

A note on science and essentialism

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ABSTRACT: This paper discusses recent attempts to use essentialist arguments based on the work of Kripke and Putnam to ground causal necessity in the world. I argue in particular that a recent argument by Alexander Bird relies on controversial intuitions about the natures of substances which no Humean would accept. While a case can be made that essentialism reflects some assumptions within scientific practice, the same can be said of Humeanism, and ultimately neither Bird's arguments, nor any empirical facts, can decide the question either way.

Keywords: philosophy of science, metaphysics, essentialism, laws of nature, Humeanism, dispositions.

1. Introduction: Essentialism and natural kinds

Since Hume denied that there was causal necessity in the world, philosophers of science have faced a dilemma. Those who agree with Hume seem forced to concede that the only difference between genuinely causal and accidental regularities lies within us, or is determined by the way we systematise the world. Those who wish to locate causal necessity in something more objective face what van Fraassen (1989) has called the 'Identification Problem': given that causal necessity is not simply logical necessity, what sense can we make of this notion, and how is science to uncover these necessities?

Kripke's and Putnam's work in the 1970s offered a new angle on this issue, with the claim that certain necessary truths are discovered by science, namely those giving the essential natures or real essences of natural kinds. Intuitively, the essential properties of a kind are the properties of its members which make those individuals members of that kind and not another. This echoes Locke's conception of a *real essence*, which is that "whereby [particular substances] are of this or that species" (*Essay*, II.xxxi.6). In the modern essentialist literature, an essential property of a kind is often construed as 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.¹

Kripke and Putnam have famously argued that natural kinds have certain of their properties essentially. The examples of the identity between water and H₂O or the claim that gold has atomic number 79 demonstrate the success of science in telling us about the nature of the world around us: in addition, the claim that these truths are necessary *a posteriori* also seems to suggest that science can tell us substantive necessary

¹ This of course neglects Locke's other main claim about real essence, which is that an object's observable properties 'flow from' its essence which is the cause of its secondary qualities. For a more substantive conception of essence, see Fine (1994).



truths about the world. Despite some well-known challenges to this view (for example, Salmon 1982), to which I will return later in the paper, the existence of necessary *a posteriori* truths such as these remains an attractive idea, and one which many find compelling.

Essentialist claims of these kinds, though, do not provide a source of causal necessity. There is no causal relationship between being water and being H₂O or between being gold and having atomic number 79. These are just (part of) what it is to be water or to be gold, just as having no hair on one's head does not cause one to be bald, it just *is* being bald. The further claim, made by authors such as Ellis and Lierse (1994), Elder (1994), Ellis (2001, 2002), Bird (2001, 2002) is that essential properties of kinds include not just what those kinds *are*, but also what they can *do*. In other words, there are causal relationships between members of kinds which are part of the nature of those kinds and which therefore could not fail to hold. These causal relationships could not be different unless the world contained different kinds of things. If this is correct, such relationships would hold of necessity, and this necessity would be non-trivial and substantive, not just a matter of logic, but something we needed to find out empirically. Moreover, the source of the necessity would be firmly in the world, in the nature of the kinds themselves, rather than in us.

2. Essentialist arguments for the necessity of the laws of nature

Brian Ellis argues that the dispositions possessed by kinds of things in the world are essential to being that kind of thing. The various chemical substances and physical particles which make them up possess behavioural dispositions which they could not lack, and remain the same substances or particles. The disposition to form a structure which conducts electricity is as much a part of what it is to be a copper atom as having twenty-nine protons in the nucleus. Science tells us what copper is, and its properties. Something which did not behave in the same way would not be copper.

Although I will not here discuss Ellis's arguments in any detail, an obvious objection to these sorts of claims seems to suggest itself. Why should we think that the disposition of some kind to behave in certain ways supervenes just on the essence of that kind and not on other features of the world as well? 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.

Ellis considers a related objection: that some laws do not supervene on the essences of particulars alone. For example, conservation laws govern all causal interactions but the mere fact that all the world's kinds essentially obey conservation laws

does not show in virtue of what this is the case (Katzav forthcoming). Ellis's response to this kind of objection is to claim that our world is one of a kind; certain properties are essential to the kind of world we inhabit, and govern the kinds which may exist in it, including, presumably, explaining why kinds which do not obey conservation laws could not exist (Ellis, 2001, p. 251).

The claim that the world is one of a kind is not the easiest to grasp, and it is not clear how it could do the work the essentialist needs it to do in constraining the possible properties of kinds within the actual world.² Why could there not be worlds of different kinds which nonetheless contained some of the same kinds as in our world, so that members of these kinds might behave in different ways? For example, might there not be worlds containing some of our kinds (which obey conservation principles) and also other kinds which do not, so that the conservation laws are not metaphysically necessary? Or might there be worlds where fundamental constants take different values, so that, for example, water boils at a different temperature, and there is no metaphysically necessary law concerning the boiling point of water?³ These objections all question whether dispositions and therefore laws supervene just on the essences of kinds. At this point, I turn to a direct argument that certain laws are metaphysically necessary because these laws do just follow from the natures of the kinds involved in them. In the following sections, I will consider whether this argument is capable of being extended into a general argument for the necessity of all laws which would therefore avoid the above objections.

Bird (2001, 2002) argues that the law that salt dissolves in water is metaphysically necessary. Suppose we accept the essentialist identification of common substances with their chemical composition, and that such identities are necessary. That is, we accept that, for example, salt is sodium chloride and water is H₂O. For a substance to be salt, then, it must be composed of sodium and chlorine ions. But composition is insufficient here. Salt is not just any old mixture of sodium and chlorine ions; these ions must be bonded ionically in a lattice structure. It is not just the entities which compose salt which are necessary to salt's identity, but the way these entities are structured, and crucially, the relationships between them.

However, Bird's argument goes, for a bond to be ionic, it must result from the electrostatic attraction between charged particles. This is the definition of an ionic bond; sodium and chlorine ions held together by some other force, say, *per impossibile*, gravitational force, or by God's will, would not be bonded ionically. Ionic bonds are governed by Coulomb's Law, which states the relationship between the particular charges and their separation. If Coulomb's Law were sufficiently different, that is, if charged particles did not attract each other in this way, ionic bonding would not be

² Chalmers (1999) points out that it is not clear how to construe conservation laws as causal laws, since they apply at the level of phenomena, regardless of the nature of the underlying causal processes. He takes this to show that Ellis's response fails.

³ There might still be a functional law, making the boiling point of water a function of the value of some fundamental constant(s). I consider this possibility in Drewery (2004).

possible. Hence, for ionic bonds to exist, Coulomb's Law, or something sufficiently like it, must be true. Hence, if we accept the claim that the bonding of the sodium and chlorine ions is necessary for salt to exist, Coulomb's Law, or something like it, must be true.

Bird then argues that if the existence of salt requires the truth of Coulomb's Law, or something sufficiently like it, the existence of salt will also require that salt will behave in certain ways, related to the properties of the ionic bond. For example, salt will dissolve in water, because this process of dissolving is also governed by Coulomb's Law, and results from the polar nature of water molecules. Hence, if salt exists, Coulomb's Law (or something like it) is true, and if water exists too, salt will dissolve in water. Hence any world in which salt does not dissolve in water must be a world in which Coulomb's Law and anything sufficiently like it is false, and so there can be no salt. Thus, salt necessarily dissolves 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. Hence the fact that salt dissolves in water is necessary *a posteriori*. So this argument appears to show that science can not only tell us substantive necessary facts about the nature of our world, but also about how things in it will behave. It directly challenges the Humean view that there are no necessities in the world, by claiming that there just could not be salt which failed to dissolve in water, and that this is a fact about salt itself which science has shown.

The relationship between salt and water, as described above, Bird labels a 'down-and-up' structure. From the existence of salt we move 'down' in the explanatory hierarchy to the existence of the law on which it depends, and then can move back 'up' again in the explanatory hierarchy from the existence of the law to the particular behavioural disposition of salt: to dissolve in water. Whether or not this down-and-up structure holds anywhere in nature is a matter for empirical science to determine. But Bird (forthcoming) cites certain results in contemporary physics, including Steven Weinberg's work,⁴ to suggest that there is reason to believe that ultimately this structure will apply throughout physics. This addresses the earlier worry about whether some laws might turn out to supervene on external factors as well as the essences of the kinds involved. For example, even a slight variation in the fundamental constants would have meant that most of the heavy metals would not have existed.⁵ Bird and Weinberg are suggesting that there is no possibility of, say, water's boiling point depending on some external factor which could vary independently, because any such independent variation would result in there being no water. If this is indeed the case then there will be either just one single underlying law or a network of closely integrated laws, whose metaphysical necessity will determine the values of the fundamental constants. Bird's down-and-up structure will be all-pervasive, and every causal law will be metaphysically necessary.

⁴ For example, Weinberg (1993).

⁵ Mauricio Suárez used this example to stress the point.

3. *The scientific basis of the essentialist arguments*

The essentialist arguments claim to respect scientific and common sense intuitions about the ontology required for scientific enquiry. According to these intuitions, causal necessity must be objective and therefore located in the world, and the essentialist account of laws and essences provides an explanation of how this is possible. Indeed, Elder (1994) argues that it is the only successful explanation of how causal necessity can be located in the world. But as Salmon (1982) has argued in some detail, Kripke's and Putnam's essentialist arguments include a crucial premise whose status is metaphysical and extra-scientific. Substantive necessary truths cannot be established purely on the basis of scientific enquiry. Clearly the essentialists' arguments will also rely on the same metaphysical premises as Kripke's and Putnam's arguments. The question I now wish to raise, though, is whether they rely on just the same kind of premise, or whether they make further metaphysical assumptions which require additional justification. If so, is such justification available?

Salmon argues that for Kripke's and Putnam's arguments to go through, a hidden essentialist premise is required, concerning what it is to be members of the same kind. For example, in the case of water's being H₂O, the premise is 'being a sample of the same substance as something consists in having the same chemical structure' (Salmon, 1982, p. 166). Such a premise, Salmon argues, can only be justified by metaphysical argument. Kripke and Putnam have not therefore shown that these sorts of substantive necessary truths can be established by scientific enquiry alone.

Bird's argument assumes, along Kripkean lines, that salt is necessarily sodium chloride, and that sodium chloride necessarily contains ions. It also aims to show that, in the case of salt, having the same structure also entails being disposed to behave in the same way. But this suggests that, for Bird, being the same substance is not a merely structural property but also something dynamic, something which essentially involves a certain kind of dispositional behaviour. Salt cannot exist unless it contains ions bonded ionically. For ionic bonds to exist there must be forces between the ions in virtue of their charge. Electrostatic forces are essentially law-governed, and so the mere existence of salt entails the existence of certain causal laws.

In this argument, scientific facts are used to argue for a metaphysical and anti-Humean conclusion. Bird, though, is not just claiming that the Humean conception of laws is incorrect. He is also claiming that on the Humean conception of laws, certain kinds of things could not exist. This can be illustrated using the idea of a Hume-world, introduced by Frank Jackson (1977). A Hume-world exactly mimics the actual world except that there is no causal necessity in the world: there are simply events which follow one another in a regular pattern. Care must be taken with this thought experiment, as Hume-worlds will not be possible on many metaphysical theories. Humeans will of course think that our world *is* the Hume-world. Essentialists such as Ellis think that Hume-worlds are impossible, because a Hume-world could not contain the same kinds of thing as the actual world. A similar claim is made by John Carroll, who suggests that there could be no such thing as perception in a Hume-world, because the concept of perception carries nomic commitments which a Hume-world could not

satisfy, hence there could be no lawless world which agreed non-nomically with the actual world (1994, p. 64).⁶

Could ionic bonds and therefore salt exist on a Humean conception of laws? The Hume-world thought experiment presupposes that salt is the substance which appears to be salt, the white crystalline substance whose empirical behaviour is indistinguishable from salt. In the Hume-world, there are measurable electrostatic charges on the ions in this crystal, which form a lattice structure. But in the Hume world, the ions just stand next to each other; they are not in any worldly causal relation to each other. When this so-called salt dissolves, this is not because of an objective worldly necessity we identify as Coulomb's Law, but is just another part of the mere succession of events. Nonetheless, a Humean will not deny that Coulomb's Law is true or lawlike: just that its necessity is not to be found out there in the world. The regularity of ionic bonding is sufficient for there to be ionic bonding. Thus the Humean will claim that Coulomb's Law, ionic bonding, and salt all exist in the Hume-world; for the Humean, this is how the actual world is.

It seems that Bird will deny that the Hume-world is possible. He discusses a world in which a powerful spirit caused charged particles to behave in an exact simulation of Coulomb's Law (2002, pp. 261-2), and claims that in such a world, which we might call a Malebranche-world,⁷ Coulomb's Law would not hold, and this world would therefore contain something which looked like salt but which was not really salt. Thus there could be no world exactly like the actual world, containing the same kinds, but where all causal activity was due to God rather than material things. So it seems Bird must also deny that Hume-worlds are possible, because for similar reasons Coulomb's Law would fail to hold in the Hume-world, and therefore there could be no salt there either. But to deny that Coulomb's Law holds in the Hume world, and that therefore there could be no salt or ionic bonds in such a world, is to beg the question against the Humean. This is to claim that the things in the world to which our ordinary concepts of salt, ionic bonding, and indeed Coulomb's Law refer have non-Humean features built in to them. That is, salt would not be salt unless it satisfied Coulomb's Law, which in turn would not be Coulomb's Law unless it involved worldly causal necessity. This seems problematic in two ways. First, there is the question as to whether our ordinary concepts do indeed involve anti-Humean intuitions, as Carroll and Bird claim. The Hume-world thought experiment suggests that we can conceive of a world just like ours but with no causal necessity in it. But second, even if we concede that our ordinary every-day concepts involve non-Humean intuitions, this does not mean that the things to which our concepts refer must be as we conceive them to be. To

⁶ Carroll does not hold the same essentialist views as Ellis and Bird, and thinks the laws of nature are physically, rather than metaphysically necessary, but that physical necessity is irreducible.

⁷ Malebranche was an advocate of *occasionalism*, the view that all causation occurs through God. When salt dissolves in water, God is the actual cause of the dissolving: the coming together of the salt and water is the *occasional* or *incidental* cause upon which God actually causes the salt to dissolve.

claim that they are is to beg the question against the Humean, for the existence of causal necessity in the world is exactly the point at issue.⁸

The Humean may allow that the presence of ionic bonds is part of what constitutes salt. But she will not concede that this makes the law that salt dissolves in water necessary. Humeanism requires the identification of kinds independently of the laws concerning them, since which regularities are laws supervenes on individuals and their properties.⁹ Should the course of events turn out to be irregular, so that salt sometimes fails to dissolve in water, we should then find that this was not a law. This would not mean that we did not have salt, or water. But, the essentialist will claim, this is not a real possibility. Science has shown us that the very forces which hold the salt crystal together require salt to dissolve: a substance which did not dissolve could not have just this structure and therefore would not be the same substance. But what is to count as having the same structure here? Merely conceding that salt must contain ionic bonds does not entail anything about how salt behaves, without the additional premise that ionic bonds must behave in accordance with Coulomb's Law. But the Humean should not concede this additional premise, for this would undermine the Humean conception of lawhood. Instead, she should argue that ionic bonds need not obey Coulomb's Law.

This discussion brings out something rather odd about the essentialist argument to show that science can establish substantive necessary truths, which is that against the essentialist intuitions, we also have a strong intuition that the science would be the same whether we lived in the Hume-, Malebranche-, or indeed the essentialist's world. Or, at least, what we could empirically show would be the same. No empirical fact could establish which of these worlds is in fact the one in which we live. So why should we think that science favours one metaphysical picture over another? The conception of science which is presupposed by the possibility of a Hume-world sees science as merely concerned with the empirical facts, and therefore is often interpreted as favouring a conception of laws as free of metaphysical commitment as possible, namely Humeanism.

Against this, an essentialist might argue that although the scientific enterprise cannot *establish* metaphysical conclusions, such as whether we live in a Hume-world or not, there is a plausible conception of science which does *presuppose* a certain metaphysical picture. The Hume- or Malebranche- worlds allow for the possibility that things just might go otherwise at some point in the future: things might stop behaving regularly, for no reason, or because God decides they will. But against this, science makes a claim to completeness which is alien to these thoughts. Scientists assume that their explanations are the only sorts of explanations for the phenomena: entertaining the possibility of science failing at some point in the future is to reject the possibility of complete scientific explanation at all. This assumption of completeness is based on

⁸ This point is made by Beebe (2001).

⁹ I am here not distinguishing between properties and kinds, but the most obvious Humean theory of natural kinds will be based on grouping together objects which share properties.

a view of causal necessity as external, objective, and located in the world, and therefore presupposes that Humeanism is false.

4. Essentialism and fundamental dispositions

In the search for an objective conception of causal necessity, I have considered Bird's direct argument for the claim that certain laws are metaphysically necessary, and suggested that it begs the question against the Humean conception of causal necessity. However, I now wish to return to the claim that this argument can be extended to show that all laws might be metaphysically necessary. I will argue that it cannot be so extended, because it is problematic to extend the Kripkean essentialist intuitions in the case of ungrounded dispositions, and it seems that Bird's argument will ultimately have to rely on these.

The disposition of salt to dissolve in water is one which can be explained in terms of the structure of both the salt and water. This disposition is either identical with, or caused by (depending on one's theory of dispositions), the categorical base which the Kripkean intuitions describe. The question then arises as to whether all dispositions will have such bases. Many dispositional essentialists posit ungrounded dispositions, namely, those which are not explainable in terms of more basic structural properties of objects. Such dispositions will be the truth-makers of whatever turn out to be the most fundamental law or laws.

If this is so, it appears that a different argument can be given as to why the dispositional essence of a substance could not depend on something external to it, as I suggested above it might in the case of water boiling at 373K. 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 are disposed to behave as electrons do. However, we do not quite have Bird's down-and-up structure here, because we have already reached the fundamental level of explanation. If electrons indeed turn out to be fundamental particles, this means that there is no law explaining their existence, which might also explain their behaviour. If these dispositional properties are fundamental, there is no deeper explanation of why electrons have these properties. The possession of these dispositions just is what constitutes being an electron: so at the fundamental level, the laws are necessary purely in virtue of this fact.

The essentialist who believes in fundamental ungrounded dispositions will therefore claim in this case that electrons have an essence, an intrinsic nature, which includes possession of certain dispositions, but there is no further explanation of this fact. The laws governing the behaviour of entities at the fundamental level hold of necessity, because they hold in virtue of the intrinsic natures of the fundamental kinds. They thus provide a foundation for necessary laws at all other levels, since the fundamental particles are what all other entities are made of. So there can be no independently varying fundamental constants, because everything is governed by the intrinsic nature of the fundamental particles.

I have argued elsewhere (Drewery 2004) that the case of ungrounded dispositions presents problems which we do not find in the case of salt, water, and so on. This is because without a structural basis for ungrounded dispositions, it is not clear how the essentialist intuitions about what constitutes being the same kind of fundamental particle can take hold. Are any variations from the behaviour of the actual fundamental particles possible? For example, on what basis could we decide whether a possible world containing particles with a slightly different charge to our electrons contained electrons or not? When such behavioural dispositions are fundamental and therefore inexplicable in terms of something more basic, it seems very hard for intuitions to get a purchase, and therefore it is not clear that the precise dispositions in question *are* essential.

However, a deeper metaphysical concern arises from the idea of explanation. The dispositional behaviour of fundamental particles is explained by the possession of the disposition. But by hypothesis, the possession of the disposition itself has no explanation. Electrons repel negative charges in virtue of being electrons. But if this disposition is ungrounded, this is just to say that electrons repel negative charges in virtue of being disposed to repel negative charges, since on the essentialist view, being an electron just consists in having certain dispositions, with no further explanation. Why electrons should have these dispositions, rather than others, has no explanation. Of course, we might argue that we would not call a fundamental particle with different dispositions an *electron*. But this makes the necessity purely verbal. So for the essentialist to claim that the fundamental laws are necessary, and therefore all laws are necessary, a source of this necessity in the world must be given.

Here the essentialist might return to Weinberg's work and argue that because slight variations in behaviour have such far-reaching consequences, an empirical argument will be forthcoming to the effect that there is only one way things could be. But this argument, like Bird's argument about salt and water, will also beg the question against the Humean in just the same way. If Humeanism were correct, all the kinds of things in the actual world could exist and behave in different ways. To claim that science has shown this is not really possible is to presuppose a certain view of what makes things members of the same kind.

In conclusion, the essentialist's argument for the necessity of certain laws relies on metaphysical assumptions about the nature of laws which require independent justification. This is in addition to the justification of the essentialist premises which Salmon has identified. At the fundamental level, the essentialist faces the further problem of grounding causal necessity in the world. We cannot yet therefore read the metaphysical necessity of laws from the discoveries of science.

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