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ESSENTIALISM AND THE NECESSITY OF THE LAWS OF NATURE

ABSTRACT. In this paper I discuss and evaluate different arguments for the view that the laws of nature are metaphysically necessary. I conclude that essentialist arguments from the nature of natural kinds fail to establish that essences are ontologically more basic than laws, and fail to offer an a priori argument for the necessity of all causal laws. Similar considerations carry across to the argument from the dispositionalist view of properties, which may end up placing unreasonable constraints on property identity across possible worlds. None of my arguments preclude the possibility that the laws may turn out to be metaphysically necessary after all, but I argue that this can only be established by a posteriori scientific investigation. I therefore argue for what may seem to be a surprising conclusion: that a fundamental metaphysical question – the modal status of laws of nature – depends on empirical facts rather than purely on a priori reasoning.

1. INTRODUCTION

The laws of nature are general principles which describe how things must be: that is, they do not state accidental correlations which just happen to be the case, they hold for a reason and constitute constraints on what events are possible. So in virtue of which facts or features of the world do the laws derive this necessary status?

There are various answers to this question, but recently a radical view has gained in popularity. This is that (at least some of) the laws of nature hold of metaphysical necessity, that is, they could not be otherwise, and that this is because they follow, in some sense, from the natures of the kinds or properties involved in them. Thus these laws could not be different unless the world contained different kinds of things.

This radical answer has gained some currency in the light of the perceived inadequacy of the standard answers to this question. It seems that either we must ascribe the necessity to some feature of us or of our reasoning practice, or we must invent some kind of 'physical necessity', weaker than logical or metaphysical necessity, but strong enough to confer the required modal force on the laws. The first option answers the question above by saying that, in effect, there is no answer, or at least, no answer of any use to a defender of objective science which includes objective laws.

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The second option faces what van Fraassen (1989) calls the 'Identification Problem': what is the concept of physical necessity? We might initially think that physical necessity is like moral or legal necessity: something is morally necessary (obligatory) if it follows from some set of moral principles, something is legally necessary if it follows from the laws. But in these cases, we have an antecedently established set of principles; in the case of physical necessity, the set of principles from which physically necessary events follow are the laws of nature themselves. An independent argument must be offered for why these principles and not others are physically necessary, and none seems forthcoming.

Various authors (Harré and Madden 1974; Shoemaker 1980; Swoyer 1982; Elder 1994; Ellis and Lierse 1994; Ellis 2001, 2002; Bird 2001, 2002, forthcoming; Mumford forthcoming) have suggested instead that the necessity involved is metaphysical; that laws are metaphysically necessary relations between properties, or between a property and a kind. What makes an object a member of a certain kind, or bearer of a certain property, is that object's possession of certain properties including certain behavioural dispositions. So just as Kripke and Putnam argued that it is metaphysically necessary that water is H_2O, or that gold has atomic number 79, the claim is that it is metaphysically necessary, for example, that water dissolves salt, and that gold is an electrical conductor.

These authors do not all use the same arguments to arrive at their conclusion that some or all laws are metaphysically necessary. We can divide them into three groups, the arguments of each being independent of each other, although some authors endorse more than one. Two of the three groups do not so much offer direct arguments for the necessity of the laws, but rather defend views from which the necessity of the laws follows. The first of these, and the one that I will spend most time discussing in this paper, is that the laws of nature are metaphysically necessary because they describe the essences or natures of kinds to behave in certain ways. These essences include dispositional (and may also include irreducibly categorical) properties which determine not just what things are, but what they do. Let us call this position the **'kind essentialist view'**; it is held by Ellis, Ellis and Lierse, Harré and Madden, and Elder. The second group of authors follow Shoemaker in analysing properties as essentially collections of causal powers. Thus, for example, the property of having a certain atomic structure simply consists in having certain behavioural dispositions. This **dispositionalist view of properties** makes the links between properties which state laws metaphysically necessary because they are, in a sense, partial identities.[1] Swoyer, Bird (forthcoming) and Mumford argue in this way, and Ellis also endorses this view. The third position offers no

overall a priori argument for the metaphysical necessity of all laws, but directly argues that *some* laws are metaphysically necessary just in virtue of Kripke/Putnam style considerations about how we identify kinds and what follows from this. In outline, the argument is that given the essentialist premise that 'water', for example, is annexed to a certain chemical structure, science may tell us that the very facts which make it possible for that chemical structure to exist at all will guarantee that the structure is disposed to behave in certain ways. Hence some laws are metaphysically necessary, but ultimately which laws have this status is a matter for empirical science to determine. This is the argument given by Bird (2001, 2002); we might label this the **'piecemeal argument'**.

According to all of these views, law statements are true in virtue of essential and metaphysically necessary features of the kinds or properties to which they refer. We should first clarify exactly what is meant by an essential feature of a kind or property. This can seem a confusing question, for we must distinguish between the properties of kinds or of properties (e.g., being multiply instantiated) and the properties of their members (in the case of kinds) or the things which instantiate them (in the case of properties). When we say a kind has an essence, we do not generally mean that the kind *itself* has some property.[2]

We may compare kind essences with individual essences, which are the properties which make a particular object the object it is. An object can survive change in its accidental properties, but cannot lose its essential properties without becoming a different object. Essential properties of individuals might include being a member of a certain kind, for example, my being a human, or might include other properties, such as my being the child of my actual parents, or a lump of clay's consisting of the same actual quantities of clay which make it up.

This idea can be extended to kinds via their members, as Locke did with his conception of real essence. Intuitively, the essential properties of a kind are the properties of its members which make those individuals members of that kind and not another. For Locke, particular substances gain their real essences derivatively in virtue of kind membership: the real essence is that "whereby they are of this or that species" (*Essay*, II.xxxi.6). There is also the thought that the essence *explains* the other properties the kind's members have: Locke speaks of the observable properties 'flowing from' the essence and the essence being the cause of the secondary properties. I will return to these traditional features of essence in the next section, but for now, we may note that the conception of the essence of a kind found in the kind essentialist view is couched in modal terms. An essential property of a kind is one which an object must possess in order to be a member

of that kind, and which no member of the kind may lack. That is, kind essences give necessary and sufficient conditions for kind membership.

For the dispositionalist about properties, viewing properties as collections of causal powers yields a parallel essentialism about properties. Again, the nature of the property is conceived of via the objects which instantiate it. For a property to be a collection of causal powers means that any object which instantiates the property possesses various causal powers. To instantiate the property just is to possess the causal powers.

All these three views, under which laws reflect essential features of kinds or properties, appear to provide an answer to the question about how the laws gain their necessary status. These views *ground* the necessity of laws in the natures of the kinds or properties in our world, rather than viewing them as somehow (arbitrarily) imposed on things, or following simply from the actual facts. Van Fraassen's Identification Problem is answered by citing the natures of the kinds or properties: the necessity of the laws is identified with the necessity that objects behave in accordance with these natures. "The causal laws are not contingent universal generalisations about how things actually behave, but necessary truths about how they are intrinsically disposed to behave" (Ellis 2001, 344).

In the rest of the paper I will examine this claim and the arguments offered in its favour. I will begin by considering the kind essentialist argument, assessing first in what way it can provide a grounding for the laws, and then whether all laws can be grounded in this way,[3] in comparison to the piecemeal argument which suggests some laws are metaphysically necessary. I finally apply the same arguments to the dispositionalist view of properties and offer some concluding remarks about the general project to show the laws are metaphysically necessary.

2. ESSENTIALISM AND THE GROUNDING OF LAWS

According to Ellis, "the laws applying to things of these kinds are directly grounded in their natural dispositional properties . . . in the sense that they (the properties) are the truth-makers" (Ellis 2001, 217). These properties are active causal powers, which determine what objects will do as well as what they are.

But of course the mere possession of a disposition is insufficient to be the truth-maker of a metaphysically necessary law. Although possession of a disposition explains why an object behaves in a certain way, it cannot explain why it *must* behave in that way. It might be a contingent matter whether some object possesses some disposition, or whether all members of a certain kind possess a certain disposition. Indeed, this is the view of

laws offered by Lipton (1999) and Cartwright (1989) who argue that the capacities of things give rise to laws and that this explains why some laws hold only *ceteris paribus*, since dispositions can fail to manifest. But these laws need not be necessary. Cartwright and Lipton offer no argument that it is *essential* to things of some kind that they possess a capacity: this may just be a contingent generalisation. What we require as the truth-maker of a metaphysically necessary law is the further fact that the disposition is possessed necessarily, or is part of the real essence of the kind. So what makes it a necessary law that copper conducts electricity is that to be copper, something *must* be disposed to conduct electricity; nothing could be copper and lack this causal power.

Kind essentialists like Brian Ellis claim that the truth and necessity of causal law statements are grounded in claims about the essences of kinds. This talk of *grounding* at first suggests that essences are in some sense ontologically prior to laws. Note that this claim about the relationship between laws and essences is quite independent of the claim that dispositions are the truth-makers for law statements: Cartwright and Lipton endorse the latter but not the former. The kind essentialist claim, then, is that law statements, whether ultimately concerning dispositions or not, are true and metaphysically necessary in virtue of the fact that certain kinds of things have a certain essence.

As various authors have pointed out (see, for example, Fine 1994), modern essentialism does not distinguish between the essence of a kind and the necessary properties of a kind. Kripke and Putnam argue that water is essentially H_2O and this comes down to the claim that in any world where there is water, it is composed of H_2O (and that in any world where H_2O is configured in the right way, it is water). Similarly, Ellis thinks that electrons are essentially bearers of a certain mass, charge and spin, that is, in every world where there are electrons, they have these dispositions, and in any world where there are things with these dispositions, they are electrons.[4] So on this view, any property that no member of a certain kind could lack is an essential property of that kind, and an essential property of a kind is just a property that no member of that kind could lack.

But if this is the view of essence that is adopted, there can be no ontological priority of essences over laws. The truth-maker for a causal law 'all Fs are Gs' is not just supposed to be that all Fs have (dispositional) property G, for this could come about purely accidentally. It is that the property G is an essential property of the kind F. But as we have seen, essential properties are simply those properties that a member of a kind could not lack. So the truth-maker of 'all Fs are Gs' is the fact that Fs could not fail to be Gs, or that it is metaphysically necessary that all Fs are

Gs. But this just *is* the law (the modal state(s) of affairs, as opposed to the linguistic item) that Fs are Gs. We might call this modal fact an essence, but describing it thus does not make it ontologically more basic.

In fact, the term essence is doing no more here than acting as a place-holder for the collection of necessary properties of kinds, the properties which figure in the laws about that kind. If a kind K has some set of essential properties $P_1, \ldots, P_n$, then each of these essential properties will correspond to a metaphysically necessary law that anything which is a K has property $P_i (1 \leq i \leq n)$. An essential property P is a property such that it is metaphysically necessary that all Ks possess P, hence it is a metaphysically necessary law that all Ks possess P. Conversely, if it is a metaphysically necessary law that all Ks have property P, then P is an essential property of K. On this view of essence and law, the two notions are interdefinable.

In what sense, then, do essences ground the truth of law statements? In a minimal way the truth-maker for a law statement is a law. So essences certainly ground law statements in providing a truth-maker in this way, since every law corresponds to part of an essence, so if the law is a truth-maker, so is the essence. However, this is all there is to the grounding. It might appear that in labelling as an essence the collection of properties figuring in the metaphysically necessary laws concerning some kind, we have given that collection some kind of unity which the collection of laws itself did not possess. But this is an illusion.

To return to the traditional conception of essence mentioned in the previous section, we noted that Locke, and indeed the earlier Aristotelian conception of essence on which he drew, identified two features of an essence. An essence is first, what makes a thing the thing that it is and not another thing (the idea of 'real definition') and second, what explains or underlies the other properties an object possesses. The modern modal view of essence advocated by Kripke and Putnam has been criticised precisely because it takes no account of these features. For example, Fine argues that not all necessary properties are essential. It is necessary that Socrates is distinct from the Eiffel Tower, but this is not part of Socrates' essence (Fine 1994, 5). Fine defends a non-reductive account of essence, arguing it cannot be analysed in terms of necessity, but instead must be understood in terms of real definition. Could the kind essentialist adopt some such traditional conception of essence to yield a more substantive way in which essences would ground laws?

The 'essences' to which kind essentialists refer are what we might label 'co-dependent'. Some necessary properties of kinds describe their interaction with other kinds. For example, salt is disposed to dissolve in

water. This process involves both salt and water, paradigm natural kinds. To whose essence does this disposition belong? Is it plausible to claim that both salt and water are essentially things which are defined with respect to the other, that their essences are ontologically co-dependent? Would salt not still be salt if there were no water, and vice versa? On an Aristotelian conception of essence, it would be possible to argue that such interactions may necessarily follow from the essences of the interacting substances, but are not actually part of those essences. In this case, the essence itself would only ground the law in a derivative way. This would be similar to putative disjunctive laws such as 'all emeralds or rubies are either green or red' whose metaphysical necessity would follow from the metaphysical necessity of the two basic laws, and hence from the essences of emeralds and rubies, but only derivatively.[5] Hence if the kind essentialist were to adopt this sort of view of essence, it might be possible to argue that essences were indeed more ontologically basic than laws, playing some role in individuating the basic necessities from which others could be derived.

However, as Martin and Heil have argued (e.g., Martin 1996; Heil this volume), there is a plausible intuition that manifestation of a disposition is the manifestation of reciprocal dispositional partners. In a disposition manifestation it is often – perhaps always – impossible to characterise one object as cause and another as effect. This is not just true of cases such as salt's dissolving in water, but holds even at the fundamental level. Basic particles such as electrons have no structure and are defined with respect to dispositional properties including their charge and spin. Ellis, and others, have argued that these are genuinely ungrounded dispositional properties, which have no causal basis. That is, an object's possession of the dispositional property cannot be reduced to or explained by some more basic structural properties of the object. Since these are dispositional properties, they determine the behaviour of electrons in their interaction with other kinds of fundamental particles. In such a case, it might well not be possible to isolate an essence for electrons which does not make reference to how electrons are disposed to interact with other kinds of things. If so, there would be no conception of the essence of an electron, independent of other kinds of thing, which determines everything electrons do. Even if the traditional conception of essence could be reconciled with this possibility, such an essence for electrons would require supplementation with laws in order to derive the interactions of electrons with other kinds of things. Hence it is not clear that there is a conception of essence which would ground laws in a substantive way.

All the essentialist arguments that it is the natures of things, rather than laws, which determine behaviour, are aimed at the view that the laws are

contingent, and that the same kinds of thing might behave in radically different ways in possible worlds where the laws are different. What I have argued in this section is that those who think that laws might actually be possessed of full-strength metaphysical necessity need not also buy into the view that natural kinds have an *essence* distinct from their necessary properties. The conception of essence in use here is not doing any work over and above the postulation of metaphysically necessary laws, and so there is no sense in which the essences of kinds actually ground the laws of nature. It is possible that a more traditional conception of essence could be invoked to provide a more substantive explanatory role, but it remains to be seen whether this will turn out to be compatible with the kind essentialists' position on ungrounded dispositions.

3. ESSENTIALISM AND NATURAL KINDS

However, there is a more serious challenge to the kind essentialist view. This threatens the whole metaphysical picture, that the laws of nature are all metaphysically necessary in virtue of the essences of kinds. This can be shown by considering Bird's (2001, 2002) arguments for what I called above the 'piecemeal' argument for the metaphysical necessity of laws. In the previous section, I suggested that the fact that the so-called essences are co-dependent vitiates their claim to be essences rather than laws. But there is another way in which the behaviour of kinds might depend on extrinsic factors.

For high level kinds, such as copper, water, and so on, we typically have an account of the dispositional properties in terms of structural properties. But we cannot reason a priori that dispositional properties supervene just on the structural ones. Bird argues that salt necessarily dissolves in water, but reaches this conclusion from consideration not just of the atomic structure of salt and water. Salt dissolves in water because of Coulomb's Law, which describes the electrostatic attraction between charged particles. But Coulomb's Law, or some close cousin of it in another possible world, is required for salt to exist at all; without such a law, the ionic structure of sodium chloride could not exist. So whenever salt exists, Coulomb's Law, or something like it, will be true and hence salt will dissolve in water. The law is therefore metaphysically necessary, but the necessary truth that the existence of salt depends on the truth of Coulomb's Law, or something sufficiently like it, is a purely empirical matter.

Bird characterises the relationship between the instantiation of certain kinds and the holding of certain laws as a 'down-and-up' structure. We move 'down' from the instantiation of certain kinds to the existence of

some law on which that instantiation depends, and then can move back 'up' again from the existence of the law to some particular behavioural disposition of the kind in question. So salt's existence depends on Coulomb's Law, or something like Coulomb's Law, and if Coulomb's Law, or something like it, is true, then salt is disposed to dissolve in water. Thus the existence of salt guarantees its possession of the disposition, and necessarily salt dissolves in water.

But, as Bird observes, whether or not this down-and-up structure holds anywhere in nature is a matter for empirical science to determine. His point is that without presupposing either kind essentialism or a dispositionalist view of properties, it can be shown empirically that certain laws are metaphysically necessary. But of course the argument cuts the other way as well. If it can be shown that the down-and-up structure does not hold for all or certain parts of the world, then there could be laws that are not metaphysically necessary. Crucially, this is an entirely open empirical question, and one which cannot be resolved purely a priori.

For example, it might turn out to be the case that the disposition of water to boil at 373 Kelvin supervenes not just on the atomic structure of water (or on the structure of the complex bonding chains in any sample of liquid water) but on the values of fundamental constants which could vary independently of these structures. If so, it might turn out that in a world where these fundamental constants took different values, water is still present, but is disposed to boil at some other temperature. Hence the disposition to boil at 373 K might not be part of the real essence of water, because water could exist and lack this disposition. In this case, the putative law that water boils at 373 K would not be metaphysically necessary. Whether or not this is the case must be determined a posteriori.

The kind essentialist may attempt to counter this claim by suggesting that at the fundamental level there is no structure on which the dispositions supervene: all there is is the disposition. For example, for there to be electrons, there must be things which behave as electrons do. From the existence of electrons, we can move down to the laws governing their behaviour, because these laws arise from behavioural dispositions which are part of the essence of electrons. There is no room for the behavioural dispositions and the essence to come apart, as with the case of water above, because to be an electron just is to have those behavioural dispositions. There is no deeper structural explanation, because these dispositions are ungrounded. Hence just from the existence of electrons (and other fundamental particles) we can infer that the laws governing their behaviour must hold, and thus the down-and-up structure holds at the fundamental level. But if the down-and-up structure holds at this level, it holds everywhere,

for everything is made up of the fundamental particles. Hence there can be no independently varying fundamental constants, for any variation would mean that we no longer have the same kinds of things.

The trouble here is that an essentialist claim is being made where our intuitions are very unreliable. Leptons and quarks are individuated purely by their behavioural dispositions (mass, charge, spin, and so on). But they are also empirically discovered basic kinds, whose essences are therefore also discovered: the fact that leptons and quarks have these properties is not analytic. But with no deeper structural explanation on which to base our disposition ascription, we have an individuation problem. Electrons are of course distinguished from other kinds by their behavioural dispositions. But we can question to what extent the actual behavioural dispositions of electrons are necessary to membership of that kind.

The fact that we are discovering the fundamental particles empirically means we can sensibly ask the question: must electrons have such-and-such a mass, charge, or spin? In our world, we individuate them by these properties: we see that the fundamental particles are divided into similar groups which share properties in this way. We label the groups 'electron', 'up quark', 'muon', and so on. But this does not tell us that basically the same groupings could occur but where the different particles possessed slightly different properties.

For example, it is epistemically possible that the charge on the electron be very slightly different. In this case, would we really say that we do not have electrons but some other kind of fundamental particle? This version of kind essentialism seems to require that any variation of disposition, however minute, results in a change of kind. But this is implausible, and certainly is not what the original essentialist arguments of Kripke and Putnam claimed. Compare the case with a non-fundamental object, say, a water molecule. While this would not survive changes in constitution (a water molecule could not contain chlorine), it seems it could survive certain changes. For example, as Psillos (2002) argues, it seems plausible that we would still call something 'water' if it consisted of molecules of one oxygen and two hydrogen atoms, bonded covalently, but where the charges are so small that the molecule fails to form the triangular shape of a water molecule in our world. Such a substance might therefore behave rather differently to our water. But even if intuitions suggest that such a substance is not water, it is surely still too strong to require *every* precise structural property to be essential. Similarly, it is surely too strong to say in the fundamental case that every precise behavioural disposition must be essential.

We do not know whether or not such epistemic possibilities are really possible, of course. Perhaps there could be no other grouping of fundamental particles with similar but slightly different properties. But this is a question for empirical science. If science tells us the only possible values for, say, the charge on the electron will yield wildly different results, that is, the behavioural dispositions of electrons must either be exactly the same as they actually are or so different that we no longer have anything like an electron, then it seems that we may agree that their actual behavioural dispositions are what constitute the essence of electrons, and similarly for the other fundamental particles. But until then, it is not clear what reasons the kind essentialist has to insist that it must be the very same behaviour in every case which constitutes what it is to be a lepton or quark; why could the behaviour not be very slightly different? Essentialist intuitions here are hard to come by.

This means that in the absence of a completed science, what is metaphysically necessary looks as if it may depend on more than just the natures of kinds. Instead, we need metaphysically necessary laws which describe how kinds are disposed to interact. But these laws may turn out to be highly conditional, ascribing dispositions to kinds which are somehow functions of fundamental constants. In that case, which dispositions a kind possesses may be contingent on the values of these constants. On the other hand, there may turn out to be only certain values such constants take, such that if they differ, some or all of the kinds we have in this world will not exist. Or perhaps there is only one way the fundamental constants can be. In these latter cases, we have a strong argument that (at least some of) the fundamental laws are metaphysically necessary. But this eventuality can only be shown to be the case in the light of a lot more empirical science.

Our science is not yet complete. We can form hypotheses about the fundamental structure of the world: we can imagine various scenarios which might actually represent how things are. Below I describe three such scenarios. Each of these is epistemically possible, but only one scenario is really (metaphysically) possible. On the first scenario, there is just one way the world could be: that is, the fundamental constants have certain values and no divergence from these is possible. Weinberg (1993) argues that at least some of the discoveries in recent physics are pointing towards this conclusion. On this scenario, there is just one possible world, at least in terms of the possible laws of physics. It might be that it would still have been possible for certain initial conditions to have been different, or for the whole history of the world to have been other than it is, to yield more than one possible world with the same laws. Or it might be that this was not really possible either. And, as Marc Lange points out (p.c.), there might

still be entirely alien worlds in which nothing like modern physics is true, for example, a world where only immaterial souls exist. Nonetheless, if this scenario holds, every law is metaphysically necessary. In the second scenario, there are various ways the world could be in that the fundamental constants could take different values, but any difference, however small, would result in very different kinds of things existing to what actually exists. In this case, again, every law will be metaphysically necessary. However, a third scenario is that there are various ways the world could be, some of which may result, as above, in very different kinds of world to ours, others of which might result in a world like ours in some respects but very different in other respects, and still other ways the world could be which might result in a world very like ours, but different in small respects. If this were really possible, some of the laws of our world would turn out not to be metaphysically necessary.

This last scenario suggests a way to explain physical necessity, in that what is physically necessary follows from the values of the fundamental constants. Our laws are physically necessary in that in any world where the fundamental constants have the same values, the laws are the same. But it is an empirical question, depending on which (if any) of the above scenarios turns out to be correct, as to whether physical and metaphysical necessity will coincide, as in the first two scenarios, or not, as in scenario three.

It might be possible to derive metaphysically necessary laws in scenario three. For example, it might be that the behavioural dispositions of the fundamental particles were a function of the values of the fundamental constants, so that there would be metaphysically necessary functional laws. Functional laws are common in science. The weight of an object depends on its mass, which is intrinsic to it, and the gravitational force acting on it, which is extrinsic. Weight is therefore a disposition which depends functionally on extrinsic factors. But of course the point remains that the dispositions we think objects have in our world may not be possessed in other worlds. If the boiling point of water turned out to be a function of some fundamental constant, then the disposition to boil at 373 K would not be part of the essence of water; rather water would have a disjunctive or functional essence. One can only retain metaphysically necessary laws by making our dispositions a special case of some more global disposition which objects possess across all worlds.

Where does this leave the kind essentialist? I suggest that such essentialists should only be prepared to cite essences when they are also prepared to provide the modal arguments to justify the assignment of particular essential properties to kinds, and I agree with Bird (2002) that this

will require doing some substantial empirical work. This is not to say that there is no room for metaphysics. The essentialist arguments also use a priori intuitions about the natures of kinds to argue for the existence of their necessary or essential properties at all. We reason a priori that certain kinds are exhausted by their constitutional properties (structural or dispositional) and conclude from this that these structural and dispositional properties are necessary properties of the relevant kinds. But the conceptual analysis relies on the empirical science for much, if not all, of its plausibility. These requirements will mean that an overall essentialist metaphysics must be defended and motivated by consideration of the empirical facts (cf. Bealer 1987).

The a posteriori investigation can be seen as investigating essences, but I have suggested it is more convincingly seen as an investigation of metaphysically necessary laws. Especially in cases where the behaviour of a kind cannot be shown to supervene just on structure, it seems much more plausible to describe the investigation as an investigation of laws rather than essences, the more so as it is an open empirical question whether such supervenience is global. Finally, whether or not the laws follow from the actual natures of things turns out to depend on whether the actual natures of things determine everything, which is an empirical question. So the kind essentialist cannot argue a priori that the laws are metaphysically necessary in virtue of the natures of kinds, without adopting such a broad conception of necessary natures that it threatens the original Kripke/Putnam essentialist intuitions on which it relies for its plausibility.

4. THE DISPOSITIONALIST VIEW OF PROPERTIES

To what extent do the arguments given here carry across to the third way of arguing for metaphysically necessary laws, the view (following Shoemaker) that the identity of properties is given by their causal powers?

It is certainly the case that on such a view we cannot eliminate or explain away laws in favour of the conditional powers of objects, because as Shoemaker points out, we need laws to determine which collections of conditional powers constitute genuine properties. The argument is that certain collections of conditional powers have a 'causal unity': they will co-vary according to the causal laws. These collections are the genuine properties, as opposed to putative disjunctive or gerrymandered properties.

My arguments of the previous section also carry over to this view. The conditional powers of a particular fundamental object, say an electron, will not carry over into worlds where a difference in the value of some fundamental constant results in the electron behaving in different ways.

This is because Shoemaker defines a conditional power in terms of causal sufficiency, and what is causally sufficient to produce certain behaviour in one world may not be causally sufficient in another. But we might still want to say that the object was an electron in this alternative world, even though its conditional powers are very slightly different. To argue otherwise seems to saddle the dispositionalist about properties with an over-restrictive and implausible criterion of property identity across possible worlds.

Again, one way to retain the metaphysical necessity of the laws, and the thought that properties are individuated by their conditional powers, is to build the possible values of the fundamental constants into the conditions, thus specifying not just the actual behavioural dispositions of an electron but all its possible dispositions too. This rather inelegant solution also raises questions about the individuation of properties and certainly conflicts with Shoemaker's own epistemological motivation for the view, which is that we know properties by the causal effects on us of their instantiation.

In conclusion, two of the three arguments for the metaphysical necessity of laws omit an important qualification, that it may not be the case that the laws follow just from the actual natures of kinds or properties. Whether or not this qualification holds is an a posteriori matter. If not, the laws of our world, specified in terms of the actual behavioural dispositions of our kinds and properties, may not be metaphysically necessary. We cannot therefore argue purely on an a priori basis from either the essences of kinds or the dispositionalist view of properties that our laws are metaphysically necessary, unless by this it is understood that the nature of these kinds or properties includes their possible causal powers as well as their actual ones. Our actual laws may or may not be metaphysically necessary, but only science can tell us which.

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NOTES

[1] It is a further question on this view whether kinds are also properties, and if so, which properties. I do not discuss this question here.

[2] *Pace* E. J. Lowe who considers kinds to be characterised by properties exactly as particular individuals are characterised by particular property instances (cf. Lowe 1989).

[3] I will not directly consider the case of laws such as conservation laws, which Ellis and others have elsewhere argued follow from the nature of the world as a whole, rather than the essences of kinds.

[4] We can formulate the Kripke/Putnam claim for a kind K and essential property P as $\Box\forall x(Kx \rightarrow Px)$. Ellis claims that this formulation expresses a merely de dicto necessity, and will not do. To capture the de re necessities he requires, he instead suggests $\forall x\Box(Kx \rightarrow Px)$, though I cannot see that this does much better. This says of every (actually) existing object, that necessarily, if it has K, it has P. But this is not a claim about a kind; it is a universal claim about every existing object, giving it a conditional individual essence. This says nothing about objects which might have existed but do not, of which no essential claim would be true. The problem is that Ellis's worry about de dicto and de re necessity cannot be resolved within first order modal logic; to formalise the de re necessity he wants, one must quantify over kinds or properties.

[5] Thanks to Marc Lange for the example and for suggesting the parallel.

REFERENCES

Bealer, G.: 1987, 'The Philosophical Limits of Scientific Essentialism', *Philosophical Perspectives* **1**, 289–365.

Bird, A.: 2001, 'Necessarily, Salt Dissolves in Water', *Analysis* **61**(4), 267–274.

Bird, A.: 2002, 'On Whether Some Laws are Necessary', *Analysis* **62**(3), 257–270.

Bird, A.: forthcoming, 'A Dispositionalist Conception of Laws', *Foundations of Science*.

Cartwright, N.: 1989, *Nature's Capacities and their Measurement*, Clarendon Press, Oxford.

Elder, C. L.: 1994, 'Laws, Natures and Contingent Necessities', *Philosophy and Phenomenological Research* **54**(3), 649–667.

Ellis, B.: 2001, *Scientific Essentialism*, Cambridge University Press, Cambridge.

Ellis, B.: 2002, *The Philosophy of Nature*, Acumen, Chesham.

Ellis, B. and C. Lierse: 1994, 'Dispositional Essentialism', *Australasian Journal of Philosophy* **72**(1), 27–45.

Fine, K.: 1994, 'Essence and Modality', *Philosophical Perspectives* **8**, 1–16.

Harré, R. and E. H. Madden: 1974, *Causal Powers*, Blackwell, Oxford.

Heil, J.: 2005, 'Dispositions', *Synthese* **144**, 343–356.

Lipton, P.: 1999, 'All Else Being Equal', *Philosophy* **74**, 155–168.

Lowe, E. J.: 1989, *Kinds of Being*, Blackwell, Oxford.

Martin, C. B.: 1996, 'Replies to Armstrong and Place', in T. Crane (ed.), *Dispositions: A Debate*, Routledge, London, pp. 126–146.

Mumford, S.: forthcoming, *Laws in Nature*, Routledge, London.

Psillos, S.: 2002, 'Salt Does Dissolve in Water, but not Necessarily', *Analysis* **62**(3), 255–257.

Shoemaker, S.: 1980, 'Causality and Properties', in P. van Inwagen (ed.), *Time and Cause*, D. Reidel, Dordrecht, pp. 109–135.
Swoyer, C.: 1982, 'The Nature of Natural Laws', *Australasian Journal of Philosophy* **60**(3), 203–223.
van Fraassen, B.: 1989, *Laws and Symmetry*, Clarendon Press, Oxford.
Weinberg, S.: 1993, *Dreams of a Final Theory*, Vintage Books, London.

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