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Scientific Practice and Necessary Connections *

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ABSTRACT: In this paper I will introduce a problem for at least those Humeans who believe that the future is open. More particularly, I will argue that the following aspect of scientific practice cannot be explained by open-future-Humeanism: There is a distinction between states that we *cannot* bring about (which are represented in scientific models as nomologically impossible) and states that we merely happen not to bring about. Open-future-Humeanism has no convincing account of this distinction. Therefore it fails to explain why we cannot bring about certain states of affairs, it cannot explain what I call the “recalcitrance of nature”.

Keywords: Humeanism; laws; necessary connections; nomological necessity.

RESUMEN: En este artículo presento un problema, al menos para aquellos humeanos que creen que el futuro está abierto. Argumentaré, en particular, que el siguiente aspecto de la práctica científica no puede ser explicado por la tesis humeana del futuro abierto: la distinción entre estados que *no podemos* provocar (representados en los modelos científicos como nomológicamente imposibles) y estados que simplemente no podemos generar. Dicha tesis no puede ofrecer un tratamiento convincente de esta distinción. Por ello fracasa al explicar por qué no podemos provocar ciertos estados de cosas; no puede explicar, pues, lo que denomino “la obstinación de la naturaleza”.

Palabras clave: Humeana (filosofía); leyes; conexión necesaria; necesidad nomológica.

1. Introduction

In this paper I will introduce a problem for at least those Humeans who believe that the future is open (such views are considered in Backmann (2013), Beebe and Mele (2002) and Swartz (2003)). I will argue that some aspects of scientific practice cannot be explained by open-future-Humeanism. Some authors took the *success* of our practice of *induction* to indicate the existence of necessary connections between distinct events and thus the denial of Humeanism. I will briefly rehearse this unsuccessful attempt for reasons of stage-setting. Afterwards, I will argue that the *failure* of certain manipulatory practices that are indicative of the *recalcitrance of nature* can best be explained in terms of necessary connections.

The context within which my argument is set is the debate between Humean and non-Humean conceptions of metaphysics of science. Humeans take as their starting point Hume’s observation that “All events seem entirely loose and separate” (Hume 1975, 74). David Lewis has characterised Humeanism by what can be considered today’s standard formulation:

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It is the doctrine that all there is to the world is a vast mosaic of local matters of particular fact, just one little thing and then another. [...] For short we have an arrangement of qualities. And that is all. (Lewis 1986, ix-x)

Humeanism implies that there are no necessary connections in nature between entities that are wholly distinct. (Such connections would be an addition to the Humean mosaic). Non-Humeans believe that there are such connections. Necessary connections can be conceived of in various ways, for instance as metaphysically necessary connections or as connections such that one entity necessitates another entity. The question of the exact nature of necessary connections—if there are any—will be bypassed in this paper.

In section 2, I will briefly rehearse arguments from our inductive practice to the existence of necessary connections. From section 3 onwards I will develop an independent argument that is more difficult for the open-future-Humean to cope with because an analysis of what is going on merely in terms of regularities is not applicable in this case.

2. *The problem of Induction*

Predictions are part of our scientific practice. We often rely on laws when we predict. There are two different strategies to take this practice as being indicative of underlying necessary connections. According to the first strategy the postulation of necessary connections helps to reject inductive scepticism. David Armstrong has argued along these lines.¹ Armstrong claims that “if laws of nature are nothing but Humean uniformities then inductive scepticism is inevitable” (Armstrong 1983, 52). However:

I believe the Universals theory can do better. The postulation of a connection between universals can provide an explanation of an observed regularity in a way that postulating a Humean uniformity cannot. (Armstrong 1983, 104)

Armstrong reconstructs inductive inferences as two-step processes and argues that both steps are innocuous. The first step is an inference to the best explanation. According to Armstrong being F has to be understood as instantiating the universal F-ness and similarly for G-ness. The best explanation of the fact that all hitherto observed Fs are Gs invokes a necessitating relation $N(F,G)$ according to which F-ness brings about or necessitates G-ness. The second step consists in inferring from $N(F,G)$ that all Fs are Gs (whether observed or not).

In order to be able to reject inductive scepticism alternative accounts of explaining why all hitherto observed Fs are Gs have to be ruled out. Helen Beebe has recently argued that Armstrong overlooks alternatives such as time-indexed necessity relations,

¹ Similarly Brian Ellis holds:

[Scientific essentialism] promises to transform our thinking about scientific rationality and the theory of inductive reasoning. If one believes, as Hume did, that all events are loose and separate, then the problem of induction is probably insoluble. Anything could happen. But if one thinks, as scientific essentialists do, that the laws of nature are immanent in the world, and depend on the essential natures of things, then there are strong constraints on what could possibly happen. (Ellis 2001, 283)

which—she claims—explain the correlations that have been observed so far equally well (Beebe 2011).

According to the second strategy necessary connections are needed to explain why our inductive practice is successful. Even though inductive scepticism cannot be countered, our inferences work. *Prima facie* this appears to be surprising given the world is as the Humean conceives of it: Suppose I prepare the coffee-machine for making a coffee. I put the powder into the filter and press the button. What is going to happen? Suppose that ultimately all there is is a Humean mosaic. Everything is loose and separate. There are no necessary connections between distinct events. So, what might happen? (i) The coffee-machine brews my coffee, (ii) the coffee-machine disappears, (iii) the coffee-machine explodes, (iv) the coffee-machine makes tea, and so on. On the simple Humean mosaic view it appears to be a miracle that it always brews coffee. Why didn't the coffee-machine ever make tea? It seems that in the absence of necessary connections tea is as likely to be produced as coffee. By contrast, if there are necessary connections it is no miracle that every single time I start the coffee-machine it fails to make tea. There are certain facts that necessitate the brewing of the coffee. So, maybe we should argue that the best explanation of the fact that the coffee-machine fails to make tea after I put in the coffee-powder and I pressed the button is after all some kind of necessary connection. Leaving out some details and disregarding the option of time-indexed necessary connections we might argue that it is plausible that a time-less necessary connection is indeed the best explanation for why the coffee-maker fails to make tea.

Well, no. As Beebe points out (Beebe 2011, 525-6) the Humean has just as good an explanation as the non-Humean—at least if she additionally assumes *regularity*. According to this conception, what is underlying the world as we experience it is not just any Humean mosaic, but one that fulfils an additional constraint: it is regular. If the mosaic and *a fortiori* the world is regular that explains why the coffee-machine regularly fails to make tea. The introduction of the regularity-constraint may appear to be an ad hoc-manoeuve because the regularity-constraint is solely motivated by what it is supposed to explain. But, the Humean will argue, the non-Humean has no better argument for the assumption of time-less necessities.

The conclusion is thus, that the non-Humean inference to the *best* explanation with respect to the success of our inductive inferences does not work. It does not work because there appears to be an equally good explanation that appeals to the general fact that the world/the Humean mosaic is regular. (For a similar line of argument see Smart 2013.)

To conclude: Two strategies to argue from our inductive practices to the existence of necessary connections can be distinguished. The two strategies deal with different issues/questions:

Issue 1: How can inductive scepticism be countered? Does the invocation of necessary connections allow us to meet the inductive sceptics standards?

Issue 2: Here it is taken for granted that our inductive practices are successful. The question is: What are the features of the world that best explain this success?

As we have seen, neither of these strategies provides a good argument for the existence of necessary connections in nature.

3. *The Recalcitrance of Nature*

A belief in universal regularity might be sufficient to explain why we can rely on our inductive practices. I will now argue that there are further aspects of scientific practice that cannot be accommodated by this strategy.

Regularities are correlations between events. Something like this: “All events of type F are followed by events of type G.” But laws do not only tell us what as a matter of fact happens—laws tell us furthermore what *might* happen and what *cannot* happen. This modal aspect plays an essential role in understanding how we intervene into the course of nature or fail to be able to do so. Intervention is tied to aspects of scientific practice that the Humean cannot fully explain. The best explanation of our intervention- or manipulation-practice refers to necessary connections in nature. (Note: When I talk of intervention or manipulation in the context of this paper I do not have in mind a technical notion of intervention. What I have in mind is that we change the states of systems (often but not necessarily with the purpose of bringing about further changes elsewhere in the system).)

Let’s take the Boyle-Charles-Law $pV=nkT$ as our paradigm case of a law. The law is idealized. However, taking less idealized laws for gases as our paradigm case—such as the van der Waals law or the Deiterici-equation—adds complications, e.g. further variables, without adding benefit for our discussion. The Boyle-Charles-law tells us that for every gas, if it has a certain value of pressure (p) and volume (V) there will be a definite value for temperature (T); (n and k are constants). The law describes how gases as a matter of fact behave. But that is not all. It also tells us how gases *would* behave if certain values of p and V were brought about. Thus, it states the *nomologically possible* behaviour of gases. Furthermore the law tells us which kind of behaviour is *nomologically impossible*: if a gas is prepared such that it has a certain pressure value and a certain volume, all but one value for temperature are impossible. The law forbids all other values. For this reason Popper conceived of laws as ‘prohibitions’ (Popper 1959, §15). This modal import of laws is essential to understand some aspects of our practice of intervention or manipulation.

We can successfully intervene into gases and bring about T_0 , e.g. by setting p to p_0 and V to V_0 . However, we cannot bring about $T_1 \neq T_0$ by setting p to p_0 and V to V_0 . It is impossible to do this, even if we try hard. We cannot bring it about that a gas has values for p, V and T that fail to stand in the relation stated by the Boyle-Charles law, whereas we can bring about value-combinations in accordance with it. Some attempts to bring about combinations of values for p, V and T are successful whereas others fail to be successful.

The important thing is that it would be wrong to describe the situation as follows: It simply happens to be the case that all gases have p-V-T combinations in accordance with the Boyle-Charles law. Rather: even if we try to bring about other combinations it does not work. *Nature is recalcitrant*.

The recalcitrance of nature is of course an ubiquitous phenomenon. We cannot bring it about that a body that moves uniformly and with constant velocity if a non-zero net force applies to it. We cannot bring about situations disallowed by the Maxwell-equations. And no matter how much money we spend on accelerators we cannot accelerate massive particles to a speed larger than the speed of light. That is of course what special relativity theory tells us. It does not tell us that *as a matter of fact* there are no massive particles with superluminal velocities. It tells us that it is *impossible* that there are such particles. It is part of the content of the law that certain situations are forbidden, i.e. impossible. What needs to be explained is why we persistently fail to bring about these situations even if we try hard. What is it that explains why we cannot bring about certain states of affairs? What explains the difference between those situations that can be brought about and those that cannot? What explains why nature is recalcitrant—or at least appears to be recalcitrant?

Two different issues need to be distinguished here. The first issue is whether on the basis of past failed attempts to bring about a certain state we can *conclude* that all attempts in the future will fail too. This is the question whether the modal sceptic's criteria can be met. Probably not. We cannot derive a "can't" from a "not yet". But as in the case of induction where the inductive sceptic's criteria could not be met there is a second issue. It concerns the following question: Nature is or appears to be recalcitrant. What are the features of the world that best explain why we cannot bring about those states disallowed by the laws? Within this second context/issue it is taken for granted that nature is or appears to be recalcitrant. Certain states cannot be brought about. The question is whether there is an explanation for this recalcitrance or impossibility.

The non-Humean has an obvious explanation for why we can bring about certain situations but not others. Laws of nature describe what happens with (some sort of) necessity. If a gas has values $p = p_0$ and $V = V_0$ it is necessarily the case that T has the value T_0 . All other values are impossible.

Whether this is the *best* explanation depends on whether the Humean can explain (or explain away) exclusively in terms of regularity or other features of the Humean mosaic the recalcitrance of nature, i.e. the impossibility of bringing about situations forbidden by the law. I will now explore to what extent this strategy may work.

4. The Humean's option and its costs

Why is it that we can bring about some combinations of pVT-values but not others? Why is it that we cannot accelerate particles beyond the speed of light? Why is there no perpetual mobile? If we could build a perpetual mobile that would certainly be of severe practical and economical interest. I will now explore the Humean's option to explain the recalcitrance of nature.

On the non-Humean view facts about the past and the present determine what can and what cannot happen. By contrast on a Humean view nothing is entailed by past and present facts. If all events are entirely loose and separate there is then nothing that explains why some situations are impossible to bring about whereas others are not. There is nothing in the past or presence that would explain why on the 10th of January 2015 it will be impossible to accelerate a massive particle beyond c .

Given certain values for p and V why isn't it possible to bring about any arbitrary value for T ? It seems that on a Humean conception no reason can be provided why it does not at least sometimes happen that $T_1 \neq T_0$ occurs after setting p to p_0 and V to V_0 . If all events are entirely loose and separate it is difficult to see what explains the failure of success these situations whether in the case of the ideal gas, the speed of light or the perpetual mobile.

Does what's happened up to now, just by itself, in the actual world, place any modal constraints on what happens in the future? The Humean has to say: No. There are no modal facts in nature that constrain what happens nor what I can do.² I can do anything (unless—maybe—if it is self-contradictory). This claim is not denied by Humeans. In fact it is sometimes explicitly endorsed to argue for the further claim that since laws don't metaphysically constrain what we are able to do, we are free in a libertarian sense even if determinism is true. Norman Swartz, for instance, explicitly holds:

It is partly up to us to decide what the grand physical truths (physical laws) of the world are. (Swartz 2003, 126)³

Interestingly Swartz acknowledges that there are limits to what we can do—that there are some situations we can bring about whereas we fail to bring about others even if we try hard.

All sorts of physical laws seem to be quite outside my sphere of influence. I cannot (I have tried) cause a friend to regrow a severed leg by waving my hands. Nor can I choose that it is a grand physical truth that human beings have three sets of adult teeth. Experience has shown me that this is the sort of world in which these things are not up for grabs, that no amount of willing and trying on my part will bring about these desired effects. (Swartz 2003, 126)

No explanation is given of why we can bring about some situations but not others. Swartz does not seem to consider this to be a problem for the Humean.

However, it seems that the Humean needs to give some account of why there is a difference between effects that we can bring about and others which we cannot bring about. I will now discuss two suggestions of how a Humean account of the recalcitrance of nature might work.

Suggestion 1:

What the above considerations show is that if we simply assume *any* Humean mosaic there is no explanation for the failure of success of the envisaged intervention. But as in the case of explaining the success of our inductive inferences the Humean might

² Humeans typically do hold that there are modal facts but they are conceived as derivative—as facts that supervene on/are constituted by the facts of the Humean mosaic.

³ Similar views have been defended for example by Helen Beebe and Alfred Mele (2002) as well as by Marius Backmann (2013).

introduce a further constraint, namely regularity. So, what if the Humean mosaic is not chaotic but regular—a mosaic such that whenever p and V are set to p_0 and V_0 T_0 will occur? It seems that if the mosaic is regular the regularity-fact explains why we never bring about value combinations disallowed by the Boyle-Charles-law. It seems to explain—in some sense of ‘explain’—why we never accelerate particles beyond the speed of light and why there is no perpetual mobile.

If “All Fs are Gs” is true then it is logically impossible for there to be a F that fails to be a G. Thus: Certain pVT-combinations occur and others don’t. That is all. And as a matter of fact what happens is regular. That is all there is to be explained. There is no need for modal connections.

I have one worry and two objections. The worry can be illustrated by an analogy. Suppose John and Lisa intended to marry. However, as a matter of fact they couldn’t. Why not? Well there is a complicated story about his and her parents, different social backgrounds and so on. There were insurmountable difficulties. Ok., but here is another explanation: Given this experience John decided never to marry—he remained a bachelor. So why couldn’t Lisa and John marry? Well, John was—as a matter of fact—a bachelor. And it is logically impossible for a bachelor to have married. Is this second explanation a good explanation? It seems that there is something wrong with it. The fact that we can classify John as a bachelor is a *consequence* of this not having married—not the other way round. Even though it logically follows from John being a bachelor that he didn’t marry, this by itself is not an explanation of why he didn’t marry, let alone of why he couldn’t marry. The worry is that the Humean might make a similar mistake. It might be that the generality “All Fs are Gs” to which the Humean appeals, is true in virtue of facts that are left out of the Humean picture.

Objection 1:

While the worry concerns Humeanism in general, the objection to follow pertains to open-future-Humeans only. The open-future-Humean holds that while the past and the present are fixed, the future isn’t. It follows—and that is the essential point—that of *now* there is no regularity such as “All Fs are Gs”. It is not yet determined which timeless regularities will turn out to be true.

It has to be kept in mind that on a Humean view the world’s laws are fixed only when the world has come to an end. So, it is indeed true that if “All Fs are Gs” is true then it is logically impossible for there to be a F that fails to be a G. But whether the antecedent is true is not yet determined. Thus, whether there will be a timeless regularity according to which certain pVT-combinations never occur or the speed of light will not be topped by massive particles is not yet determined. It depends among other things upon whether or not we are successfully bringing about certain situations. And what should there be in a Humean world that stops me to now accelerate a particle beyond the speed of light? According to the Humean there is nothing in the past and the present that makes it impossible to accelerate a particle beyond the speed of light or to build a perpetual mobile. So the alleged explanation of why we can now bring about certain situations but not others in terms of timeless regularities does not work. It seems to put the cart before the horse: Given the Humean’s assumptions there are

no modal facts. There is nothing that can hinder me doing this or that. The regularities there are depend (at least in part) on what we are able to bring about. The openness of the future undermines the explanation in question.

Objection 2:

There is a further objection one may raise against Humeans who appeal to the logical impossibility of bringing about an F that fails to be a G given the generalisation “All Fs are Gs” is true. The argument serves both to explain why it is impossible to accelerate particles beyond the speed of light and to explain why we cannot produce gold-spheres of a certain size. But it seems obvious that there is a difference between the two cases: It would have been possible to produce gold-spheres that are larger than those that will have been produced at the end of the time.

This objection will probably fail to impress any Humean. Up to this point I have not taken into consideration that Humeans have a respectable account of lawhood, namely David Lewis’s best system-account. This account will certainly help to distinguish accidental regularities such as the case of the gold spheres from genuine laws such as claim that particles cannot be accelerated beyond the speed of light. According to Lewis’s best system account

[A] contingent generalization is a law of nature if and only if it appears as a theorem (or axiom) in each of the true deductive systems that achieves a best combination of simplicity and strength. (Lewis 1973: 73)

A generalization is a law if it is part of an ideal theory. The ideal theory in turn is determined by (supervenes on) the entire Humean mosaic (past, present, future).

Does this account of lawhood help to dispel the second objection against suggestion 1? It may very well establish a difference between “No massive particle can be accelerated beyond the speed of light” and “No golden sphere has a diameter of more than 5m.” It may turn out (we don’t know yet) that the first is part of the ideal theory whereas the second isn’t. However, even if this works out, it remains true that if the recalcitrance of nature is explained according to suggestion 1 it works for both, the alleged law and the alleged accidental regularity. It works simply in virtue of both being generalisations. So if the account of Lewis is of any help with the recalcitrance-issue, the help must be of a different kind. I will now turn to the second suggestion of how to explain (away) the recalcitrance of nature.

Suggestion 2:

Helen Beebe and Alfred Mele acknowledge that the recalcitrance of nature poses a problem for the Humean.

Fred is able to eat cake for breakfast tomorrow insofar as his doing so is consistent with his world’s past (and the laws of logic), but also that he is able, in just the same sense, to move his arm faster than light, and to leap over Manchester Town Hall in a single bound. This is a legitimate worry to have, because the Humean view does indeed have those consequences. (Beebe and Mele 2002, 212)

Their strategy to cope with this problem is to distinguish two modal claims. The first claim they hold to be true in virtue of metaphysical indeterminateness of the Humean mosaic:

- a) I can now (or on the 10th January 2015) accelerate particles beyond the speed of light.

However, there is the closely related claim which, they argue, is false:

- b) If I were now (or on the 10th January 2015) to try to accelerate particles beyond the speed of light, I would succeed.

It is b)'s falsity that accounts for the (appearance of the) recalcitrance of nature. Why is b) false even though a) is true? The falsity of b) becomes apparent when we evaluate the counterfactual in terms of Lewis' semantics. In order to evaluate the counterfactual according to Lewis' semantics we have to consider the nearest (i.e. most similar) worlds in which I try to accelerate particles beyond the speed of light. We then have to figure out whether I would indeed succeed. The counterfactual is false if I fail to succeed in the nearest possible world. Since for Lewis sameness of laws is very important for spelling out the similarity relation (I will not go into any details here) and assuming that it is indeed a law in our world that nothing can be accelerated beyond the speed of light, we have to assume that it also holds in the nearest possible worlds. Thus it turns out to be false that I would succeed in accelerating particles beyond the speed of light. This then explains the recalcitrance of nature: The counterfactual "I would succeed even if I tried hard" is false.

One advantage of suggestion 2 is that—in contrast to suggestion 1—it might allow to differentiate between the case of the gold-spheres and the case of the accelerated particles. In the nearest possible world in which I try to build to construct gold-spheres that have a diameter of more than 5m, I might very well succeed in doing so.

However, I do have an objection to this line of argument that applies to the open-future Humean and a worry that concerns Humeanism in general. The objection is this: According to the open-future-Humean the future facts are not yet fixed. There simply aren't any future facts now. *A fortiori*—as mentioned above—it is not yet determined what timeless regularities there will be. Of *now* it is not determined whether "All Fs are Gs" is true. It is therefore not yet determined which generalisations go into the competition for the best system. Thus, it is not yet determined which laws there are. It is for example premature to claim that "All gold spheres have a diameter of less than 50 m" will *not* be part of the ideal theory (assuming it is true of all gold spheres so far). It is simply not yet determined whether this will be an axiom or a theorem of the ideal theory. Since the truth-conditions of counterfactuals such as b) depend on what the laws are, the truth-conditions are not yet fixed. This is not an epistemological point. It might be true—assuming a regular humean mosaic—that what we consider to be true generalisations now will eventually prove to be genuine generalisations and it might therefore be true that we have already now a good grip on the best system. But still, for the open-future-Humean the future is open, i.e. future facts are not yet determined. *A fortiori* the best system is—as a matter of fact—not yet determined either. For the open-future-Humean it is thus *wrong* to claim (at any point in time) that if

I were now to try to accelerate particles beyond the speed of light, I would fail to succeed.

The problem I have just outlined is a problem for the open-future-Humean only. It is not a problem for the eternalist because for the eternalist the laws are fixed and thus the truth-value of the counterfactual b) is fixed too. I do, however, have a worry concerning the humean eternalist's explanation for why I am unable to accelerate a particle beyond the speed of light *now*. Ultimately the Humean answer for why nature is recalcitrant *now* has to appeal—via the laws and the best system—to the entire humean mosaic. The Humean thus explains a fact (my *now* not being able to succeed in what I want to do) partly in terms of future facts. The worry is that this does not accord well with our usual standards of what should go into an explanation. Future facts are not usually admitted to play the role of *explanantia*. It thus seems that the Humean eternalist changes the standards of explanation in accounting for the recalcitrance of nature.

5. Conclusion

What I hope to have shown is that the Humean conception has certain costs if the future is taken to be open. It does not account for a distinction that is even acknowledged by Humeans: We not merely happen not to bring about certain pVT-combinations, rather we *cannot* bring them about. We have tried hard, but it did not work. There seems to be a difference between on the one hand trying hard to bring about a situation S and failing to do so and on the other hand by mere happenstance not to have brought about a situation S. The open future-Humean cannot explain the recalcitrance of nature. It seems she has to flatly deny that there is this difference and argue that this aspect of our experience of recalcitrance turns out to be merely apparent in the light of Humeanism (see also Schrenk forthcoming). As a consequence the open-future-Humean has to deny that laws make claims not only about actual situations but also about possible and impossible situations. So it might be advisable for a humean to hold humean eternalism rather than open-future-Humeanism. But as I have indicated there might very well be problems with this position too.

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