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Necessarily the Old Riddle
Necessary Connections and the Problem of Induction

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Abstract

In this paper, I will discuss accounts to solve the problem of induction by introducing necessary connections. The basic idea is this: if we know that there are necessary connections between properties F and G such that F-ness necessarily brings about G-ness, then we are justified to infer that all, including future or unobserved, Fs will be Gs. To solve the problem of induction with ontology has been proposed by David Armstrong and Brian Ellis. In this paper, I will argue that these attempts to solve the problem of induction fail. Necessary connections fail to reliably imply the respective regularities for two main reasons: Firstly, according to an argument originally presented by Helen Beebee, the respective necessary connections might be time-limited, and hence do not warrant inferences about future cases. As I will discuss, arguments against the possibility or explanatory power of time-limited necessary connections fail. Secondly, even time-unlimited necessary connections do not entail strict or non-strict regularities, and nor do they allow inferences about individual cases, which is an important function of inductive reasoning. Moreover, the proposed solution to the problem of induction would only apply to a tiny minority of inductive inferences. I argue that most inductive inferences are not easily reducible to the proposed inference pattern, as the vast majority of everyday inductive inferences do not involve necessary connections between fundamental physical properties or essences.

Keywords

Dispositional essentialism, laws of nature, necessary connections, problem of induction.

1 Introduction

There is a proposed solution to the problem of induction that precedes the first modern formulation of the problem by David Hume by a couple of centuries[1] The proposal is that we could solve the problem of induction if only we had the right ontology. The basic idea is this: if we know that there are necessary connections between properties F and G such that F-ness necessarily brings about G-ness, then we are justified to infer that all, including future or unobserved, Fs will be Gs. This possible solution of the Old Riddle, widely discussed in scholasticism, has been revived by David Armstrong (1983: 54–9, 96–102) and Brian Ellis (1998: 114–6) and defended by Benjamin Smart (2013) and Tyler Hildebrand (2018). In this paper, I will argue that these attempts to solve the problem of induction fail.

Before I delve into the discussion about whether the necessitarian attempts can be successful, I will begin by first characterising what the problem of induction amounts to, because the solution discussed in this paper depends of a specific view of what it would take to justify induction: to replace inductive inferences with at least truth-conducive inferences. Following this, I will turn first to David Armstrong's proposal, before we turn to more recent dispositionalist approaches like Brian Ellis's. After reviewing the current state of the debate about time-limited necessary connections, I will go on to argue that the necessitarian arguments to solve the Old Riddle fail irreparably. Necessary connections fail to reliably imply the respective regularities for two main reasons: Firstly, the respective necessary connections might be time-limited, and hence do not warrant inferences about future cases. Arguments against the possibility or explanatory power of time-limited necessary connections fail. Secondly, even time-unlimited necessary connections do not entail strict or non-strict regularities, and nor do they allow inferences about individual cases, which is an important function of inductive reasoning. Moreover, the proposed solution to the problem of induction would only apply to a tiny minority of inductive inferences. This leaves the majority of inductive inferences unaccounted for: I argue that most inductive inferences are not easily reducible to the proposed inference pattern, as the vast majority of everyday inductive inferences do not involve necessary connections between fundamental physical properties or essences.

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[1] For an overview over Medieval attempts to justify induction, see (Psillos 2015). Mary Shepherd (2000 [1824]) also put forward a version of this attempt in her response to Hume.

2 The Old Riddle

The prominent formulations of the problem of induction differ significantly.[2] However, the formulation of the problem that still dominates the discussion today is David Hume's account in the *Treatise of Human Nature* (2000 [1739/-40]). Hume formulates the problem as follows: if inductive inferences were a product of reason, i.e., if they were justifiable, they would need to presuppose the premise that nature is uniform. If one wants to infer a universal regularity from an observed regularity, one needs to presuppose that the regularities do not change irregularly. This gives rise to a dilemma. According to Hume, there are only two possible ways to know that nature is uniform, either deductively (Hume's term is "demonstrably"), or inductively (which Hume calls "probabilistically"). According to Hume, I cannot reason for the uniformity of nature demonstrably, since that would entail that nature's regularity is a necessary fact. It is fair to assume that to Hume, the issue is that a deductive inference to the uniformity of nature would have to be made *a priori*, and would hence be a necessary fact. That does not seem to be possible: That nature is uniform is something we can only know from observation. But if we wanted to infer the uniformity of nature from observation, we would have to infer it *inductively*. But unfortunately, it would create a vicious circle if we had to inductively justify the uniformity thesis, which we then need to justify our inductive practice (Hume 2000 [1739/-40]: Section 1.3.6).

As Peter Strawson (1952: 250) has argued, this formulation of the problem is problematic, because it puts an impossibly high demand on what a justification is meant to achieve. The issue with this formulation is that it requires inductive inferences, if they were justifiable at all, to be enthymemes of deductive inferences, i.e. deductive inferences with suppressed premises. This is what a justified inductive inference would look like according to Hume:

P_1: All observed ferromagnets have so far attracted iron.

P_2: Nature is uniform.

P_3: If nature is uniform, then ferromagnets do not change their behaviour.

C: All future and unobserved ferromagnets attract iron.

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[2] I have argued elsewhere that there at least three different notions of justification in the literature. Whereas in sceptical accounts, a possible justification is often supposed to show how induction could be truth-preserving, there also exist notions of justification which demand to show that induction is truth-conducive, or that inductive practice is *rational* (Backmann 2019).

The problem of induction is thus that it is impossible to justify the suppressed premise P_2, which together with P_3 would render the inferences in question truth-preserving (see BonJour 1998: 190 and Backmann 2019). That such a justification is impossible to obtain is entirely unsurprising, given that these are maybe the best known *sceptical* formulations of the Old Riddle.

In contrast to Hume's sceptical formulation of the problem, Laurence BonJour, for example, formulated the problem of induction as follows:

> If we understand epistemic justification […] as justification that increases to some degree the likelihood that the justified belief is true and that is thus conducive to finding the truth, the issue is whether inductive reasoning confers any degree of epistemic justification, however small, on its conclusion. (BonJour 1998: 189)

Thus, according to BonJour, the problem is not how we could show that induction could be made truth-preserving by introducing a suppressed premise which would render inductive inferences as enthymemes of deductive inferences, but merely to show how induction could be truth-conducive.

As will become apparent below, the necessitarian attempts orientate themselves along the lines of the sceptical attempts. They try to justify induction by filling in a supposedly suppressed premise and thereby reduce them to enthymemes of inferences that do not contain induction, although they do not claim that these amended inferences are truth-preserving, as they contain an inference to the best explanation. Now that we have a clearer picture of what sort of inferences we are dealing with and what the problem of induction amounts to, let us turn to the proposed necessitarian solutions to the problem, starting with David Armstrong's account, and then move on to newer dispositionalist attempts.

3 Armstrong's attempt

David Armstrong proposed to solve the problem of induction with reference to necessitation relations between universals. Say we want to justify what appears to be the following inference:

P$_1$ All ferromagnets observed so far have attracted iron.

C Future or unobserved ferromagnets will attract iron.

Armstrong's claim is that such an inference could be justified if we knew that there is, for example, a necessary connection between being a ferromagnet and attracting iron. The inference pattern Armstrong proposes covers two steps: Firstly, we observe that so far, all ferromagnets have attracted iron. From this, we infer via an inference to the best explanation that there is a necessary connection between being a ferromagnet and attracting iron.[3] For Armstrong, or any proponent of the Armstrong-Dretske-Tooley (ADT) view, necessary connections take the form of necessitation relations between universals. That there is a necessitation relation between being an F and being a G is expressed as $N(F, G)$, where N is a higher order polyadic universal, denoting the necessitation relation. $N(F, G)$ is also the form that laws of nature take in the ADT-view. Armstrong now claims that the necessary connection $N(F, G)$ deductively implies the universal regularity $\forall x(Fx \rightarrow Gx)$, which in turn entails that all future or unobserved Fs will also be Gs. This inference pattern is a supposed solution to the problem of induction because Armstrong holds that in contrast to induction, the rationality of IBE is a brute fact. We could thus justify induction by reducing it to an inference pattern of IBE+deduction (Armstrong 1983: 54–9, 96–102). In Armstrong's own words:

> A series of states of affairs is observed, each a case of an F being a G. No Fs which are not Gs are observed. The postulation of the single state of affairs, the law $N(F, G)$, gives a unified account of what is otherwise a mere series. Furthermore, it *deductively* [my emphasis] yields a prediction which enables it to be tested, the prediction that all other Fs will be Gs. […] If this is correct, then induction becomes a particular case of the inference to explanatory ('theoretical') entities. (Armstrong 1983: 96, my italics)

Accordingly, the inference regarding ferromagnets would look something like this:

P$_1$ All ferromagnets observed so far have attracted iron.

C$_1$ There exists a necessary connection between being a ferromagnet and attracting iron (from P$_1$, by IBE)

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[3] Andreas Hüttemann (2014: 32–3) also argues that the resilience of nature to produce a certain state of affairs is best explained by necessitarianism to be true. If one consistently fails to bring about an F that is no G, then we are justified to infer that there is a necessary connection of some kind between being an F and being a G.

$\mathbf{C}_2$ All ferromagnets attract iron (from C_1)

$\mathbf{C}_3$ All future or unobserved ferromagnets will attract iron.

Armstrong goes on to claim that this is another advantage of the ADT-view over Humeanism. He claims that while his account with the above inference pattern can solve the problem of induction by providing a way to infer the nature of future or unobserved cases from the nature of past or observed cases via the detour of inferring the necessary connection by IBE, the Humeans could do no such thing (see Armstrong 1983: 54–9). I will not discuss Armstrong's arguments against Humeanism any further in this article.[4]

Armstrong is not the only person to have proposed using ontology to solve the Old Riddle. So let us take a look at another necessitarian attempt to solve the Old Riddle before turning to our arguments against the necessitarian proposal.

4 Dispositional accounts

Brian Ellis, like David Armstrong, holds that the Old Riddle can be solved by applying a necessitarian ontology (Ellis 1998: 109).[5] Ellis's own brand of dispositionalism, scientific essentialism, is a view according to which the laws are the consequences of the irreducibly dispositional properties of the concrete things, which bear these dispositional properties essentially. A ferromagnet's disposition to attract iron is part of the essence of being a ferromagnet: if it didn't attract iron, it wouldn't be a ferromagnet. Since the laws are only consequences of the essential dispositional properties, they are neither contingent, nor ontologically prior to the causal processes a thing engages in. The kinds of objects there are, the dispositional properties they have, and the processes they are engaged in, all form natural kinds in his view. What natural kinds there are is for the sciences to discover.

Ellis believes that such an ontology makes a solution to the problem of induction possible. The basic idea is this: if we know what sort of essential dispositional property P a kind of things E has, then we can from this predict how that thing is going to behave

[4] See Smart 2013 for a discussion on whether Armstrong's arguments against the Humeans have any force. I do, however, believe Smart's arguments against Armstrong rely on an unfair representation of what sort of universals are admissible in the ADT-view.

[5] He also argues, in a very cursory way, that his scientific essentialism could solve Goodman's New Riddle (Ellis 1998: 107). I disagree, but this is a project for a future paper.

in certain circumstances C. The specific process that the exposure of E to C gives rise to, such as a ferromagnet's attracting iron if there is some in the vicinity, is also a natural kind, just like the kind of things E is, whose identity is fixed by having disposition P. Hence, we are able to infer the following:

> L1: For all x, necessarily, if x has P, and x is in circumstances of the kind C, then x will display an effect of the kind E. (Ellis 1998: 114, italics adjusted for consistency)

From this we are allowed to infer the regularity that

> Necessarily, if a is in circumstances C, then a will display an effect of the kind E. (Ellis 1998: 115, italics adjusted for consistency)

This is Ellis's solution to the Old Riddle: if we know what sort of dispositional properties a natural kind has, then we are justified to infer how members of that kind will behave in future or unobserved cases (Ellis 1998: 116). Ellis's account of how to justify induction is very similar to Armstrong's, although their respective ontologies differ quite significantly. The general idea with both is that if we know that there holds a specific necessary connection, then we can infer the respective universal regularity, which includes all unobserved or future cases. Note that for his solution of the problem of induction, Ellis presumes that our world is deterministic, which is the main point of entry for Stephen Mumford's and Rani Anjum's criticism, which I will discuss further below. Let us now turn to the arguments against the necessitarian solutions. I will begin with the argument from temporally limited necessary connections. While I agree with the general direction this argument takes, I will argue that it does do not quite go far enough, and I will defend it against some criticism. Following this, I will turn to further arguments against the necessitarian accounts: that they fail to secure the deductive inference to the respective regularities or individual cases, and that the proposed solution, even if it did work, only applies to a very limited number of the inductive inferencer we would ideally want justified.

5 Why the necessitarian attempts don't work

In the following, let us discuss a number of arguments against both above-mentioned proposed necessitarian solution, as well as a number of more general arguments against the strategy to solve the Old Riddle with ontology, regardless of the specifics of Armstrong's and Ellis's accounts. After defending Helen Beebee's argument from temporally limited necessary

connections in section 5.1, I will turn to the question whether necessary connections, even if we grant that the argument from temporally limited necessary connections can be defused, actually imply the required universal regularities in section 5.2. There, I will also address a worry that I am arguing against a strawman here: you might worry that clearly, many laws of the sort that Armstrong calls "oaken" laws, only allow us to deductively infer non-strict regularities, and that it would be unreasonable to expect to be able to securely deduce a strict universal generalisation in every instance of this inference rule.

5.1 Time-limited necessary connections

Helen Beebee (2011) offers a compelling argument against the necessitarian attempts to justify induction. In this section, I will briefly recount the argument from temporally limited necessary connections, defend it against some recent criticism, and then go on to argue for a stronger claim. Remember that the necessitarians argued that we infer the existence of a necessary connection from an observed regularity via IBE. Beebee holds that without further argument, it is not clear why a temporally unlimited necessary connection such as the Armstrongian $N(F, G)$ is the best explanation for the fact that so far, all Fs have been Gs. *Prima facie*, there are at least two possible necessitarian explanations why so far, all Fs have been Gs:

> (SF) [So far]: F and G have been necessarily connected so far.

and:

> (T) [Timeless]: F and G are timelessly (eternally) necessarily connected. (Beebee 2011: 510)

If we accept that a necessary connection could be time-limited, then why should the temporally unlimited necessary connection be a better explanation for the observed regularity than the time-limited one? However, such a time-limited necessary connection would not entail the universal regularity that $\forall x(Fx \rightarrow Gx)$, only that the regularity has held *so far*. So unless there is an independent argument against time-limited necessary connections, she claims, there is no way to hold that the time-unlimited one is actually the best explanation for the observed regularity. But without that, Armstrong's inference pattern breaks down (Beebee 2011: esp. 509–11). In order to infer a regularity that covers future cases, we need a temporally unlimited necessary connection. But without knowing that timeless necessary connections are indeed the *best* explanation for observed regularities, we cannot infer them

via IBE.

Beebee notes her argument as portrayed above does not work in a dispositional essentialist picture. In dispositional essentialism, the essences of the natural kinds are made up of their dispositions: a ferromagnet wouldn't be one if it did not have the disposition to attract iron. So in this view, it is supposedly impossible that the necessary connection is time-limited: ferromagnets cannot at some point stop to attract iron; they would cease to be ferromagnets. However, Beebee argues, there is still a way to construct a sceptical alternative explanation. The trick is that when we observe things like ferromagnets, we first have to establish that they are actually members of the relevant natural kind, which is supposed to have a particular dispositional essence. Say we observe a number of items which we, because of their behaviour, conclude are members of the natural kind "ferromagnet", and which have so far attracted iron. According to Beebee, Ellis proposes the following inference:

> (SE) All observed Fs have produced Gs. The best explanation of this is that the Fs are members of a natural kind K, whose essence is or includes the disposition to produce Gs. Hence all Fs (by virtue of membership of kind K) produce Gs. (Beebee: 520)

However, Beebee argues, although it may not be possible that members of a particular natural kind ever have a different dispositional essence, it might be possible that future Fs cease to be members of that particular natural kind. That makes the following alternative explanation possible for the fact that so far, all Fs have been Gs:

> (SF*) *The observed* Fs are (or were, at the time at which they were observed) members of an Ellisian natural kind K, whose essence is or includes the disposition to produce Gs […].

However, that does not entail the following, which would be needed for Ellis's solution to the problem of induction:

> (T*) *All* Fs are members of an Ellisian natural kind K, whose essence is or includes the disposition to produce G. (Beebee 2011: 521)

Her argument amounts to the claim that while it might not be possible to change a natural kind's dispositional essences, it might be possible to change which natural kinds there are: things that look like ferromagnets might cease to be ferromagnets in the future, and hence, we would not be justified to infer that things that look like ferromagnets always attract

iron in future or unobserved cases, because they just might stop being ferromagnets at some point (Beebee 2011: Section 5).

5.1.1 The modality of temporally limited modality

While I agree that it must be possible that what essences are instantiated in nature could change, if, e.g., evolution should be at all possible, I hold that Beebee might concede too much when she agrees that in the Ellisian essentialist picture, it is supposedly impossible to change what is necessarily connected to what. So let us take a step back to discuss the possibility of necessary connection to be temporally limited. We have to keep the dialectic in mind here: remember that the argument so far was that if time-limited necessary connections are possible, and if they are at least as good explanations for the observed regularities, then we are not justified to prefer time-unlimited necessary connections as best explanations for the observed regularities. But without being able to make that IBE, we cannot deduce the universal regularities that give us the predictions about future or unobserved cases. Necessitarians have two ways to respond: 1) they could claim that time-limited necessary connections are impossible, or 2) that they would not be the best explanation for the observed regularities. In this section, I am going to pre-empt 1), before I turn to 2), when I defend the argument from temporally limited necessary connections against a criticism by Tyler Hildebrand (2018). Some of the arguments I am going to discuss concerning the temporal scope of necessary connections will seem quite baroque. But this is exactly the point: the discussion below will show just how metaphysically extravagant these arguments would have to be, while they still wouldn't work.

There are, *prima facie*, three ways to argue that it is impossible that necessary connections, regardless of whether they are of the ADT- or the dispositional essentialist kind, are time-limited, all of which are dubious. One could either argue that a change of necessary connections is 1) logically, 2) physically, or 3) metaphysically impossible. Logical modality can be ruled out without much argument here. Time-limited necessary connections are clearly not logically impossible. Logical modality (unless misconstrued as something like conceptual modality), is a consequence or a feature of the respective logical system. And no logical system implies that ferromagnets do not at some point repel samples of iron.

Time-limited necessary connections also cannot be physically, or nomologically, impossible. In the case of the ADT-view, physical modality simply is the modality of necessary connections in nature: that it is physically necessary that any F is a G is the consequence of the natural law $N(F, G)$. In order to argue against the physical possibility of time-limited necessary connections, it would need to be physically impossible that at some instant in

time t_1, $N(F, G)$ holds, while at a later instant, t_2, $N(F, H)$ holds, but not $N(F, G)$. But for this change to be physically, or nomologically, impossible, there would need to be a second-order natural law, i.e. a complex, relational universal, which makes it the case that at all times, $N(F, G)$ holds but not $N(F, H)$. This second-order law would have to necessarily relate the law, which is a complex second-order universal, to another universal, but which one? A universal such as "being universally valid" U? First and foremost, we would not accept such a universal in the ADT-view, since universals are supposed to be fundamental physical properties in the that view. But let us assume that we could accept such a universal. Since the law $N(F, G)$ is a complex universal anyway, it can figure in necessary connections itself. Let's say we would get the following law: $N((N(F, G)), U)$. Again, I am sceptical that such a law is actually permissible in the ADT-view, especially if we look at Armstrong's responses to the identification problem, where he identifies N with causal necessity (Armstrong 1993). In such a case, the law $N(F, G)$ would *cause, bring about* its own universal validity. Whether one finds such a notion comprehensible at all I will leave up to the reader—I certainly do not.

But even if we grant all this, we would still have to find a way to make sure that the law of nature that ties $N(F, G)$ to its unlimited validity would have to be temporally unlimited itself. So presumably, it would require a third-order law to ensure that, and so on *ad infinitum*. So even if we could make sense of the claim that it is physically necessary that the existing necessary connections hold timelessly in the ADT-view (and I don't believe we can), that still would result in a regress.

In the dispositional essentialist case, physical modality, if there is such a modality at all, is reducible to metaphysical necessity: if it is physically necessary that Fs are Gs if the right stimuli are present, then this is so because it is the very nature of Fs to be Gs if the right stimuli are present. So for the dispositional essentialist, in order to argue that it is physically impossible for a necessary connection to change, one would have to argue that this is not physically, but *metaphysically* impossible.

That leaves us with the third option, i.e. that necessary connections are temporally unlimited with metaphysical necessity. For the ADT-view, it seems to go against the very motivation behind that view to invoke metaphysical necessity to prohibit time-limited necessary connections: after all, it is supposed to be metaphysically *contingent* which universal is connected to which in this view. And both David Armstrong (1983: 79–80) and Michael Tooley (1977: 686) explored ways to make irreducibly time-limited laws possible without adding temporal indices to their universals. For the ADT-view, at least in its historic form, we would have to leave the metaphysical possibility of changes regarding

which universals are necessarily connected open. I will return to this issue shortly below when I discuss Tyler Hildebrand's (2018) criticism of Beebee's argument.

As mentioned above, I hold that Beebee concedes too much when she argues that in dispositional essentialism, essences, and the necessary connections they bestow, could not change. In dispositional essentialism, it seems like it should be more straightforward to prohibit time-limited necessary connections. After all, in this view, the necessity of ferromagnets to attract iron is metaphysical necessity, is a matter of the very nature of what it means to be a ferromagnet. However, I cannot see how we could find a non-circular argument why it is supposedly metaphysically impossible that metaphysical modality could be temporally limited. When we want to analyse the notion of metaphysical modality, we cannot claim that certain features of metaphysical necessity are metaphysically necessary. Similarly, we cannot argue that it is metaphysically possible that metaphysical modality *can* be temporally limited, without having to concede that the possibility of it changing over time can then change over time, too. In essence, metaphysical modality does not seem to be the right sort of modality to rule out that metaphysical modality is time-indexable.

To sum up: for both views I have discussed here, dispositional essentialist and classical ADT-views alike, it appears that arguments for the view that necessary connections have to be necessarily temporally unlimited are hard to come by. As we have seen, these arguments would have to be quite baroque, and their possibility of success slim. Remember that above, I said that the only way to argue against the argument from temporally limited necessary connections would be to somehow show that either 1) necessary connections cannot be temporally limited, or 2) that temporally unlimited necessary connections are better explanations for the observed regularities. We have seen that the first option is hard to come by, so let us now take a look at the second option to refute the argument from temporally limited necessary connections, before turning to even more arguments against the necessitarian proposal.

5.1.2 The explanatory power of temporally limited necessary connections

In a recent paper, Tyler Hildebrand (2018) criticises the argument from temporally limited necessary connections. First, he argues against the claim that time-limited necessary connections are at least as good explanations for the observed regularities as are the temporally unlimited ones. Then, he goes on to offer a number of sophisticated positive arguments *for* the claim that unlimited necessary connections are actually good explanations for observed regularities. Within the confines of this paper, I cannot piece by piece deal with every one of his elaborate positive arguments, so I will restrict my comments here to his negative

one. This should not take much force away from my argument here, since, as Hildebrand himself concedes, only once he has refuted the argument from temporally limited necessary connections, there is even an opportunity for a positive response (Hildebrand 2018: 673).

Beebee's original argument was that the necessitarians have to show that the hypothesis (T), according to which F and G are timelessly connected, is a better explanation for the observed regularity that its rival (SF), which states that F and G have only been necessarily connected so far. However, Hildebrand argues, this demand is too strong. Strictly speaking, T and SF are not merely compatible, but SF is actually *entailed* by T. As such, SF does not undermine the induction that future Fs will also be Gs, since SF in itself does not entail that Fs and Gs are not necessarily related in the future. And SF itself is a disjunctive hypothesis. It is a disjunct of other induction-undermining hypotheses that feature, presumably, a reference to specific times at which the necessary connection holds. Since SF itself does not undermine induction, but only some of its disjuncts, the necessitarians do not have to show why SF is a worse explanation for the observed regularity than T, but only why the induction-undermining disjuncts are worse explanations. And that, he claims, is easy: T is simpler than its induction-undermining rivals, since these include references to specific times, which the general hypothesis T doesn't (Hildebrand 2018: 672–3).

Hildebrand goes on to offer a more general argument against hypotheses that include references to specific times. He discusses three ways in which a necessitarian law of the form $N(F, G)$ could be time-limited. Either the relata are time-limited, or the relation itself, or the conditions under which the relation holds. He offers sophisticated arguments for why we should reject every one of these possibilities on metaphysical grounds, not merely because they offer bad explanations. For the purposes of this paper, it is sufficient to show that at least one of these possibilities is still open in order to uphold the argument that time-limited necessary connections are no worse explanations than temporally unlimited ones. So let us focus on the first possible analysis of temporally limited necessary connections, i.e. that the relata of the law $N(F, G)$ are temporally indexed. Compare the two laws $N(F, G)$ and $N(F^*, G^*)$, where F^* and G^* are gruesome properties which include references to specific times, very much like Goodman's original property "grue", which stated that an object was grue if observed before the year 3000 and green, or after 3000 and blue (Goodman 1983: 74). Hildebrand argues that there are metaphysical reasons to reject gruesome properties according to the ADT-view of natural laws. He argues that according to the ADT-view, the only properties that are real universals, and which can figure in natural laws such that they can be related by the second-order two-place universal N are *sparse* properties, in contrast to *abundant* properties. And these sparse properties, in contrast to

the gerrymandered ones such as "grue", do not feature any reference to particular times, places, or individuals—they are genuinely universal. If we take Armstrong's, Dretske's, and Tooley's theory of universals and laws seriously, then gruesome gerrymandered properties such as "grue", or F^* and G^*, are not real universals, and hence cannot be necessarily related. Thus, Hildebrand argues, we can reject induction-undermining hypotheses such as $N(F^*, G^*)$ as explanations for the observed regularities, because they do not express a genuine metaphysical possibility.

There are two severe issues with Hildebrand's argument, one with his general attempt to divert the attention from SF to its induction-undermining rivals, and secondly with his rejection of gerrymandered properties as proper universals in the sense of the ADT view. Let us start with his argument that SF should not be the focus of our attention since it does not undermine the inductive inference, and that hence necessitarians do not have to show that it is a worse explanation for the observed regularity than T. There is a big problem with shifting the argument that way: for the argument from temporally limited necessary connections to work, SF does not need to undermine the inductive inference that all future and unobserved Fs will be Gs. Instead, it suffices that SF does not *deductively entail* that all Fs will always be Gs, as that is the inference pattern the necessitarians argue to replace 'simple' induction with. Let us remember how the necessitarian solution is supposed to work: we observe a regularity that so far, all Fs have been Gs. From this, we infer via IBE that $N(F, G)$. And from this, we are supposed to *deduce* that all Fs, including the future and unobserved ones, are Gs. Armstrong proposes to *eliminate* the 'simple' enumerative inductive step in favour of IBE + deduction. But SF does not deductively entail that all Fs are Gs. The demand for the hypotheses T and SF is higher than Hildebrand gives them credit for. So even if SF is a disjunctive hypothesis, we still need to exclude it in total, and not merely some of its disjuncts, in order to halt the argument from temporally limited necessary connections.

At this point, you could argue that nevertheless, we could still hold that no specific hypothesis with a temporal index is a viable alternative to one without reference to times, places, or individuals. Hence, we have reason to prefer T.[6] We could do this, for example, by rejecting gerrymandered properties such as the above-mentioned. However, here Hildebrand's argument underestimates the power of Goodman's New Riddle. Even *if* we, as Armstrong and his allies claim, could exclude temporally limited universals, there remains

[6] Eduardo Castro (2014: 74) also proposes this as a reason to prefer T to SF.

the problem of identifying which properties are the time-limited ones. True, "grue" and "bleen" seem obviously time-limited, whereas "blue" and "green" don't. But this only appears to be this way because we speak in a non-grueified language. If we grueified our entire language, "blue" and "green" would be the time-indexed predicates. For example, "green" is the property of being an object being grue before the year 3000 and being bleen after 3000. This symmetry between "grue" and "bleen" on the one hand, and of "green" and "blue" on the other hand, is well documented (see, e.g., Hesse 1974: 74). It is by no means a novel result of the extensive debate about the New Riddle that we can only judge which predicates are gruesome from within a language. So while the rejection of temporally limited universals might be metaphysically justified, we have no way to tell whether $N(F, G)$, or $N(F^*, G^*)$ is the gruesome law.

As it stands, Hildebrand's criticism of the argument from temporally limited necessary connections remains inconclusive. But, as we will see, even if we could somehow exclude time-limited necessary connections, the necessitarian solution to induction would still fall, if we could show that, e.g. the deductive inference from $N(F, G)$ to "all Fs are Gs" fails. Let us now turn to this particular issue.

5.2 Necessary connections do not necessarily imply regularities

The worries for the necessitarian do not stop with the argument from temporally limited necessary connections. For the necessitarian attempts to work, the existence of a necessary connection has to deductively imply the corresponding regularity. However, in both the ADT-account as well as the dispositional account, this inference is problematic. In this section, I will review this crucial step in the argument. I will first discuss whether the regularities deduced from the necessary connections are supposed to be universal or strict, and then go on to discuss that deducing either is not as straightforward as necessitarians assume. This will again lead us to a discussion of what one could even expect a justification of induction to be.

Crucial to the necessitarian solution to the Old Riddle as I have discussed it so far is that it is possible to deduce a regularity from the necessary connections, which in turn you have inferred from an observed regularity with an inference to the best explanation. Before I discuss the prospects of being able to do so, we should remind ourselves of the whole purpose of the exercise: you want to be able to make an epistemically justified inference about the characteristic of unobserved or future cases from past and present cases. You want to be able to make predictions. The whole goal of the exercise it not merely to be able

to infer a universal generalisation, but you want to be able to use that in order to make an inference about the colour of the plumage of the next raven you observe, whether a ferromagnet in the far future will attract iron, or, e.g., if it is at least likely that a certain medical treatment will be successful if you try to alleviate a headache after a particularly memorable New Year's party. So the universal regularities you deduce from the necessary connections are not worth that much for our endeavour to solve the Old Riddle if they themselves don't let us infer anything about particular cases. Clearly, if you are able to infer a strict, universal regularity, that inference is easy: that *F*s are *G*s implies that any particular *F* is a *G*. So once you have been able to infer that there is a necessary connection via IBE, you could make two truth-preserving deductive inferences: to the universal regularity, and to every individual instance of that regularity. In the following, I will argue that the problem is that 1) necessary connections rarely, if ever, imply strict universal regularities, and 2) that if they merely imply non-strict universal regularities, you are left none the wiser about whether a particular future or unobserved *F* is a *G*, or even *whether there are any* future or unobserved *F*s that are *G*s at all. But if we are not able to make that inference, that prediction, then we have gained nothing over and above simple induction.

5.2.1 Strict regularities

Let us start with strict, universal regularities. Armstrong himself conceded that not all laws are without exception: he distinguished between "iron laws" that have no exceptions, and "oaken laws" that do. Clearly, only iron laws would warrant inferring a strict universal generalisation of the sort "All *F*s are *G*s" from the necessary connection without further conditions.[7] Armstrong's oaken laws are nothing but *ceteris paribus* (cp) laws. So if the goal is to infer strict regularities from the laws, could one make cp-laws workable for Armstrong's proposal to solve the Old Riddle by listing all cp-conditions? However, Armstrong admits that in principle, there could be infinitely many exceptions to oaken laws, making it impossible to convert an oaken law into an iron one by explicitly listing all exceptions Armstrong (1983: 139). So taking Armstrong's own view on oaken and iron laws into account, it would only ever be possible (at best) to deduce strict regularities from the

[7] In order not to again delve too deep into the metaphysical *minutiae* of Armstrong and Ellis's account, I will grant that necessitarians can actually solve the Lewis/van Fraassen inference and identification problem according to which the ADT-view faces a dilemma: either being able to give an account of how the necessary connection can imply a universal regularity, or give an account of what this natural necessity actually is (see van Fraassen 1989 and Lewis 1983: 366).

necessary connections if the law in question was an iron one.

But even if we granted that it would be possible to derive a universal regularity from an iron law, the proposal to solve induction would only ever be possible for iron laws or oaken laws for which we know all exceptions, and know in which cases these exceptions are present. And for all we know, the majority of laws are oaken, if the observed regularities, most of which are not exceptionless, are anything to go by. If we have any hope at all to find iron laws in nature, then we should find them in the realm of fundamental physics. And even if we are lucky and we find iron laws in physics, we will not be able to bring these to bear if we try to justify everyday inductive inferences, even in the sciences, unless you want to argue that all laws can be reduced to exceptionless fundamental physical laws. Remember that we are not merely debating whether all apparent phenomena are explicable by fundamental physical laws, in principle, in the far fictitious future where we have all the information needed to be able to do so. We are debating how to give an epistemic justification for a type of inference we use everyday: when we make predictions about about the plumage of ravens, the efficacy of a medical treatment, or if I will like the next Radiohead album. Insisting that we have to be able to deduce a strict, exceptionless regularity from the laws from which we can deduce every instance of the regularity would just mean that for the vast majority of inductive inferences, we would not be able to replace simple induction with that inference pattern. Certainly not now, and maybe not ever. In a way, the attempt to solve the Old Riddle would render induction unjustifiable for the vast majority of inductive inferences. I will return to this issue below when I discuss whether the necessitarian proposal follows a reasonable standard of what one can expect a justification of induction to do.

Mumford and Anjum (2011: Chapter 3) have pointed out that a very similar problem exists for Ellis's account. The issue is that there could be factors such as finks or antidotes that prevent a disposition from being manifested. Originally, the finks and antidotes problem has been formulated as an objection for conditional analyses of dispositions (Martin 1994, Bird 1998, 2007: 25–9): if one wanted to define that F is disposed to manifest G *iff*, were F exposed to stimulus S, it would manifest G, then obviously it would be a problem if that counterfactual were false. And it is; in an antidote case, there could be a second background condition present that prevents the disposition from being manifested, such as an actual antidote. Take, for example, arsenic and its disposition to kill me if ingested. The objection is that without further qualification, the counterfactual that "if I ingested a sufficient amount of arsenic, I would die", is false: I could have also ingested an antidote that prevents the manifestation of the disposition. The finks case is a bit more

speculative and less straightforward: a disposition could be such that if the stimulus was present, the actual occurrence of the stimulus would cause the bearer of the disposition to lose that disposition. Picture a porcelain vase: the vase is fragile and has the disposition to break if the right kind of stimulus occurs. However, imagine the vase is such that if struck by a hammer, the vase, instead of manifesting its disposition to shatter when struck, changes its molecular makeup in a way that it is no longer fragile. Thus, the occurrence of the stimulus prompts the vase to lose its disposition to shatter if struck.

Now at first sight, since Ellis does not propose a conditional analysis of dispositions, but rather claims that dispositions are irreducible to the conditionals they warrant, he does not have to offer a solution to the finks and antidotes problem. However, without solving that problem, he cannot claim that Scientific Essentialism can solve the problem of induction. His claim was that

> L1: For all x, necessarily, if x has P, and x is in circumstances of the kind C, then x will display an effect of the kind E. (Ellis 1998: 114, italics adjusted for consistency)

implies:

> Necessarily, if a is in circumstances C, then a will display an effect of the kind E. (Ellis 1998: 115, italics adjusted for consistency)

However, neither L1, nor L2 are true if a disposition can be counteracted. If a disposition can be counteracted by an antidote or a fink, then an individual will not necessarily manifest the disposition if the stimulus is present. By trying to use his dispositional essentialism to solve the problem of induction, he inherits the problems of the conditional analysis. Mumford and Anjum are correct that Ellis cannot solve the problem of induction that way unless he solves the finks and antidote problem,[8] which, ironically, would remove one of the greatest motivations to adopt dispositional essentialism over and above the conditional analysis of dispositions.

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[8] I do, however, take issue with Mumford and Anjum's (2011: 140–3) characterisation of the Old Riddle as a pseudo-problem, which I cannot go into within the scope of this paper.

5.2.2 Probabilistic regularities

So clearly, this demand is too strong, and one might argue that it would be unreasonable to demand that the necessary connections have to imply strict regularities. So what about Armstrong's oaken laws? Or if we, like Mumford and Anjum, propose that the necessary connections (or powers) only imply probabilistic regularities, that if *F*s have the power to be *G*s, that we can infer that future and unobserved *F*s will *tend* to be Gs? (see, e.g., Mumford and Anjum 2011: Chapter 3). I will argue that even if we could infer probabilistic regularities, that wouldn't necessarily help regarding any inference about the behaviour of future or unobserved cases.

The main issue is that if the necessary connection can be counteracted, if the laws are oaken, then we are not justified to *deductively* infer any probabilistic regularity, or any frequency from that necessary connection alone. This is obvious for indeterministic cases. Take, for example, the fact that smoking causes cancer. Let us suppose that the actual mutation that smoking can cause and which will lead to cancer is an indeterministic, but lawful, process: suppose that in every single case where the relevant substances come into contact with a cell, it is genuinely undetermined whether that cell mutates in a way that leads to cancer. In that case, it would be highly unlikely but possible that no-one ever develops cancer through smoking, even if smoking has the disposition to cause cancer, or if there is some other lawful necessary connection. Given indeterminism, it is completely possible that an observed regularity does not match the respective disposition at all. Granted, that would be an extreme case. But it would be very much possible that the apparent regularities do not match the frequencies implied by the necessary connection. If that is possible, then the necessary connection does not *deductively* imply the probabilistic regularity. Deduction is truth-preserving. If it is true that there is a necessary connection, and if that necessary connection deductively implies a universally quantified generalisation, then that generalisation *must* be true. If indeterminism is true and permissible in your ontology, the neat set of deductive inferences from necessary connections to probabilistic regularity to individual case break down, and the necessitarian attempt to solve the problem of induction with them.[9]

But indeterminism does not need to be true in order for it to be difficult, if not practi-

[9] This result is the motivation for Mumford and Anjum's 'dissolution' of the Old Riddle. I disagree with Anjum's and Mumford's claim that their observations afford a dissolution of the problem, which I cannot elaborate further on within the constrains of this paper (Mumford and Anjum 2011: Chapter 3).

cally impossible, to derive probabilistic regularities from the laws, and to make predictions based on these regularities, if we had them. If it is the case that it is always possible that the manifestation of a disposition can be prevented, or that even a deterministic necessary connection can be prevented from being instantiated, then it is possible that F necessitates G without a single F ever being a G. So if we want to be able to infer the correct probabilistic regularity from the necessary connection, we would need a lot more information to be able to do so: we would need to add every single cp-clause, and we would need a lot more information about the boundary conditions in order to predict anything about individual cases. The necessitarian proposal to infer probabilistic regularities from the necessary connections, and to be able to infer anything about individual cases, rests on whether they are able to solve the cp-problem in a specific way. Remember that we are supposed to *deduce* the regularity from the necessary connection. We would need to be able to list every single cp-clause, every possible exception, in order to be able to make a truth-preserving inference to the probabilistic regularity. Again, this appears practically impossible.

So in any practical case, if it is possible that the necessary connection can be counteracted, or if indeterminism is true, we would be unable to actually make the series of inferences necessitarians propose we replace simple induction with. To make matters worse, neither would the necessary connection alone be enough to deduce the probabilistic regularity from, nor would the probabilistic regularity suffice to make a deductive prediction about individual cases. At this stage, you might propose that maybe the inference to the regularity, or from that to the individual cases, could be ampliative, not deductive. But that would defeat the entire point of the necessitarian proposal, which was to replace simple induction by IBE and deduction.

This is the result of our analysis so far: we have seen that the necessitarian proposal does not work if temporally limited necessary connections are possible, and if it is possible that they are no worse explanation for the observed regularities than temporally unlimited necessary connections. I have argued that both is possible. We have also seen that the necessary connections alone do not simply deductively imply the required regularities, and that the probabilistic regularities do not necessarily tell you much about individual cases.

Before I wrap up, let us take a quick look at the underlying standard for what could count as a justification to stand behind the necessitarian proposal, as I believe that this standard for a justification is the source of all of the problems the necessitarian attempt of a solution to the Old Riddle comes with.

5.3 What do we want from a justification?

I have mentioned above that there exist various different accounts of what the problem of induction actually amounts to and what, accordingly, could even count as a justification of induction, if one were possible. The probabilists like Reichenbach (1935), Salmon (1974), and Donald Williams (1947) held that the problem of induction was to demonstrate how inductive inferences could confer at least some degree of truth upon the conclusion.[10] They sought to solve the problem accordingly, for example by arguing that the law of large numbers entails that a large enough sample would resemble the population close enough to justify inductive inferences. On the other hand, the classical sceptical formulation of the problem by Hume can be read differently: there, the problem of induction is supposed to be that we cannot justify an additional premise that would turn induction into an enthymeme of a truth-preserving, a deductive, inference. The inductive character of these inferences would thus be eliminated. The strategies of Armstrong and Ellis try something similar: they try to turn inductive inferences into a series of inferences, which are supposedly more secure. They first introduce an IBE from the observed regularity to the existence of a necessary connection, from which we are supposed to deduce the universal regularity. But they fall short of eliminating the ampliative step altogether. We also have to know *that* $N(F, G)$ holds, or *that* Fs are disposed to be Gs if in presence of the according stimulus. And there is no way to acquire such knowledge without an ampliative inference of some kind, in this case an IBE.

This is exactly Hume's Dilemma in slightly different terms: where he claimed that we can't presuppose that nature is uniform without either inferring that information inductively, which would result in a circularity if we then took that information to justify inductive inferences, or by inferring the regularity of nature deductively, by an a priori argument, which is impossible. In Armstrong's and Ellis's case, we would have to infer that there is a necessary connection either ampliatively, i.e. via IBE, which is itself in need of justification, or by an *a priori* argument, which is impossible. We cannot know *a priori* that ferromagnets necessarily attract iron. But then, we'd have to infer it *a posteriori*, and since we cannot directly observe that there is a necessary connection between being a ferromagnet

[10] There is an important difference between pragmatic solutions to the Old Riddle like Reichenbach's on the one hand, and law of large numbers approaches such as by Donald Williams on the other. I will not discuss their differences here. Both attempts, however, require a large sample for an inductive inference to be justified.

and attracting iron, we'd have to infer this ampliatively. Armstrong and Ellis agree: they hold that the discovery of necessary connections of the respective kind via IBE is the task of modern science.

But not only is IBE an ampliative step which is itself in need of justification, it is one whose justifiability is hotly contested. Two main issues must be settled to justify IBE. Firstly, we have to be able to specify what exactly makes one explanation the uniquely best one, and secondly, we have to demonstrate how the best explanation can be truth-conducive. Both problems are far from trivial. Even granted that we can decide on a theory of explanation, and that we can decide on criteria for what makes a good, or even the best, explanation: then what guarantees that the best explanation is actually true? The most famous argument against the truth-conduciveness of IBE is the argument from a bad lot (van Fraassen 1989: 143). It is possible that *all* explanations that are actually available for a certain phenomenon are bad, and false. So even if we can decide on the single best explanation out of the set of available explanations, that explanation might still be just the best explanation out of a bad lot: the best explanation doesn't necessarily have to be a good one, or true.

I will not debate IBE any further here. However, what we can see here already from this very brief introduction into the worries of IBE is that not only is it itself an ampliative inference that is in need of justification, but that this justification is by no means trivial. Armstrong (1983: 54 & 59) called the rationality of induction a brute fact, but if we take the above-sketched controversy surrounding IBE into account, that sounds like a gross overstatement. Moreover, he seems to employ a different standard for what could count as a justification of an ampliative inference here: while Armtrsong's and Ellis's attempt at transforming simple induction to a set of IBE and deductive inferences mirror Hume's and Popper's standard of justification to demonstrate that induction is at least truth-conducive, Armstrong appears to be perfectly happy with IBE being *rational*. This appears to be a double standard: it is something different altogether to show that an inference is rational than to show that it is truth-conducive. I have argued elsewhere (Backmann 2019) that it is possible to demonstrate that induction is practically rational if we treat it as a form of Bayesian conditionalising. There are formal arguments like the dutch book argument or the expected epistemic utility account that are designed to show that conditionalisation is practically rational. Granted, these arguments only deliver that induction is *practically* rational. However, if we can settle for a demonstration of rationality as a justification for IBE, as Armstrong holds, why should we employ a different standard for induction?

But even if we grant that Ellis and Armstrong can solve all the issues discussed in this

paper, their proposal would be applicable to very few inductive inferences: those for which we can identify a necessary connection. For Armstrong, universals are supposed to be genuine physical properties which form natural kinds, and which to discover is the task of the sciences (Armstrong 1978: 11). The same holds for Ellis's account, who proposed that dispositional properties are natural kinds, which to detect is the task of science. But we use induction every day, featuring all sorts of properties that aren't natural kinds or fundamental physical properties. Say it is somewhere in the early 2000s, and I have just for the first time listened to Radiohead's *Amnesiac*. Listening to more and more albums from *OK Computer* onwards, I grow more and more confident that I will also like the next Radiohead album I will listen to. This inference, which has proven to be *very* successful so far, is clearly an inductive inference in the sense that I infer from a sample—listening to parts of Radiohead's catalogue and observing my reaction to it—that my reaction to as yet unobserved samples of their body of work will be the same. However, according to Armstrong's own ontology, there is no such universal such as being a Radiohead album and being liked by the author, which could be necessarily connected. The same goes for Ellis's view. Unless we want to needlessly bloat our ontology, it would seem quite a stretch to claim that Radiohead albums have a disposition, which is supposed to be a natural kind, to evoke a positive response in me, or that I have the disposition to respond well to Radiohead albums from *OK Computer* onwards. And yet, it seems that my inference that I will like a yet unobserved Radiohead albums because I liked their past ones is a perfectly natural one. But it is not one that could be reduced to the necessitarian inference pattern as described above. So these inferences, ones that we engage in every day, would still be unjustifiable. What sort of justification of induction would leave the vast majority of inductive inference unjustified?

To wrap up, the attempt to justify induction employs the historically risky strategy to try to show that induction is truth-conducive, relies on it being possible that IBE is justified by virtue of being rational, while ignoring attempts to show that induction could be, if not demonstrably truth-conducive, then at least rational. And to make matters worse, the attempted justification would leave the vast majority of actual inductive inferences unjustified.

6 Conclusion

The necessitarian attempts to solve the problem of induction fail. As long as we cannot show that time-limited necessary connections are impossible, or that they are worse explanations

for observed phenomena than temporally unlimited ones, we cannot infer anything about future cases from them. But even if we would grant that necessary connections are necessarily temporally unlimited, it still remains questionable whether we can deduce regularities from them. Strict regularities can, at best, only be deduced from a necessary connection in very few cases of iron, exceptionless laws. Necessary connections that allow to be counteracted do not deductively imply stable probabilistic regularities. And to top the whole problem off, the proposed solution would still only work for the narrow range of inferences that actually concern necessarily connected natural kinds. The vast majority of cases of simple induction we encounter every day would not be able to be reduced to the proposed inference pattern, and would be unjustified.

While I have discussed this attempt to justify induction mostly using Armstrong's and Ellis's existing accounts, I hope that the arguments I presented here are suitably general to apply to other possible attempts to justify induction with necessary connections, and the problems would remain the same. Any account that tries to justify induction by introducing necessary connections would have to show how we are justified to infer that the necessary connection holds, and that it is temporally unlimited, and it would have to demonstrate how we are allowed to infer the relevant regularities or individual cases from that necessary connection, all while still applying to a suitably large variety of inductive inferences we'd like to have a justification for. Judging from our results so far, I am not convinced such a programme will be successful.

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