DISPOSITIONS AND THE ARGUMENT FROM SCIENCE

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Abstract — *Central to the debate between Humean and anti-Humean metaphysics is the question of whether dispositions can exist in the absence of categorical properties that ground them (that is, where the causal burden is shifted on to categorical properties on which the dispositions would therefore supervene). Dispositional essentialists claim that they can; cateogoricalists reject the possibility of such 'baseless' dispositions, requiring that all dispositions must ultimately have categorical bases. One popular argument, recently dubbed the 'Argument from Science,' has appeared in one or another form over much of the last century and purports to win the day for the dispositional essentialist. Taking its cue from physical theory, the Argument from Science treats the exclusively dispositional characterizations of the fundamental particles one finds in physical theory as providing a key premise in what has been called a 'decisive' argument for baseless dispositions. Despite sharing the intuition that dispositions can be baseless, I argue that the force and significance of the Argument from Science have been greatly overestimated: no version of the argument is close to decisive, and only one version of the argument succeeds in scoring points against the categoricalist. Not only is physical theory more ontologically innocent than defenders of baseless dispositions seem to appreciate, most versions of the Argument from Science neglect important ways that dispositions could be grounded by categorical properties.*

1. INTRODUCTION

One central thesis of dispositional essentialism—the metaphysic according to which at least some properties have dispositional essences—is that our world contains (or could contain) *baseless* dispositions.[1] Baseless dispositions are dispositions not ultimately grounded by any categorical (i.e. non-dispositional[2]) properties, where to be 'grounded' is to have some distinct causal basis that is responsible for the manifestation we initially credit the disposition with producing. Categoricalism (sometimes known as 'Categorical Realism') is the thesis that all dispositions must ultimately have categorical properties that ground them; it is this thesis that the dispositional essentialist denies when she claims that some or all dispositions can be baseless.[3]

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[1] Dispositional essentialism is not the only view according to which there are (or could be) baseless dispositions. Notable is the Martin/Heil 'identity' view that fundamental properties are at once both dispositional and categorical [Martin 2008, Heil 2003]. Due to limited space, this discussion will focus on dispositional essentialism; nevertheless, the conclusions reached here should apply equally to those other views, as they too take properties to have dispositional essences (even if not exhaustively so).

[2] How best to characterise the dispositional/categorical distinction is a thorny issue. As the present argument works under most conceptions of the distinction, I will not explore it here.

[3] Categorical properties lack essential causal and modal features, so something must be added for a categorical property to properly ground a disposition. Nevertheless, as categoricalism concerns what is necessary for grounding dispositions, questions of what that additional something might be can be set aside.

One incredibly popular argument raised in defence of baseless dispositions—the 'Argument from Science'—takes its cue from contemporary physics, where it is suggested that the properties of the fundamental particles are dispositions. According to the argument, what it means for the fundamental entities to be fundamental is that they lack constituent parts. It is then claimed that any property had by the fundamental physical entities must itself be fundamental, and therefore incapable of having some other property that grounds it. As the properties of the fundamental physical entities—spin, charge, mass, etcetera—are apparently dispositional, it follows that these dispositions are fundamental, so we have empirical evidence that there are baseless dispositions.

Stephen Mumford [2006: 471] suggests that the question of whether dispositions can be baseless turns on the Argument from Science, and that 'the whole debate between Humean and anti-Humean metaphysics might rest on [its] viability'; this is no exaggeration. The doctrine of 'Humean Supervenience'—championed by Lewis [1986] and by far the most widely held form of categoricalism—claims that the most fundamental or 'sparse' properties are categorical, and thus lacking modal or causal characteristics. What causal or modal facts obtain do so because they supervene on the 'vast mosaic' of categorical properties plus the laws of nature. Hence if categoricalism is false, so too is Humean Supervenience. And if Ellis and Lierse [1994: 32] are to be trusted, then that is the case: they claim that the Argument from Science appears to be decisive against categoricalism. It would seem the importance of the Argument from Science is beyond question.[4]

Nonetheless, despite its importance and its frequent employment in the literature, the significance of the Argument from Science has been overstated: it is far from decisive against categoricalism. Of the four versions of the argument that can be distilled from the literature, only one can claim to score points against the categoricalist; the rest fare far worse. In fact, two versions of the argument are fallacious (the direct version and the 'structureless' indirect version), and a third (the 'no good conception' indirect version) merely raises a worry to which the categoricalist has an adequate response. Only the fourth—the 'explanatory' indirect version—boasts any serious result. Though the categoricalist is not entirely without a response to this version of the argument, the dispositional essentialist scores some points in her favour. This falls well short of demonstrating the falsity of categoricalism, but with the scarcity of knockdown arguments, these points may prove significant. I recommend all future applications of the Argument from Science make use of this version.

The order of presentation is as follows: I start with a preliminary discussion of the general features of the Argument from Science (§2), after which I present and discuss the four specific versions: the direct version (§3) and three indirect versions (§4).

2. THE ARGUMENT FROM SCIENCE

Though the Argument from Science (AFS) has a distinguished ancestry that can be traced back at least as far as the early modern period—a time when empiricist ideals led to concerns over access to the intrinsic nature of substance, and worries about secondary qualities did

[4] To be clear, I am concerned only with the extent to which the Argument from Science impacts this debate. There may be independent reasons for endorsing or rejecting categoricalism that I will not consider here.

little to lessen the inscrutability of concrete reality—it is a more recent incarnation that is the present topic of interest. The nearest thing to the contemporary form of the AFS first appears in C.D. Broad's *The Mind and Its Place in Nature*. He writes:

> we cannot wholly *reduce* causal characteristics to non-causal characteristics by correlating the former with the persistence of a certain type of internal structure. When we say that the movements of the minute internal parts obey the laws of mechanics we are ascribing a certain causal characteristic to them. And when, *e.g.*, we say that a certain minute spatial structure of a body causes it to select and reflect the red component of white light we are ascribing a causal characteristic to this structure. The most that we can do by this means is to reduce a number of causal characteristics which seem to be independent and disconnected to a comparatively few fundamental causal characteristics [1925: 435-436].

But the first explicit use of the AFS where it is clearly intended as an argument for baseless dispositions appears in Harré and Madden's *Causal Powers*.[5] They write:

> The nature of physical objects, according to the scientific tradition, are given in terms of their inner structures and the nature of the individuals of which that structure is composed… structure exists when the elementary parts of a spatially extended body are so related in space that certain relations among the parts are invariant under a variety of transformations… we come in the end to structures of elementary entities which are themselves structureless and characterised wholly by their powers and liabilities [1975: 104].

However, the argument does not get its name until quite some time later, when Ellis and Lierse dub it the 'Argument from Science'[6]:

> There is one argument against categorical realism, however, which appears to be decisive. This is the argument from Science. With few exceptions, the most fundamental properties that we know about are all dispositional. They are of the nature of powers, capacities and propensities. Therefore, we must either suppose that these basic properties are not truly fundamental, and that they will all eventually be shown to be dependent on categorical properties, or else we must concede that categorical realism is false [1994: 32].

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[5] A drawn out and less explicit version of the AFS can be distilled from (the earlier) Harré [1970]. Though his conclusion there is similar, it carries only a weak commitment to baseless dispositions.

[6] The AFS has also been referred to as 'the Ultimate Argument' [Psillos 2006] and 'the Ungrounded Argument' [Mumford 2006]. In addition to those already mentioned, versions of the AFS appear (either implicitly or explicitly) in: Blackburn [1990], Ellis [2001, 2002], Foster [1982], Goodman [1954], Harré [2001], Holton [1999], Jackson [1998], Mackie [1973], Martin [1993, 2008], McKitrick [2003], Molnar [1999, 2003], Mumford [1998], and Strawson [1980].

As we shall see, to speak of *the* AFS (in the singular) is, strictly speaking, to speak mistakenly. It is not just one argument, but a small, close-knit family of arguments. Though distinct, the arguments within the AFS family overlap each other to such an extent that it is not surprising that they would be conflated at times. I shall, accordingly, continue to speak of the AFS in the singular, and refer to various 'versions' of it.[7] I consider an argument a version of the AFS as long as it satisfies the following two criteria: first, it must include as its central premise some claim to the effect that:

[P] Physical theory describes the fundamental physical entities exclusively in dispositional terms;[8]

and second, it must have as its conclusion the following claim (or something similar):

[B] There are (or could be) baseless dispositions.[9]

Before turning to the discussion of the specific versions of the argument, there are a few preliminary points worthy of mention concerning the AFS in general.

As indicated above, [B] is the rejection of categoricalism, the claim that all dispositions must ultimately have categorical bases. To be clear, categoricalism is not the claim that all dispositions must have occurrent properties that ground them, as dispositional properties are as occurrent as any other. Rather, it is the stronger claim that somewhere down the line each dispositional property must have a categorical property that serves as its base. This need not be the immediate property that grounds a disposition, as many dispositions have as their bases other dispositional properties (the fragility of a glass might be like this, with the dispositions of the constituent molecules to bond to one another grounding the fragility), but all such dispositional hierarchies must terminate in a categorical property base. Conversely, [B] is the claim that *not all* dispositions must ultimately have categorical bases; to wit, some dispositional properties are baseless.

I shall assume for the purposes of the present discussion that [P] is a true and accurate statement of how things are according to fundamental physics. This might be an overly charitable concession—recent discussions in the philosophy of physics suggest that the dispositions ascribed to the fundamental entities (spin, charge, etcetera) might only be

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[7] Following its appearance in Ellis and Lierse [1994], the AFS shows up—and is referred to by name—in Ellis's later writings [2001, 2002]. Though the 2002 version is effectively the same as the 1994 version, the 2001 version differs markedly, and offers two distinct (though closely related) arguments, neither of which is identical with the 1994/2002 version. I submit this as further evidence for treating this family of arguments as different versions of the same argument.

[8] Some instances of the AFS replace [P] with a stronger claim to the effect that the basic physical entities have only dispositional properties [Mumford 2006], but this goes beyond physical theory and replaces it with a substantive metaphysical thesis. For further discussion see §3.

[9] Most versions of the AFS have as their conclusion the stronger of the two disjuncts, namely that baseless dispositions exist, not that they are merely possible. Though dispositional essentialism is compatible with metaphysically possible but non-actual baseless dispositions, the arguments in question treat [P] as a claim about how things are in our world at the most fundamental level, so cannot consistently argue that baseless dispositions are a mere possibility. (One cannot consistently demonstrate that a category is genuine by pointing to the actual occupants of that category and at the same time maintain that the category is real but contingently empty.)

(properly) attributable to whole systems of entities, and not the constituents of the systems as [P] requires—but I shall make it nonetheless.[10] As it happens, nothing hangs on this assumption; my primary interest in the AFS concerns what would be the case were [P] to be true, so whether [P] is in fact true is less important. Though there is certainly some reason to suspect that it is (and most proponents of the AFS seem reasonably convinced that it is), even if [P] is false it is harmless to consider what would follow from its truth, and consequently what impact the AFS would have if sound. I shall also assume that whatever scientific theories turn out to be (sets of statements? models?) we can interpret the use of dispositional predicates in them as a commitment to the existence of dispositions, and further that a general attitude of scientific realism is at work in converting statements of physical theory to claims about what exists. I should think that anyone who presents the AFS in defence of [B] will assume the same.

So what reasons might one have for thinking that [P] and what it suggests about the nature of the fundamental properties is true? Here are the three reasons that appear the most compelling. The first is that the terms physicists use to characterise the fundamental physical entities are dispositional: 'spin', 'charge', 'mass', and so on are all overtly dispositional terms. And not only are these terms *prima facie* dispositional (in that they strike one as concerning what the fundamental entities can and will do)—the same conclusion can be drawn from a closer examination of their use and interpretation within contemporary physics. For instance, 'charge' names the disposition to produce electromagnetic fields, and 'spin' the disposition to contribute to the total angular momentum of a system [Ellis 2002: 47]. The second reason also concerns the terms that physicists use to characterise the fundamental physical entities, only this time it is what they are *not* saying that matters. Absent from these characterisations are categorical terms; dispositional terms exhaust the class. Finally, the third reason is that attempts to locate structure within the fundamental entities have consistently come up empty. Molnar writes:

> Ever since Rutherford had found 'bombardment' as a method of probing for subatomic structure, every significant increase in the level of projectile energy has led to discoveries of new, deeper levels of structure. But now there exists a strong body of evidence, from experiment to theory, to show that this history will not keep repeating itself. Collisions have been produced in accelerators with energies over a hundred thousand times above the level at which new structures could have been expected to reveal themselves if history was going to repeat. Yet electrons and quarks continue to come out as point-like, structureless entities [2003: 133].

Jointly, these reasons provide (some) evidence in support of [P] and the ontological picture it suggests. As I have said, what matters most is what would follow if [P] were true, not whether in fact it is, but we have been given some reason to think it might be.

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[10] For more on the thought that properties like spin and charge are 'holistic' properties of whole systems and not their constituents, see Healey [1991] and Teller [1986]; a parallel possibility is raised by Harré's [1986] notion of 'ultra-grounding'. In a similar vein, Psillos [2006: 154] casts doubt on the AFS on the grounds that the dispositions of the fundamental entities flow from 'fundamental symmetries'.

3. AFS: THE DIRECT ARGUMENT

Though [P] is suggestive of a certain ontological picture, it is compatible with a wide range of ontologies (the most apposite being those that endorse categoricalism), and therefore is insufficient to support [B] on its own. It follows that any direct version of the AFS will have to include additional premises to get from [P] to [B]. These will—in all likelihood—include metaphysical claims about what exists in accordance with what current physics tells us.

Jennifer McKitrick employs one such approach in her defence of baseless dispositions. Having recounted how physical theory characterises the fundamental entities ([P]), McKitrick claims that it is an empirical question whether or not the dispositions described in physical theory (such as the disposition to repel negatively charged particles) are baseless dispositions—what she calls 'bare' dispositions. She goes on to say that if this question is an empirical question, then this alone is sufficient to establish that baseless dispositions are metaphysically possible. She writes:

> I have suggested that fundamental properties such as charge are examples of bare dispositions. The plausibility of this claim goes towards showing that bare dispositions are possible. Of course, these examples are debatable. It is an empirical question whether, for example, the disposition to repel negatively charged particles has a distinct causal basis. However, if one grants that it is an empirical question, one has granted my thesis that bare dispositions are *possible*. For all we know, electrons may have bare dispositions, and even if they don't, they might have [2003: 368].[11]

Hence, in addition to [P] and [B], we find McKitrick making use of the following two premises (one explicitly, the other implicitly):

[1] It is an empirical question whether the dispositions of the fundamental entities (as posited by physical theory) have distinct categorical bases.

[2] If the truth value of a proposition can be determined empirically (i.e. if the question of its truth is an empirical question), then the proposition states a metaphysical possibility.

Let us start by looking at [2]. We consider a question 'empirical' when the truth or falsity of the proposition at hand can be determined through empirical methods. For instance, it is an empirical question whether I have two catalpa trees in my yard, because you can determine whether or not this is true by searching my yard for catalpa trees and counting the number you find. For the most part, we take empirical questions to be those that can be answered by science, even if they could only be answered in principle, or

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[11] Though in the quotation she says 'possible', not 'metaphysically possible', it is the latter she intends, as the title of her paper indicates: 'The Bare Metaphysical Possibility of Bare Dispositions'.

according to a 'final' science.[12] However, on this understanding, something's being an empirical question does not make it metaphysically possible. Believers in the necessary a posteriori should have no trouble agreeing with me. Take the question of whether David Beckham is a robot. This is an empirical question: a few relatively simple tests will tell us one way or the other. If it turns out that he is not a robot, then—following Kripke—he is necessarily not a robot, and it is metaphysically impossible that he is. The truth or falsity of the proposition can be determined empirically, but the proposition does not state a metaphysical possibility. [2] looks to be false.

But perhaps McKitrick has some other (non-Kripkean) picture of metaphysical possibility in mind. Perhaps what she has in mind is analogous to common interpretations of nomological possibility: the metaphysically possible worlds are those that have the same ontological facts or features as our world, such that they follow the same set of metaphysical 'rules'. Accordingly, if the concrete particulars of our world are bundles of universals, then a world with bare particulars is a metaphysically impossible world. On this interpretation empirical questions hold the metaphysical rules fixed, because they are questions about matters resolvable via (largely) observational means in the actual world. Thus admitting that something is an empirical question is to concede that it is metaphysically possible, meaning [2] is true. However, even if we buy into this picture of metaphysical possibility, this direct version of the AFS is only sound if [1] is also true—and that I submit is not the case.

The only access we have to the unobservable entities of microphysics is through their responses to various tests. We are restricted, as it were, to poking and prodding at them with bombardments, and 'seeing' (through instruments) how they react. This informs us about the reactions, responses, and outputs that the fundamental entities produce in response to testing; it tells us what behaviours the entities exhibit. In combination with a realist attitude, these observations tell us what capacities the entities possess. But we should not take this realism about the capacities to tell us that the entities therefore have only dispositional properties. Given the method employed in investigating the microphysical world, the fundamental entities would have to be characterised in dispositional terms. Jackson writes:

> When physics tells us about the properties they take to be fundamental, they tell us about what these properties *do*. This is no accident. We know about what things are like essentially through the way they impinge on us and on our measuring instruments. It does not follow from this that the fundamental properties of current physics, or of 'completed' physics, are causal [1998: 23].

Similar sentiments are expressed by Blackburn: 'Just as the molecular theory gives us only things with dispositions, so any conceivable improvement in science will give us only a better

[12] The recourse to final science arises in cases where no observations can settle the matter determinately. For instance, observational evidence is sufficient to demonstrate that a given law of nature does not hold, but not that it does. That said, long before a final science is reached we can gain fallible knowledge of laws and the like if they form part of our best scientific theories and are well confirmed.

pattern of dispositions and powers. That's the way physics works' [1990: 63-64].[13] It follows that physics is in no position to tell us what sorts of properties are had by the fundamental entities, as the only characterisation it is capable of producing is dispositional.[14] As this dispositional characterisation is compatible with ontologies that countenance baseless dispositions *and* those that require that all dispositions have categorical bases, microphysics is ontologically innocent.

Might it be objected that the dispositional characterisation of the fundamental entities is merely a mid-way point on route to a deeper, non-dispositional, characterisation? In response to considerations of the sort expressed by Jackson and Blackburn, Mackie argues that:

> it is only the style of reference to these entities that is characteristically dispositional, that the entities characterised by their powers are merely *temporarily* ultimate, they are merely the last items we have so far introduced in the regress of explanation [1973: 138].

And Mumford echoes that:

> we have a property or state of a subatomic particle with just the one mode of characterising it available to us: the dispositional. We cannot rule out a priori, however, a situation in which a categorical characterisation becomes available to us as theory advances [1998: 169].

However, it is clear that we should resist Mackie and Mumford's suggestions that the dispositional characterisation of the fundamental entities is even potentially temporary. Though further investigation might unearth yet smaller fundamental entities, these too will be characterised dispositionally, for that is the nature of the methodology in microphysics. Therefore, contra Mackie and Mumford, it looks as if dispositional characterisations *necessarily* mark the end of scientific explanation in microphysics.[15]

The nature of scientific practice in microphysics leaves us unable to say (with any confidence) what the intrinsic natures of the properties of the fundamental entities are really like. Because the dispositional characterisation applied to the fundamental entities is an inescapable consequence of the methodology, that the characterisation is exclusively dispositional provides no evidence that the fundamental properties are exclusively dispositional—even if that happens to be the case.

Returning to the direct version of the AFS, that physical theory is ontologically innocent means that contrary to what McKitrick claims, the question of whether the dispositions of the fundamental entities have distinct categorical bases is not an empirical question. Even without any well-developed stance on how to draw the line between empirical questions and metaphysical questions (and even if there are numerous borderline

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[13] See also Foster [1982: 65], Strawson [1980: 280], Langton [1998: 183-4], and Lewis [2009: 211].

[14] We shall see in §4 that the 'no good conception' indirect version of the AFS exploits this feature of physics.

[15] This need not be the stopping point of all explanation regarding the objects and properties postulated by physics, as we can offer metaphysical explanations and ontological models that tell us how it is that the dispositions are had. But when we do so we are doing metaphysics, even if it is the physicist who is doing it.

cases), it is clear that the question of this proposition's truth is not an empirical matter. If no amount of empirical evidence can increase or decrease our confidence in a proposition's truth or falsity (never mind demonstrate which it is), then the question of the proposition's truth or falsity is not an empirical question. Such is the case with the proposition at issue in [1]. No amount of empirical evidence—not even in principle—can give us any reason to increase or decrease our confidence in its truth or falsity. Therefore, as the question is not empirical, [1] is false, and this is sufficient to block the claim that baseless dispositions are therefore a metaphysical possibility (even on the more charitable interpretation of metaphysical possibility). Hence the direct version of the AFS fails.

Might it be objected that some observations *do* increase our confidence in the falsity of the proposition at hand, and that therefore the question is empirical? More specifically, is it not the case that the repeated failure to find some even more basic fundamental level with categorical properties that would underlie the dispositions of the fundamental entities provides good evidence that the dispositions of the fundamental entities do not have distinct categorical bases? Is this case not just like that concerning the laws of nature, in that no observation can positively confirm that these dispositions lack a more basic categorical structure, but through repeated observation we can nevertheless come to have good—though fallible—knowledge that these dispositions lack categorical bases? And thus, does it not follow that just as the matter concerning the laws of nature was deemed an empirical question, so too should this case?

The short answer is no; the reason is twofold. The first—and shorter—part of the response is that even if we found a more basic structure, the methodology of microphysics would again necessitate a dispositional characterization of the newly-discovered fundamental level, and so we would still be in the dark about what sort of properties these truly fundamental entities possessed. We would be replacing one ontologically innocent characterisation of the so-called fundamental entities with another, newer, ontologically innocent characterisation of the truly fundamental entities. Hence our apparent failure to locate a lower level of structure with categorical properties gives us no reason to think that [B] is true, because even if we found a lower level we would still be in the dark about the nature of the properties at that level.

However, if the only options are that (i) the fundamental entities have baseless dispositional properties, or (ii) the so-called fundamental entities are not fundamental and there is an even lower level of fundamental entities in possession of categorical properties, then the evidence against there being an even lower fundamental level *should* raise our confidence in the first option. This is the case even if the characterisation is ontologically-neutral. Because the second option is conjunctive, though we lack evidence pertinent to the properties involved, the evidence makes it reasonable to doubt that there is a lower level, in which case the second option is no longer live. This is where the second part of the response comes in. Simply put, these are not the only options. There is an additional option—frequently overlooked by proponents of the AFS—that offers a distinct version of categoricalism and on which empirical evidence has no bearing.[16]

Consider three worlds, w_1, w_2, and w_3, each with different ontologies, but all such that [P] is true at them. Hence, despite the ontological differences, at the time of

[16] I suspect that overlooking the third option has led to undue confidence in the force of the AFS, especially the indirect 'structurelessness' version of the AFS. More on this in §4.

consideration the scientific knowledge in each is the same as ours presently is. The three worlds are as follows:

> w_1: the dispositions of the fundamental particles are baseless
>
> w_2: the 'fundamental' particles of physics have discernable constituent parts (a lower level of structure) and the dispositions of the (previously thought to be) fundamental particles can be reduced to the categorical properties of these constituent parts
>
> w_3: the dispositions of the fundamental particles have categorical properties as their bases

The two options considered above map onto worlds w_1 and w_2 respectively. If these two worlds exhausted the options, then we would have (or could have) sufficient empirical evidence to raise our confidence in the claim that the actual ontology is like that of w_1. But we have another option: w_3 is a ([B]-false) world with a categoricalist ontology at which [P] is true.[17]

Unlike w_2, the categorical base properties in w_3 are not the properties of a lower level of even more fundamental entities: the categorical bases of the dispositions in w_3 are had by the fundamental entities themselves, not constituent parts of the fundamental entities, as with w_2. Hence empirical evidence against the fundamental entities being complex has no bearing on whether our ontology is like that of w_3 or not. Nor can any other empirical evidence raise or lower our confidence in whether our world is like w_3. Though categoricalism and its denial are ontologically distinct, there is no observational difference between a baseless disposition and one that has a distinct categorical base, nor any possible observation that can give us reason to prefer one over the other. Hence, even though empirical evidence gives us reason to doubt that our world is a w_2 world, no empirical evidence can ever begin to separate the w_1 worlds from the w_3 worlds, so the question of whether the dispositions of the fundamental entities have distinct categorical bases is not an empirical question, and the direct argument does not go through.[18]

We have seen that the question of whether the dispositions of the fundamental entities have distinct categorical bases is not empirical. This question is most likely a metaphysical question. Assuming this is correct, might it make a difference to the proposition's being metaphysically possible? That is, could the direct argument be salvaged

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[17] Though its popularity has no bearing on the debate, it is interesting to note that w_3 does not depict an esoteric categoricalist view: the most widely held version of categoricalism—Humean supervenience—looks like this.

[18] Note that this argument against the direct argument would be successful even if the methodology of microphysics permitted categorical characterisations of the fundamental entities. Much the same argument can be used against another (very) direct version of the AFS, also presented by McKitrick. McKitrick claims that [P] gives us actual examples of baseless dispositions; so [B] follows directly. However, the reason she cites as evidence that [P] gives us actual baseless dispositions is that: 'it seems probable that there is no structural, micro-physical property of an electron which accounts for its dispositions to repel and attract other particles—at any rate, current physics does not tell us otherwise' [2003: 356]. This version of the AFS is guilty of assuming that the grounding of dispositions by categorical properties requires that the fundamental entities are complex.

if [1] and [2] were modified to be about metaphysical questions instead of empirical ones? Again, the answer is no. The long and the short of it is that something's being a metaphysical question does not make it a metaphysical possibility, on either conception of metaphysical possibility. On both conceptions, in order for a proposition to express a metaphysical possibility it would have to be true. That its truth or falsity is a metaphysical question does not alone license treating it as metaphysically possible.

Before leaving the discussion of the direct argument, let me note that the point about the methodology of microphysics also rules out any potential direct version of the AFS that relies on a strong theory of physicalism in order to get from [P] to [B]. For instance, it might be argued that we come to believe in the existence of fundamental entities because the theories that countenance them offer the best explanation of macro phenomena, and that a similar argument to the best explanation holds for the dispositional characterisation of said entities. As these theories make no use of categorical terms, we should believe that the properties of the fundamental entities are exclusively dispositional.[19] But knowing what we do, we can see that the application of this principle to the properties of the fundamental entities is misguided; their characterisation would be dispositional no matter what the properties were like. That fundamental physics makes no use of categorical terms is no indication that the fundamental entities do not have categorical properties.

4. AFS: THE INDIRECT ARGUMENTS

Strictly speaking, a successful indirect argument is one that demonstrates the falsity or incoherence of the alternatives to the stated conclusion. As it happens, all three indirect versions of the AFS fall well short of this ideal, as none is able to demonstrate that categoricalism is false or incoherent. Nonetheless, there is a weaker from of indirect argument frequently utilised in metaphysics that aims to show that one view is in a better position, as it either avoids undesirable features of the alternative, can resolve problems with greater ease, or is more in keeping with some relevant set of intuitions. The result is not a knockdown argument in favour of its conclusion; instead we get a kind of scorekeeping between competing views. The view with the greater score comes out ahead, suggesting it is the view to be preferred.

Two of the three indirect versions of the AFS discussed in this section (the 'no good conception' and 'explanatory' versions) clearly have this weaker target as their goal. But as we shall see, even in this weaker respect of indirect argument only the 'explanatory' version can claim much of an advantage over categoricalism. The 'no good conception' version raises a worry that the categoricalist can meet without surrendering many points, if any, to the defender of baseless dispositions. The remaining argument—the 'structureless' version—aims to show that categoricalism is false, but fails in that attempt.

4.1 Structurelessness

A common manoeuvre by categoricalists is to attempt to show how the dispositional

[19] This thesis would need to be supplemented by a thesis to the effect that only things explicitly mentioned in our physical theories exist. However, this thesis is implausible: physical theory makes no mention of macro phenomena or individuals.

properties found at one level of granularity have categorical bases at a lower level. Most often this proceeds by showing how the dispositions at the first level arise from the categorical properties plus the structure of the constituent entities at the lower level.[20] For instance, it may be claimed that solubility—in something like table salt—arises from the properties of the sodium and chlorine atoms and their structure in the salt.[21] The first of the indirect versions of the AFS seeks to block this structure-based grounding of dispositional properties.

In response to the categoricalist's strategy of moving to lower level structures, dispositional essentialists point to the claims of current physics: [P] strongly suggests that the move to lower levels bottoms out with the fundamental entities. As the dispositional properties of the fundamental entities cannot be explained in terms of deeper structure (because there is no deeper structure), the categoricalist's strategy breaks down and we are left with baseless dispositions.

Of all versions of the AFS, the indirect 'structurelessness' version is by far the most common, but also the least convincing.[22] The problem with it, and the reason it fails to show that categoricalism is false, is that there are other ways of having categorical bases—other structures, if you will. Call the way mentioned in the previous paragraph the 'compositional' sense of structure. In order to have compositional structure the entities with the dispositional properties must be composed of even smaller entities.[23] The second sense is what we might call the 'supervenient' sense. Here the categorical properties are instantiated by the same object which is characterised dispositionally, without moving to a lower level of constituent entities. The 'lower' level is a level of properties: the dispositional properties of the object supervene on the categorical properties of the object. The structure is a supervenient structure.[24]

The key move in the structurelessness version of the AFS is that it offers [P] as empirical evidence for denying that our world is like w_2. Current physics suggests we have located the smallest physical entities and that they have dispositions. If that is the case, then the categoricalist cannot claim that these dispositions are grounded in categorical properties of the constituent entities; to this extent this version of the AFS is successful.

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[20] Plus some causal-cum-modal feature, such as a law of nature.

[21] Dispositional essentialists explain the solubility of the salt in much the same way, but their explanations countenance lower level dispositions.

[22] Instances of this version of the AFS can be found in Blackburn [1990], Broad [1925], Goodman [1954], Harré [1986], Harré and Madden [1975], Martin [1993, 2008], Molnar [1999, 2003], Mumford [2006], Psillos [2006], and Strawson [1980]. Most of these are brief mentions, with the exception of Mumford, who formulates a detailed and explicit instance of the 'structureless' version of the AFS. In Williams [2009] I respond that Mumford's formulation is either question begging or involves an equivocation of 'simple'. The argument in §4.1 is inspired by that response.

[23] One might talk in terms of the entities in question as requiring 'proper parts', but this is perhaps best avoided on the off chance that the fundamental physical entities have proper parts that are not physical parts. For instance, it will not do to say that the dispositions of the fundamental entities can be grounded by categorical properties of the top and bottom halves of the fundamental entities. (I have no reason to doubt the possibility of this for much larger objects, however, as the tops and bottoms of those might correspond with perfectly good physical parts.)

[24] The compositional/supervenient distinction directly corresponds to that found between the two categoricalist worlds discussed in §3: w_2 is a compositional structure world, w_3 a supervenient structure world.

However, the dispositional essentialist goes on to conclude that at least some dispositional properties are not grounded, but the only conclusion that actually follows from this argument is that at least some dispositional properties cannot be grounded *in this way*. It does not follow from the lack of compositional structure that there is no possible grounding structure: the supervenient sense remains an open possibility. Hence the argument fails.

It might seem that the natural response here is to expand this version of the AFS to cover both sorts of structure. But no such strategy is open to the dispositional essentialist. [P] provides strong evidence against grounding via compositional structure, but it is silent on supervenient structure. As argued in §3, [P] is unable to decide between worlds w_1 and w_3, so cannot be used to rule out supervenient structure, and therefore cannot be used to show that there are baseless dispositions. Whether or not the dispositions of the fundamental physical entities have subvenient categorical properties is a metaphysical question, not an empirical one. Furthermore, if we were to give [P] a metaphysical reading, such that it was sufficiently strong to rule out worlds like w_3, we would either have smuggled in [B] as part of one the premises, resulting in a question begging version of the AFS, or converted [P] into an unsubstantiated claim (that there are baseless dispositions is not part of current physical theory).

In either case, this version of the AFS has no leg left to stand on. It could only succeed if categoricalism required that all dispositional properties be grounded via compositional structure; as this is not the case, we are not forced to reject categoricalism.[25]

4.2 No Good Conception

The second indirect version of the AFS attacks categoricalism on the basis that the categoricalist can give no illuminating account of the nature of the would-be categorical properties that purportedly ground the dispositions of the fundamental entities.[26] Let me give a brief run down of the argument.

As with all indirect arguments, the argument starts by listing the views available to us; in this case we have the disjunction that categoricalism is either true or false (and that if categoricalism is false then [B] is true). This is followed by some explanation of categoricalism and any relevant entailments; here we get a claim to the effect that if categoricalism is true then all dispositions ultimately supervene on categorical property bases. We then have the statement of [P], from which it follows that the supervenient base is comprised of categorical properties instantiated by the fundamental entities (and not their parts), as the fundamental entities lack constituents. After that it is argued that because physics gives us our best (and only) account of the fundamental entities, and this characterisation is exclusively dispositional, the categorical base properties have natures that are unknown to us—their natures are opaque. On the other hand, if [B] is true, the nature of the dispositional properties is exhausted by their dispositionality, and hence they are

[25] As I indicated in §2, Psillos [2006] responds to the AFS (the 'structureless' version), claiming that in fundamental physics the structure is built up, not broken down. It is 'symmetries' between the particles that account for their dispositions, where 'symmetry' is understood as a categorical structure of a system of particles. This extrinsic grounding of dispositions via symmetries provides another way this version of the AFS fails.

[26] As it boils down to much the same argument, I have not bothered distinguishing this version of the AFS from that according to which we lack knowledge of the natures of the would-be categorical bases.

completely transparent. Assuming that increased perspicuity is preferable in an account of the world, it is concluded that dispositional essentialism is to be preferred to categoricalism.

As I have indicated, the conclusion of this version of the AFS is not that categoricalism is false or incoherent and we are forced to accept [B], but rather that when it comes to weighing up the alternatives, dispositional essentialism has the advantage that dispositional properties (can) have their natures revealed to us. Speaking of the dispositional properties of the fundamental entities, Ellis argues that '[i]f such properties have categorical bases, then they are unknown to us. Moreover, there is no prospect in modern physics of being able to characterise the most fundamental existents (for example, the particles and fields or modern physical theory) by their categorical properties alone' [2001: 114-5].[27] Bird cuts to the heart of the issue when he says that 'We do not want our metaphysics of properties to condemn us to necessary ignorance of them' [2005: 453]. But are we really ignorant of them? And is the dispositional essentialist that much better off?

Let me start by noting that the difference here is not between dispositional properties we have direct access to versus categorical properties we have only indirect access to, as our access to each is indirect. What is directly available to us is a store of information about how the fundamental entities behave or react, leading to the use of dispositional terms in the theories that describe them.[28] It is a step—however short—to go from those behaviours to an account of dispositional properties that explain the behaviours. Is it really such a big step to go from those dispositions to some categorical property that grounds them? It hardly seems so; what we have are two different conceptions of the properties that produce these behaviours. This is where the purported advantage comes in: according to the dispositional essentialist, properties are exhausted by their dispositionality, so when you postulate a dispositional property to explain some behaviour, what you see is (almost) what you get. There is nothing more to the property than the ability to produce that type of behaviour in circumstances of that sort. On the other hand, if there are categorical bases, then there must be more to the categorical base properties than just the ability to produce said effect. If that were not the case, then we would no longer have a distinction between dispositional and categorical properties—they would all be dispositional. So there has to be something more to the categorical properties, and this something more is necessarily hidden.

But let us consider how significant this disadvantage is. After all, the categorical properties are not *entirely* hidden: we know of them indirectly, as this or that property in virtue of which objects have such and such dispositional properties. We have knowledge by description. What remains hidden might be quite insignificant. The picture suggested by this version of the AFS is that we see only the proverbial tip of the iceberg, and the great mass of the categorical base is hidden to us. But the reverse, where what is unknown is quite limited, is perfectly consistent with categoricalism. Nor is it the case that the dispositional essentialist is clearly better off. Many defenders of dispositional essentialism take

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[27] Molnar [2003: 135-6] offers a similar argument. Having indicated that 'the fundamental physical magnitudes are represented as ones whose whole nature is exhausted by their dispositionality', Molnar throws down the gauntlet, challenging the categoricalists to respond to the fact that there is 'a strong presumption in favour of saying that the properties of the subatomic particles are powers. The onus is on anyone who wants to overturn that presumption to give some positive characterisation of the non-dispositional nature of the fundamental physical magnitudes'.

[28] Even this is slightly charitable. What is direct is the observation of readouts of instruments. But as no-one cares to deny the reality of what these instruments indicate, we can effectively look through them to the behaviours. As ought to be clear, direct does not imply theory-free.

dispositional properties to be 'pleiotropic'; that is, a single dispositional property is capable of producing a variety of dissimilar manifestations for a wide range of circumstances [Molnar 2003: 194]. That means that the true nature of the property is hidden from us, and necessarily so, as we have no way of determining which of the various behaviours are the product of the same dispositional property.[29] Hence, if dispositional properties are pleiotropic, then dispositional essentialism and categoricalism may be closer on points than it first appeared.

However, even if dispositions are not pleiotropic and categorical properties are predominantly hidden, this still need not put dispositional essentialism in the lead. Consider the final step in this version of the AFS, according to which perfect transparency of properties is superior to even partial ignorance. Why should anyone think this? Full disclosure of nature's secrets is desirable, but as our aim is to model reality, the world need not comply; the desire for transparency cannot be translated into a legitimate reason for preferring dispositional essentialism over categoricalism. It is hubris (or perhaps naiveté) to think that the microphysical world can be fully known to us, and hence that we should select a metaphysic accordingly. Unsurprisingly, notable categoricalists share this attitude. Both Lewis [2009] and Jackson [1998] concede that categoricalism implies ignorance about the fundamental properties, and yet they remain unmoved. In fact, Lewis not only concedes ignorance, he argues for it—it is what he calls 'Humility' about fundamental properties. His take on the matter is clear: 'Who ever promised me that I was capable in principle of knowing everything?' [2009: 211].[30] If complete knowability and characterisability are not virtues, then dispositional essentialism can claim no advantage over categoricalism regarding this matter. I submit that this version of the AFS gives us little reason to prefer dispositional essentialism to categoricalism, if it gives us any reason at all.

4.3 Explanatorily Idle

The third indirect version of the AFS is similar in many respects to the second. It too concedes that there is nothing inconsistent about the metaphysical picture in which categorical properties ground the dispositional properties. But where the second indirect version is concerned with how these categorical properties can be adequately characterised, the third straightforwardly asks what possible explanatory role these categorical properties could play. [P] gives us the complete characterisation of the fundamental entities. The dispositional essentialist claims that dispositional properties suffice to explain the manifest and potential behaviours of the fundamental entities. Therefore, to postulate categorical properties to serve as bases for the dispositional properties is to postulate explanatorily idle properties. Molnar writes: 'any qualities we might postulate for the particles such as, for example, size and shape, are explanatorily idle. The only intrinsic properties needed to

[29] Do we not get a good picture of which manifestations belong to which dispositional properties by observing which types of manifestation tend to be found together? This is certainly some indication, but even in instances of perfect correlation, it could be the case that we have two properties travelling together, or that the correlation is accidental.

[30] See also Langton [1998].

explain the behaviour of the electron are its powers' [2003: 178]. To my mind this version of the AFS is the strongest, though it is still far from decisive.[31]

All parties in the debate accept that the fundamental entities must possess dispositional properties to account for their behaviours. Nor does anyone deny that the characterisation of the fundamental entities provided by physical theory is exclusively dispositional. But this means there is no explanatory work left to do: what can the categoricalist claim the categorical properties are needed for? It will not do to say that the categorical properties are hard at work providing bases for the dispositional properties, as that is precisely what is at issue. It looks like any categorical properties would have to be explanatorily idle: score one for the dispositional essentialist.

Might the categoricalist claim I have misrepresented her case? After all, the categoricalist does not claim that the categorical properties are the base properties of *causally efficacious* dispositional properties: she takes the dispositional properties to be inactive. According to her, dispositional properties are not capable of explaining much at all; her dispositional properties are not those of the dispositional essentialist. Her dispositional properties *need* categorical bases, because on their own they are incapable of producing effects; categorical properties do the heavy lifting. Hence the categorical properties are not explanatorily idle, they have important work to do.

What we have are competing metaphysical models that admit dispositional properties, but where the roles of the dispositional properties differ dramatically in each. Whereas one view tells us that dispositional properties are causally efficacious, and therefore capable of explaining the behaviour of the fundamental entities, the other tells us that dispositions cannot be causes, so we need categorical properties to do the work. According to the categoricalist, the accusation that the categorical properties are explanatorily idle comes from mistakenly thinking of the dispositional properties in terms of the first model, and not the second, in which they are incapable of producing effects.

To some extent the categoricalist is correct: some of the initial argumentative force of this version of the AFS comes from this mischaracterisation of the competing positions. It is undeniable that if we conceive of dispositional properties as the dispositional essentialist does, then any categorical base properties would be superfluous. And if this were the only way of reading this version of the AFS, it would be fallacious. But the correct reading of the argument does not demand we equivocate in our understanding of 'dispositional property'.

Properly understood, the argument weighs up two competing ontological explanations of the same basic data. Those data constitute the now familiar [P]. As I have argued, [P] is ontologically innocent, at least to the extent that it is compatible with [B] and its denial. The task put to the two competing ontologies is that of explaining how these fundamental entities exhibit the behaviours that they do. In other words, what needs explaining is how the fundamental entities have the dispositions they have: it comes down to a question about the nature of properties. The first response, that of the dispositional essentialist, is that there are properties whose nature is exactly like what needs explaining. It is a perfect fit, providing exactly what is needed with no remainder. On the other hand, the categoricalist posits a structure of properties: causally impotent dispositional properties (similar in nature to what requires explanation, but absent causal features) and categorical

[31] It is also the rarest: it appears explicitly in Molnar [2003: 178], and is implied in Mumford [2004: 171-2].

properties (base properties that do the causal heavy lifting—but only with the help of a law of nature or the like).

Placing them side by side brings their differences into focus. And once we consider those differences relative to the task at hand, categoricalism appears to have an explanatory structure that is unmotivated. Why such complexity? Why have two sorts of properties where one can do the job? The claim that the categorical properties are explanatorily idle comes from considering the whole ontological model as given by categoricalism, recognising that it does more than it needs to, and seeing that it has parts that have almost no role to play. Dispositional properties are all that we need, as they provide all the explanation the scenario demands. To add more is to add idle elements; that is why dispositional essentialism comes out ahead on points.[32]

However, despite being behind on points, the categoricalist is not down for the count: there may be other ways for the categorical properties to earn their keep, even if at the fundamental level they appear superfluous. The AFS focuses on the properties of the fundamental physical entities, and with regards to those properties specifically, categoricalism looks second best. But categoricalism is a general principle about the need for grounding dispositions, and as with any far reaching metaphysical principle, it should be judged over the range of its extent, not just in one arena. After all, no serious metaphysics is done piecemeal—the final tally of scores is extended over a wide range of issues.[33] Honest toil for categorical properties need not be at the fundamental level—it could be argued that this is the place where the costs of categoricalism come in—but they had better do work *somewhere* if we are to believe it is worthwhile accepting them at the fundamental level. Moreover, wherever they earn their keep (if in fact they do), part of their job description had best involve the grounding of dispositions.[34] In a systematic metaphysic there are bound to be costs, but there must also be gains. Hence the onus is on the categoricalist to let us know how the categorical bases are earning their keep, as for the time being they are on the wrong side of a losing score.

5. CONCLUSION

Despite its popularity, I submit that the AFS can do little to tip the scales one way or the other in the debate between Humean and anti-Humean metaphysics. Though I take the explanatory form of the AFS to cause the categoricalist to sweat under the collar a little, no version of the AFS is even close to decisive. The debate is live and well.

As for the AFS, I am less sure that it is live and well. Two versions are fallacious and another is too weak to convince anyone that [B] is true. I suggest that in general the AFS not be employed in defence of [B]. However, if we are forced to resort to scorekeeping, keeping just the explanatory version may be worthwhile. It highlights the

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[32] At least as far as it concerns this issue. The final score will involve a number of issues, but it is beyond the scope of this discussion to consider how anything but this issue contributes to the overall tally.

[33] With the right combination of views (say, a sparse ontology of properties restricted to those of fundamental physics, plus nihilism about composition), the fundamental level could be the only game in town, in which case categoricalism would be in trouble.

[34] It is not enough that categorical properties merely exist. Dispositional essentialism is compatible with there being categorical properties.

apparent lack of any useful role for categorical properties in explaining microphysical phenomena. As an important test of any metaphysic is how economical it is, and if dispositional properties alone can do the work, then it is a cost to admit idle categorical properties. At the very least the explanatory version of the AFS makes clear that the categoricalist owes us some answers. Hence, if the AFS is to be employed at all, I recommend future applications be restricted to the indirect explanatory version.

All in all I think the lesson here is that far too much has been made out of the fact that physical theory describes the fundamental physical entities exclusively in dispositional terms. Despite appearing to stack the deck in the dispositional essentialist's favour, [P] is far more ontologically innocent than it seems. As such, it is not going to be the deciding factor in any deep ontological debate.[35]

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