following chance counterfactual:

- **Chance:** If the first 999 tosses of this coin had landed heads, then the 1,000th toss would have a chance of $\frac{1}{2}$ of landing heads.

Intuitively, this is true. Yet on a natural understanding of the Humean picture, it turns out false. According to the Humean, a coin has chance $\frac{1}{2}$ of landing heads only if it inhabits a world in which approximately half of all coins like this land heads-side up when tossed.¹⁶ So there is *no* metaphysically possible world at all—let alone any near one—in which 999 of 1,000 coin tosses

¹⁴ We bracket the caveats about equally close worlds, or ever-closer worlds. See Lewis (1973) for details.

¹⁵ See, for instance, Elga (2000) and Bennett (2003).

¹⁶ Note that the specifics of this derivation may differ in the details. For a frequentist Humean, a coin has a chance of $\frac{1}{2}$ just in case the ratio of heads-lands to tosses is $\frac{1}{2}$. For a more sophisticated Humean, a coin has a chance of $\frac{1}{2}$ just in case the global mosaic has contents optimally systematized (balancing simplicity, informativeness, and fit in a canonical language) by indeterministic laws with a value of $\frac{1}{2}$. We evaluate a third kind of analysis, the Mentaculus, below.

come out heads and yet the last remaining toss has chance $\frac{1}{2}$ of landing heads-side up. The only world we can be taken to when we consider the antecedent, “if the first 999 tosses had landed heads,” is a world in which the last toss is very likely—perhaps guaranteed, given the laws there—to land heads, rendering our consequent false.

In other contexts, some Humeans have argued that holding the laws fixed, *as laws*, or *as true*, will fix problematic undermining counterfactuals.¹⁷ Setting aside worries about how to motivate such a move, we argue that it will not help in this case, for the simple reason that the antecedent specifies a world that is not systematizable by actual laws. Thus, we cannot consistently require that the actual laws be laws in those worlds.¹⁸ Interestingly, these proposals focus on *nested* counterfactuals, which generate a longstanding, related issue for Humean laws. Thus, even if they are successful, much more needs to be said in order to address the problems for non-nested counterfactuals we raise here.

First, consider requiring that antecedent worlds have the actual laws of nature as laws. We’ll have *no* way to analyze a large class of counterfactuals. To see this, consider what happens when we apply the idea to the chance counterfactual: “If the first 999 tosses had landed heads, then the 1,000th toss would have a chance of $\frac{1}{2}$ of landing heads.” If we require that the actual laws be laws in the worlds we counterfactually consider, we will be restricted to worlds that have an even balance of heads- and tails-lands. Thus, we cannot consider a world with *only* 1000 tosses, 999 of which land heads. The problematic world is ruled out by fiat and we are left without an analysis.

¹⁷ See Löw and Jaag (2020) and Bhogal (forthcoming).

¹⁸ Bhogal (forthcoming) argues we ought to give up metaphysical consistency and consider worlds in which the laws of nature are not Humean laws of nature. Even if metaphysical inconsistency were not too steep a price for many Humeans, we argue below that such a proposal is not even straightforwardly logically consistent because it is unclear what it would mean for the same toss to have both a chance of $\frac{1}{2}$ as well as a chance of 1.

What if we merely require that the actual laws are *true* in counterfactual worlds? We would need to consider a world in which the heads frequency is near one, and thus the Humean chances in that world are near to one as well, but *also*, somehow, it is *true* that the chance of heads is $\frac{1}{2}$. This is a puzzling situation since, for Humeans, chances are supposed to closely track frequencies. According to Lewis, any world in which our undermining future does come to pass is one that “contradicts the truth about present chances” (1994, p. 482). We find it implausible that incompatible chances could be truthfully ascribed to the same token event in this way.¹⁹

But let us grant that there is no strict, logical inconsistency here: our laws can count some single event as having chance $\frac{1}{2}$ even though it figures in a heads-only global sequence. Indeed, on some competing views of chance, the chance values do not logically constrain frequencies at all.²⁰ Then the counterfactual, “if the first 999 tosses had landed heads, then the 1,000th toss would have a chance of $\frac{1}{2}$ of landing heads,” would be true (good), but so would, “if the first 999 tosses had landed heads, then the 1,000th toss would be near certain to land heads” (bad), as would variants specifying any chance value at all in the consequent (really bad). Arguably, this would render such counterfactuals useless; at the very least, it would scupper the Humean project of *reducing* chances to the occurrent decoration of space-time. We conclude that “holding fixed

¹⁹ Note that this isn’t a case of reference-class relativity, where conflicting chances may be ascribed to the same event as a result of conditionalizing on different portions of the mosaic.

²⁰ Here is a way to approach a proposal like this. For the Humean, the space of metaphysically possible worlds includes all combinatorially possible distributions of fundamental properties across elements in or of space-time. So in our example, the space will include all the combinatorially possible sequences of heads and tails across any given series of flips. Following Hall (ms), we can circumscribe the nomologically possible worlds as those *consistent* with (the *truth* of) our actual laws—regardless of whether our actual laws qualify as optimal systematizations of, and thus laws in, all these worlds. Now, our actual laws say that coin flips have chance $\frac{1}{2}$ of landing heads-side up. On the proposal we are considering, the truth of this is consistent with *all* of our metaphysically possible worlds: after all, this is a claim *just* about *chances*: it doesn’t explicitly say anything at all about occurrent sequences of heads or tails, nor does it even implicitly constrain (frequencies across) our various combinations of fundamental properties. Instead, perhaps we just say that any metaphysically possible intrinsic duplicate of a coin (in our world) with chance $\frac{1}{2}$ of landing heads has the same chance in any other worlds, regardless of any frequencies there. (So maybe a duplicate can count as having this same chance even in a world in which objects behave entirely differently—not landing heads or tails or even flipping at all.)

the laws” does not give Humeans a way to formulate and evaluate our undermining chancy counterfactual as true.

Humeans have directed much of their efforts to showing that this is, in fact, the right result.²¹ According to these Humeans, it is a defining feature of (belief about) anything that counts as chance that it stands in a certain relationship to (belief about) rational subjective credence. Allegedly, cases of undermining threaten this relationship: in such cases, Humean laws assign a non-zero probability to some course of events even though, in light of these very same laws, we are (rationally) certain that this course of events will not actually happen. Humeans’ standard fix is to block any threat of mismatch between *relevant* objective probabilities and rational credences by setting both to zero—by denying that their laws assign salient non-zero chances to all self-undermining futures like the one we consider. The so-called “New Principle” makes this explicit: we should align our credence with the *conditional* probability that our 1,000th toss lands heads, *given* that the chance of heads is $\frac{1}{2}$. But according to Humeans, for the chance of heads to be $\frac{1}{2}$ is, in part, for the global mosaic to be such that (roughly) half of all tosses land heads. So our credence here should be zero, matching the likelihood that a *contradiction* obtains: all 1,000 coin flips land heads, but only half do.²²

²¹ For discussion, see Lewis (1994) and Hall (2004).

²² Fernandes (this volume) argues that it is a weakness of the Humean view that it cannot allow arbitrary (but unlikely) divergence between chances and frequencies since, she claims, scientific practice presupposes that such divergence is possible. Roughly Fernandes argues that any attempt to permit some crucial divergence—enough to accommodate our chancy counterfactual, for instance—will permit *too* much: it will undermine Humeans’ claim that their metaphysical reductionism about chance has a key advantage when it comes to motivating the connection between (beliefs about) objective chances and subjective credences formulated in the Principal Principle (or some variant thereof). We think Humeans are wrong to claim any such advantage to begin with—see also Hall (2004). Still, there is an important sense in which our paper is a generalization of this sort of challenge to Humeanism. Specifically, we suggest that (i) threats of undermining arise not just with chances but also with other locally ascribed but globally based features of the world; and (ii) Humeans need to be able to accommodate the truth of at least some counterfactuals about such features. Importantly, we are also arguing that (iii) even before Humeans try to accommodate the truth of our counterfactuals, they face the non-trivial challenge of *coherently formulating and entertaining* many of the counterfactuals in question. We can apply a version of our worry in (iii) for the case of chance: If chances just *are* artifacts of global patterns or frequencies, then what does (or could) it even *mean* for chances and frequencies to diverge in a world—so that, say, our 1,000th flip has chance $\frac{1}{2}$ of coming up heads even

To put it another way, the default Humean move is to dismiss our case as one in which information about chances is inadmissible, since it is manufactured so that we already know that there are 1,000 flips in total. Any intuition that our counterfactual about chance is true, or even coherent and well-functioning in these circumstances, is more or less inconsequential. In more realistic, more interesting cases, relevant information about chances is (more) admissible, and Humeanism can deliver all the right verdicts—purportedly, accommodating all of the *important* intuitions.²³ The situation here is reminiscent of the philosophical discussion around anti-Humean arguments from “lonely” worlds. Anti-Humeans claim to describe (sparse) worlds that match entirely in their total categorical decorations (frequencies) while being subject to different laws, thereby disproving Humean supervenience. Humeans must dismiss any apparent possibility here as *merely* apparent. But many are happy enough to do so: by their lights, any intuition of distinct laws in such cases is inconsequential, and any suggestion that we need to accommodate such an intuition is question-begging.²⁴

5 Mentaculus

Interestingly, by positing a mathematical measure over worlds, a new proposal called the *Metaculus* does have the resources to evaluate chance counterfactuals like ours. In

though we have had 999 heads outcomes? Again, we sympathize with Lewis’s (1994, p. 482) claim that on a natural understanding of the Humean account, such a scenario is incoherent.

²³ Perhaps, for example, Humeans can recover the right rational credence for a case in which we do not know how many coin flips there are in total. For Humeans, if we know that (according to our actual laws) coin flips have chance $\frac{1}{2}$ of landing heads, then we automatically know a lot about the global character of our actual world—about half of the coin flips across space-time land heads—and so about the general character of nearby worlds “consistent” with our laws as well. But to generate any contradiction, we have to know more about the occurrent decoration of space-time: that there are only 1,000 flips in total, or that the frequency of heads across the first 999 flips is representative of the global frequency, etc. Without that, then knowing that the first 999 flips land heads does not threaten chance $\frac{1}{2}$ for our next flip. After all, Humeans can point us to a near world in which 999 tosses land heads but the 1,000th still has chance $\frac{1}{2}$ of doing so—since there are, in that world, many more than 1,000 tosses in total.

²⁴ For a compelling Humean response to such cases, see Beebe (2000).

this section, we show how. Unfortunately, the strategy does not generalize, so we will go on to show how other kinds of counterfactuals (even some chancy ones) remain in need of further resources. Importantly, simply *dismissing* the alleged data is not such an easy option for our other cases.

The *Mentaculus* is a precise, probabilistic framework that specifies the laws of nature. It has been developed persuasively and in a great deal of detail by David Albert (2000) and Barry Loewer (2007; 2008; 2009). The *Mentaculus* includes three postulates:

1. Low Entropy Initial Macrostate: The actual world began in a macrostate of very low entropy.²⁵
2. Statistical Postulate: Each way the actual world could have begun, consistent with the low entropy condition was equally likely—or, more precisely, the region of phase space corresponding to possible low-entropy initial conditions conforms to the Lebesgue measure.
3. Deterministic, Newtonian Microevolution: the positions and velocities of the fundamental particles evolve according to Newtonian laws.²⁶

The *Mentaculus* describes a set of “trajectories” or “worlds,” each of which began in the same low-entropy macrostate that the actual world did, though each in a different particular microstate. These different worlds evolve deterministically and uniquely. Some of them share our current macrostates, and some of them do not, though none of them shares our exact microstate. Since this set of worlds is well defined in phase space, there are precise measures that correspond to various macrostates (though, as we argue below, picking out the relevant

²⁵Albert and Loewer emphasize that nothing about the fundamental direction of time hinges on this use of “began,” but that issue is orthogonal to our purposes here, so we use this simpler formulation.

²⁶ While these assumptions are in fact false (our world is quantum mechanical and general relativistic, not Newtonian), we will follow the practice in the literature of ignoring those complications. This is justified because the arguments concerning counterfactuals and entropy are very likely to carry over to the more complicated theories.

macrostates in other worlds is not straightforward). For instance, of all the worlds (restricted to the low-entropy initial state) containing macrostates of rolling a die, one half of them land in a microstate of an odd number, a sixth of them land in a microstate of showing five pips, etc. This picture, then, yields ratios for any process. Simply divide the measure of worlds with the relevant outcome by the measure of worlds with the relevant input. While the Mentaculus can be interpreted in a variety of metaphysical ways,²⁷ when we treat this overall picture as a Humean way of describing the actual world, we can count those ratios as “chances” due to the role they play in science and guiding our credence. Thus, we can (in theory) derive the chance of any counterfactual event.²⁸ David Albert (2015, pp. 7-8) describes how this process works:

Start (then) with the initial macrocondition of the universe. Find the probability distribution over all of the possible exact microconditions of the universe which is uniform, with respect to the standard statistical-mechanical measure, over the subset of those microconditions which is compatible with that initial macrocondition, and zero elsewhere. Evolve that distribution forward in time, by means of the exact microscopic dynamical equations of motion, so as to obtain a definite numerical assignment of probability to every formulable proposition about the physical history of the world. And call that latter assignment of probabilities the *Mentaculus*.

The crucial feature of the Mentaculus, as far as our chancy counterfactuals are concerned, is that it posits further structure—namely, measures—over the worlds under consideration. The Humean can take those measures over sets of worlds to be chances for particular events,

²⁷ See Demarest (2016; 2019) for further discussion.

²⁸ A broadly statistical mechanical approach to counterfactuals has been developed in different ways by Kutach (2002), Albert (2000), Loewer (2007), and Fernandes (forthcoming). All of these accounts rely on the background of the Mentaculus. These approaches to counterfactuals can be contrasted with linguistic accounts, such as Stalnaker (1968) and Lewis’s (1973) approach and with Bennett’s (2003) approach, all of which require similarity judgments and which allow for “miraculous” exceptions to the laws of nature. Tomkow and Vihvelin (ms) have developed Bennett’s account in light of statistical mechanics. While these authors provide illuminating analyses of many other issues that arise for counterfactuals—ranging from the direction of time to the fixity of the past and control of the future—they have not yet satisfactorily addressed the issues we raise here.

regardless of whether or not those chances are how the worlds within the set themselves would be systematized. For Humeans who embrace the Mentaculus, chances remain artifacts of laws that best systematize, and so supervene on, the totality of actual categorical facts. Importantly, though, this best system builds in its distinctive further structure when it includes our initial low-entropy microstate among the laws.²⁹ This is what allows frequencies within some “non-actual worlds” to diverge from our laws’ chance ascriptions. Since a more standard Humean treatment of chance lacks this further ingredient, it lacks the resources to accommodate the possible divergence between frequencies and chances required by our counterfactuals.³⁰

Consider, again, the case of a world with only 999 tosses of a coin. Plausibly, the Mentaculus includes continuously many such worlds. Plausibly, of those worlds that go on to have one more coin flip, measure $\frac{1}{2}$ of them will land heads, and measure $\frac{1}{2}$ will land tails.³¹ This is what allows us to conclude that the chancy counterfactual is true: “If the first 999 tosses had landed heads, then the 1,000th toss would have chance $\frac{1}{2}$ of landing heads.” We rely on the *measure over* a relevant *set* of worlds, not the chance values *at* any particular worlds.

Humeans are not eager to introduce metaphysical entities, and they may worry that this account is *ad hoc*—a modification of the metaphysical picture merely to render certain counterfactual judgments true. So why should a Humean countenance the plurality of Mentaculus worlds? Because these worlds are nothing more than a useful way of systematizing

²⁹ Of course, the viability of this non-standard Mentaculus approach hinges on whether Humeans can make the case that such information earns a place in the best system of laws for our world. This issue is perhaps particularly pressing given other existing challenges for Humeans, including that of accommodating the particular sort of “informativeness” at work behind familiar division between initial conditions and dynamical hypotheses. See Hall (2015).

³⁰ In principle, nothing prevents other Humeans from adding a similar structure, to our knowledge, none have done so. (For any candidate along these lines, moreover, we would want to ask this question: How *substantive* are any alleged differences between this proposal and the Mentaculus itself?) Regardless, the Mentaculus serves as a nice case study.

³¹ There are many “plausibly” clauses here because of the technical promissory notes concerning the way that trajectories evolve in a phase space with six dimensions for each particle.

actual patterns. By supplementing our microphysical dynamics with a characterization of the low-entropy macrostate and a uniform measure, we sacrifice a little simplicity but gain a *far* more informative characterization of our actual mosaic. The alternative microphysical trajectories are a straightforward consequence of this addition. Thus, they have no independent existence; they are not on equal footing with our world. Instead, the Mentaculus takes seriously David Lewis's characterization of other worlds as tools for evaluating counterfactuals *about our* world (1986, p. 22):

It's the character of our world that makes some A-worlds be closer to it than others. So, after all, it's the character of our world that makes the counterfactual true....But it is only by bringing the other worlds into the story that we can say in any concise way what character it takes to make the counterfactuals true.

John Heil makes a similar point (2013, p. 172):

When a philosopher resorts to talk of possible worlds to support a claim about what is or might be the case, it is worth asking what feature of the universe as we have it might make the claim true. The danger is that easy talk of possible worlds screens us off from serious ontology.

When we appreciate the true purpose of the Mentaculus, we need not consider the trajectories within it as independent entities that, in turn, ground their own set of laws and to which we are beholden in our counterfactual reasoning. Rather, the trajectories take their place in the Mentaculus *only because* together, they represent facts about the actual world and its laws in a powerful, unified way.

6 Undermining Generalized

Chances aren't the only things whose existence depends on the global patterns. Special science kinds do as well. Consider, for example, pH. HCl is an acid. But, at least on a natural understanding of Humeanism, acidity depends upon the existence of global patterns of acids and

bases systematized by our special science of chemistry. A perfect intrinsic duplicate of some actual sample of HCl would not be an acid in a world without the same patterns. Compare Lewis's characterization of pain: "We may say that *X* is in pain *simpliciter* if and only if *X* is in the state that occupies the causal role of pain for the *appropriate* population" (1980, p. 219). He adds, "an appropriate population should be a natural kind—a species, perhaps." Apparently, this characterization prevents the Humean from considering an entity's pain without *also* positing the existence of a broad pattern of beings that give rise to the kind of being it is.³² Thus, consider the following examples of counterfactuals (which should be true, but come out false):

- **Disposition:** If this chunk of salt were the only macroscopic solid, it would be soluble.
- **Special Science Kind:** If this solution of HCl contained the only complex molecules, it would be an acid.
- **Functional Category:** If a microphysical duplicate of this person (who happens to be in pain from burning his hand) were to coalesce out of thermal equilibrium, he would be in pain.³³
- **Non-Fundamental Mass:** If there had been a single particle, it would have had mass.

Each of these antecedents directs us to some metaphysically possible world in which the Humean mosaic is much sparser than our actual one, yielding laws very different from our own. This makes trouble for Humeans, since—at the very least—it is not clear how they can recover the intuitive truth of the consequents. In a world without enough patterning to support the existence of non-fundamental science kinds, the relevant regularities do not hold. This problem

³² See Hawthorne (2004) and Weatherson (2007) for more detailed discussion of this point.

³³ If there are worries about whether *all* mental states, including pain, are essentially representational, we can add to the antecedent enough causal history (such as that the being coalesces out of thermal equilibrium inside of a room with a hot stove which burns his hand) for the pain state to be representational, but not enough to justify the inclusion of laws about pain in the Humean lawbook. See Davidson (1987), and the resultant literature—much too large to properly canvas here.

has been emphasized in the context of nested counterfactuals. For instance, the above can be marshaled in support of these nested counterfactuals (which should be true, but which come out false):

- **Nested Disposition:** If there were only one macroscopic solid (an intrinsic duplicate of this salt), then if it were placed in water, it would dissolve.
- **Nested Special Science Kind:** If there were only one solution of complex molecules (an intrinsic duplicate of a solution of HCl), then if it were measured with a pH strip, it would have a pH of 3.
- **Nested Functional Categories:** If a microphysical duplicate of this person (who happens to be in pain from burning his hand) were to coalesce out of thermal equilibrium, then if he were asked how he felt, he would say that he is in pain.
- **Nested Non-Fundamental Mass:** If there had been a single particle, then if there had been a second one, they would have been gravitationally attracted.

Much has been written on these nested counterfactuals in the context of Humeanism. What we would like to emphasize is that the problems of nested counterfactuals stem from a very general feature of Humeanism: our actual laws, and their associated global patterns, are surprisingly essential to the intuitively “local” affairs described by typical counterfactuals. Generally, any non-fundamental feature under consideration in a Humean counterfactual will require radically global conditions be met for plausible truth values. If those global features are ruled out by particular features of the antecedent, then the Humean likewise has to relinquish the non-fundamental properties, kinds, dispositions, functions, etc., that relied on them. We now turn our attention to a deeper worry that threatens any attempt to rescue Humeanism from the above problems.

7 How to Identify Non-Fundamental Things

Recall Albert's claim that the Mentaculus yields a definite numerical probability for, "every formulable proposition about the physical history of the world" (2015, pp. 7–8). We now argue that such statements are surprisingly difficult to formulate and entertain for worlds that do not share our laws. Consider the statement, "A chunk of salt dissolves in water." How do we go about identifying whether or not there is a chunk of salt, whether or not there is water, or whether or not one dissolves in the other? On a natural interpretation of Humeanism, *what it is* to be salt is just to be part of a global pattern that is systematizable in a certain way. The same goes for water, dissolving, etc. Note that it is open to the Humean to define some macroscopic entities in *compositional* terms. Water is a plausibly case of this kind: water is (metaphysically essentially) H₂O. However, the Humean has emphasized the importance of global patterns in characterizing non-fundamental kinds. It is *because* some compounds have the same causal profile that we group, say, NaCl, CaCl₂, K₂Cr₂O₇, and NaSHO₄ together as "salts." Any disjunctive, compositional definition for a special science kind (that references only purely fundamental terms) will depend on the global patterns. Anyway, it is implausible that such definitions could be provided for more than a few very simple cases of special science kinds. Every single non-fundamental property owes its existence to the patterns in which it features. Thus, for the Humean, if there is no pattern, there is no kind. Note that this is first and foremost a *metaphysical* problem about what it takes to have salt in a Humean world; it is only secondarily a problem of language or definitions.

This presents a problem for counterfactuals. Typical counterfactuals *presuppose* notions that depend on the actual laws of nature. It is not clear that Humeans, using Lewisian semantics for counterfactuals, even have the resources to evaluate these counterfactuals at all—it is not

clear how we are to *entertain* their antecedents, never mind determine their truth-values. To see this, focus on the antecedent: “If this chunk of salt had been the only macroscopic object to form.” Intuitively, the antecedent is pointing us to a world with just one macroscopic solid, this chunk of salt. Yet in that world, there *are no* chunks of salt! The Humean could offer a translation: “this chunk of salt” is to be understood as the actual, particular microstate that instantiates the actual chunk. Presumably, that microstructure, since it is specified in fundamental terms, could be duplicated in similar worlds lacking the robust patterns required for the existence of the kind, “salt.” But arguably this is too restrictive. Certainly, we can intuitively consider antecedents that posit the existence of some chunk of salt or other: “If the only macroscopic solid to form had been a chunk of salt.” We may prefer that antecedent if we are not concerned with any actually existing, particular microstructure.

Let us revisit the three approaches we considered in the case of chance to see how they fare in cases of non-fundamental features. First, we can hold the laws fixed *as laws*. Second, we can require that the actual laws be *true*. Third, we can add external structure to the set of worlds under consideration, as the Mentaculus does for chances. Again, requiring that the laws be held fixed *as laws* will rule out, by fiat, all of the counterfactuals we are considering. Perhaps the Humean can say something to minimize the importance of such counterfactuals. But note that the vast majority of counterfactuals we care about in ordinary contexts, and in many scientific ones, presuppose or explicitly appeal to non-fundamental properties. Furthermore, many of these counterfactuals concern local, specific states of affairs. It is at least highly counterintuitive to think that a counterfactual about a single chunk of salt’s solubility requires the existence of a large number of such chunks (in order to secure the patterns underlying the single chunk’s “saltiness”).

What of the proposal that we require the laws be true? It is not even clear what it is for a statement to be true if it appeals to kinds of things that *by that world's own lights* do not exist, such as, "A chunk of salt dissolves in water." This seems no less problematic for law statements, such as, "Salts dissolve in water." The Humean could, of course, declare that such laws are trivially true, but this seems to come at the cost of making all laws trivially true, including, "Chunks of schmalts dissolve in schmwater." Worse, if "negative" laws can be laws too, we'll arrive at a contradiction. "Salts do not dissolve in water," could be a trivially true law equivalent to: it's not the case that: "Salts dissolve in water." More generally, the challenge here extends well beyond manufactured "lonely" or "sparse" scenarios that some Humeans readily discount.

- **Dispositional Kind:** If a drop in blood sugar didn't produce a spike in cortisol and adrenaline, people wouldn't get hangry.
- **Special Science Kind:** If giraffes were, on average, six inches shorter, then far fewer mammals would die from lightning strikes.
- **Functional Kind:** If there were no predators, then prey's rate of reproduction would be a direct function of food availability.

Maybe these counterfactuals are true, maybe not. But they are coherent, well-functioning, and plausibly evaluable. For Humeans, though, it is simply not clear *where* their antecedents direct us—or, indeed, whether there are any relevant worlds in which their antecedents obtain.

Unfortunately, the Mentaculus does not help with *this* problem. The Mentaculus provides well-defined chance values for ratios of well-defined macrostates on trajectories. But what it does *not* do is provide well-defined metaphysical principles for what *counts* as a macrostate of, say, a chunk of salt, or a predator. This is because the relevant macrostates in the actual world are special in virtue of the *actual patterns* they are embedded within. When we are asked to

consider a measure over all of the microstates that could “instantiate” some macrostate, M , we need a recipe that goes beyond the actual instantiations of the actual patterns. And, as we’ve argued, including (merely) possible patterns doesn’t help identify macrostates in worlds without those patterns. Even so, the Mentaculus treatment in the case of chance does offer us insight into what an adequate Humean treatment of such cases would need to look like.

8 What a Humean Solution Might Be

The Mentaculus gives the Humean a good response to the case of undermining chances because it teases apart chances and frequencies for “possible” events. The chance is not determined by facts about the frequencies (or systematization) within some particular “possible” microphysical history, or “possible world.” Rather, the chance is determined by a measure over microphysical realizers of our actual, initial, low-entropy macrostate, conditionalized on possible events. As a result, it equips Humeans to attribute chances to “possible” events—by equating chances with ratios of worlds—even when these chances come apart from the frequencies within the worlds in our salient sets. In other words, it lets us appeal to the actual laws—the ones systematizing our actual world—and make associated chance attributions even when the antecedents of our counterfactuals point us to sets of worlds with different laws and chances of their own.

However, the measures that the Humean Mentaculus identifies with chances are only as well-defined as the macrostates they concern. So, if the Humean is to succeed in providing an analysis of chances and counterfactuals, they need somehow to *apply*, or *appeal to*, the macroscopic properties, kinds, dispositions, etc. of the actual laws even when the actual laws aren’t the laws *of* the worlds under consideration. Unlike what happens when we restrict all relevant counterfactual scenarios to ones that share our same actual laws *as laws*, this should let

us keep the worlds we need for counterfactual analysis. We need a way to *apply* the dispositions, special science kinds, etc. to objects in “possible” worlds, even when those worlds lack the global base that grounds or subvenes the dispositions, special science kinds, etc. While the suggestion of “holding the laws fixed” points us to a kind of rigidity, it is one poorly suited to this problem because it requires too much of our “possibilities.” Our arguments show that what is important is the ability to rigidify the *non-fundamental properties*—be they chances, dispositions, special science kinds, functional kinds, etc., without extending that rigidity to some systematization of an entire world. As we have seen, it won’t work to require the actual laws be laws, and it won’t work to require the actual laws be true—or at the very least, it is just not *clear enough* what it means to require them to be true, since, recall, some terms in the law statement will not refer to anything in too sparse a world. Rather, we need a way of using the robust patterns of the actual world in order to identify and characterize merely possible *objects* in the localized way distinctive of scientific reasoning and counterfactuals, without requiring extraneous corresponding global conditions.

Jeff King (2007, pp. 80–86) addresses an analogous worry, which arises for his own account of propositions; his response may provide Humeans with a helpful resource here. On his view, propositions do not exist in worlds without language—just as sentences, on the standard view of linguistic entities, do not exist in worlds without language-users. King offers an account of how propositions can be true at linguistically impoverished worlds by developing ideas from Robert Adams (1981) and Kit Fine (1985) in the actualism literature. These authors are concerned with propositions such as: \ulcorner Socrates does not exist. \urcorner Since the proposition is possibly true (Socrates is not a necessary being), we need a way to express that truth. However, on King’s preferred view of structured content, propositions get their constituents from objects that exist.

Intuitively, propositions about Socrates require the object *Socrates* in order to be truth-evaluable. Thus, King distinguishes between two notions: **TRUE** and **true at**. On his view, \lceil Socrates does not exist \rceil is not TRUE, but it *is* true at some worlds. Intuitively, the counterfactuals we considered above are true, even though the worlds in which the antecedents hold are systematized by laws that would render them false (or meaningless). However, if we could appeal to something like King's idea, perhaps we could make precise a way to *use* the kinds, functions, and properties of the actual laws in order to evaluate propositions and counterfactuals (even at worlds lacking the requisite metaphysical structure).

We think the Mentaculus points toward the general form of a solution. Recall that the Mentaculus posits a measure over a set of worlds. This measure allows for precise calculations *as long as we are able to identify the relevant macrostates*. The numbers associated with certain events are not determined by the patterns in the world in which those events take place, but rather by the numbers in the structure placed over the worlds. Thus, in a similar fashion, perhaps there is a way to associate a possible object's dispositions, kinds, properties, functional roles, etc., with a structure placed *over* the worlds, rather than with patterns emerging wholly from within its own world.

One way to do this might be to stipulate some long disjunctions of actual and merely *possible* arrangements of fundamental properties that “count”—or that *would* or *should* count—as, say, chunks of salt, or acids, or giraffes. In principle, this strategy could work for any “Lewisian” Humean, since the characterization could be given in terms of perfectly natural properties and relations. However, we doubt that such a project could be carried out in a fully general way. Another related option might be to highlight relevant (non-fundamental, categorical) macrostates within the Mentaculus framework. In order for this approach to yield an

attractive *Humean* proposal, there would need to be a nonmodal characterization (purely in terms of the actual mosaic) of which nonactual microstates count as instantiating a particular macrostate. An alternative might be to extract some distinctive functional role played by actual members of some relevant class, and then use that role—rather than intrinsic categorical bases—to highlight other members of the class across Lewisian possible worlds. But while we see (dimly) how this sort of strategy *might* work for chances or acids, we do not even know how to begin for, say, giraffes.

All these suggestions are extremely speculative, and working out the details will require great care. The most important point, though, is that there is a non-trivial challenge for Humeans here. Intuitively, we need something that lives in the space between microphysical duplicates of actual instances, which are too restrictive—there can be microphysical alterations to an actual chunk of salt that leave it as an instance of salt—and possible objects that instantiate a robust enough possible pattern, which are too restrictive in another way—there can be fairly lonely chunks of salt. What exactly this might be is very much an open question; we are not sure whether Humeans can rise to the challenge.

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