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## DISPOSITIONAL ESSENTIALISM

Brian Ellis and Caroline Lierse

### I. Introduction

Dispositions, Mellor once remarked, are as shameful in many eyes as pregnant spinsters used to be, 'ideally to be explained away, or entitled to a shotgun wedding to take the name of some decently real categorical property' [18]. This 'Victorian prejudice' against dispositions still exists. On reflection, this fact is perhaps not really surprising. Dispositions have dallied in most corners of the metaphysical arena, mixing unashamedly in the (not always respectable) company of behaviourism, counterfactuals, induction, nomic necessity, and causation. For dispositions to be taken seriously, it is argued, they need to ground themselves in some decent categorical bases; for only then can their claim to be genuine properties be respected.

In this paper we shall argue that the subordinate status thus assigned to dispositions is unwarranted. However, we do not seek to restore their reputation by attacking the status of categorical properties, or by arguing that all properties are basically dispositional, as some philosophers have done.<sup>1</sup> For the present lowly status of dispositions is not merely a function of their relationship to categorical properties. It is a consequence of their traditional affiliation with an inadequate ontology, based on a Humean metaphysic, and a flawed semantics of dispositional terms. What is needed, and what we seek to provide, is a more adequate semantics, and an ontologically more satisfactory theory of dispositions — one which allows at least some dispositions to be counted as genuine properties existing in their own right.

A number of philosophers have argued in favour of a non-Humean ontology which includes basic dispositions.<sup>2</sup> Others have suggested a realist semantics of the kind we shall advocate for terms denoting genuine dispositions.<sup>3</sup> What is new in our theory is the link we establish between real dispositions and natural kinds of processes. We hold that, just as there are natural kinds of objects, there are natural kinds of *processes*, and that these kinds of processes are essentially displays of natural dispositions. That is, for a process to be one of a given natural kind, it must be

<sup>1</sup> See, for example, [13, esp. pp.40-41], [21, p.70], and [18].

<sup>2</sup> For example, Harré [14] and Harré and Madden [15], [16] have argued against Hume that things have causal powers which derive from their essential natures. Shoemaker [27] has defended the claim that properties are essentially distinguished from each other by what they dispose their bearers to do; hence the dispositions of things are of the essence of the properties they possess. Fales [8], [9] has argued that the essential properties of the most fundamental natural kinds are their monadic properties, and, in so far as these properties are dispositional, things of these kinds must behave as these properties prescribe.

<sup>3</sup> See [9, ch.8, section 2].

a genuine display of the appropriate real disposition. If it is not, then it is not truly an instance of this kind of process, however like it it may appear to be. The laws of nature which describe these kinds of processes are thus related directly and essentially to *natural dispositions*. The natural dispositions are, indeed, the truthmakers for these laws.

## II. The Humean Metaphysic

In Hume's ontology there is a sharp distinction between the way a thing *is*, and how it is *disposed to behave*. The way it is depends on what its properties are. How it is disposed to behave depends on what the laws of nature are. The two are supposed to be independent of each other. Things having exactly the same properties, but inhabiting different possible worlds, will behave differently, if the laws of nature are different in these different possible worlds.

In Hume's theory, there are no causal powers, capacities or propensities. There are just things having various properties, which they have independently of their dispositions. Such properties are said to be *categorical*. They don't do anything; they merely *characterise*. If two things have a categorical property in common, then they could be the same or similar in this respect, even if they belonged to different possible worlds, and the laws of nature were different in these different worlds. Consequently, they would be the same or similar in this respect, however differently these things might be disposed to behave in these different worlds. The categorical properties of a thing thus depend only on what it is like *in itself*, and tell us nothing whatever about how it will behave.

In general, the categorical properties are those first-order properties which could be instantiated in a Hume world,<sup>4</sup> i.e., in a world without causal powers or propensities. The paradigmatically categorical properties are spatiotemporal. That is, they are the kinds of properties which depend ontologically on how things are distributed in space and time. Shape is the obvious example of such a property. Other properties which are often said to be categorical have a kind of mixed status. That something has a certain crystalline structure, for example, depends on the spatial arrangements of the atomic or molecular units which make it up. To this extent, it is categorical. However, the property of being a crystal of a certain kind is not purely categorical. For this property is also ontologically dependent on the kinds of bonding which hold between the atomic or molecular units, and hence on the kinds of causal links which exist between them.<sup>5</sup> Such causal links, which explain the stability of the crystal structure, its cleavage planes, and so on, could not exist in a Hume world.

According to Hume, the properties of things can change over time, and any changes which can conceivably occur, or fail to occur, are in principle possible. A billiard ball, for example, might turn into a flower pot, or a person's hand might not

<sup>4</sup> See [6, pp.238-245] for an account of the Hume world.

<sup>5</sup> For example, if the molecules in a glass of water were, by extraordinary chance, to become momentarily arranged in a cubic lattice, the water would not for that moment become crystalline. To become crystalline the water would have to freeze, and the appropriate kind of bonding between the molecules would have to be established.

be disposed to be burnt by fire. However, in our world, there are certain universal regularities which are incompatible with such happenings. Consequently, not all of the changes, or failures to change, which could conceivably occur ever do so. The universal regularities, which are thus seen as restricting the range of possible occurrences, are supposed to be, or at least to be consequences of, the laws of nature. Thus conceived, the laws of nature are contingent. For the changes which are permitted or prohibited by them could obviously have been different.

Intimately connected with this Humean metaphysic is the traditional analysis of dispositional terms. In a Humean metaphysic, a disposition is *defined operationally* in terms of a subjunctive conditional (or conditionals) which states the relevant antecedent condition for it to manifest itself, and what will consequently happen. For example, to say that  $x$  is fragile is said to be synonymous with stating that if  $x$  were (suitably) knocked,  $x$  would break. As the subjunctive conditional defines fragility, it follows that there is a logical relation between being fragile and breaking when knocked. Being a logical connection, it must hold in all possible worlds. However, the supposed categorical basis of fragility may differ from world to world. Hence, there is no necessary connection between a disposition and its base; consequently, there is no necessary connection between a categorical object and its behaviour, a situation perfectly congruent with a Humean ontology.

In the simplest cases, dispositions are said to be single-track. That is, they can manifest themselves in only one kind of circumstance, and then only in one kind of way. Such dispositions are characterised by a single subjunctive conditional. More often than not, however, dispositions are multi-track. That is, they can reveal their presence in a range of antecedent circumstances, yielding a range of different consequent events. Fragility is obviously a multi-track disposition, for a fragile object can manifest this disposition in a wide range of antecedent circumstances: for instance, after being dropped, knocked, struck, stretched, or compressed, resulting in such effects as shattering, cracking, splintering, rupturing, or cleaving. Consequently, to specify fully the meaning of a multi-track dispositional term like 'fragility', it is necessary to enumerate the full list of subjunctive conditionals which operationally define the term.

This is the kind of ontology and semantic theory of dispositions usually favoured by Humeans. However, we reject both the ontology and the associated semantics of dispositions. Given this metaphysic, and such an analysis, it is inevitable that dispositions should not be regarded as properties in their own right, but, at best, as properties which supervene on categorical properties and the laws of nature — hence the dependent second-rate status commonly ascribed to them. In contrast, we maintain that there is often a necessary connection between an object and the behaviour (i.e. dispositional properties) it manifests. We do not deny that things sometimes have categorical properties, but we claim that they also have dispositional properties, and that these may be no less fundamental than the categorical ones. In the case of the fundamental particles, the dispositional properties may indeed be all that we have.

### III. Categorical Realism

The most widely accepted Humean theory of dispositions is *categorical realism*.<sup>6</sup> Categorical realists accept the traditional analysis of dispositions in terms of subjunctive conditionals. Consequently, they hold that dispositions bear a special relationship to subjunctive conditionals — a relationship which is not possessed by other properties.<sup>7</sup>

The subjunctive conditionals in terms of which dispositions are traditionally defined are typically *causal* conditionals, i.e., conditionals which hold in virtue of causal laws. Consequently, dispositions are generally held to be dependent upon causal laws. However, on some sophisticated versions of the theory, allowance is made for the possibility that some dispositions may depend only on fundamental statistical laws.

Because they presuppose a basically Humean metaphysics, categorical realists hold that the laws of nature, and hence the causal laws on which dispositions depend, are contingent. Let us call this the Contingency Thesis.<sup>8</sup> According to the Contingency Thesis, the laws of nature concerning the behaviour of things of the kinds that do exist might well have been different. For there is no logical reason why things must obey the laws they do. The Contingency Thesis implies that it is possible for other worlds to exist, containing the same kinds of things as this world, but having different laws governing their behaviour.

It is an immediate consequence of the Contingency Thesis, and the categorical realist's theory of dispositions, that if something has a certain disposition, then, necessarily, there is a possible world in which it (or its counterpart) does not have this disposition. What is brittle here might well not be brittle there. Hence, the identity of a thing cannot depend on its dispositional properties; it can only depend on its non-dispositional properties. The dispositional properties of things cannot, therefore, be fundamental properties. They must be dependent on the laws of nature.

A metaphysical wedge is thus driven between dispositions and the properties of the entities which possess them. Given that the laws of nature are contingent, the relationship between a given disposition and the categorical properties which are supposed to ground it must also be contingent, and hence the grounding properties and the disposition must be ontologically distinct from each other.<sup>9</sup> If this is right, then we are free to associate dispositions with categorical bases according to how the laws are in each possible world, thus ensuring that objects which are disposed to behave in a particular way in a given world are ascribed the dispositional properties which correctly describe their behaviour.

<sup>6</sup> For a general defence of categorical realism, see [1], [2], [20], [23], [24].

<sup>7</sup> Prior [22] is among those who argue that this is one characteristic of dispositions which distinguishes them from categorical properties. However, Mellor [19] rejects this distinction by arguing that all paradigmatically categorical properties entail subjunctive conditionals.

<sup>8</sup> This is not only accepted by Humeans who hold a regularity theory of laws; it is also widely accepted by many who would reject the regularity theory. It is accepted, for example, by Dretske [7], Tooley [29] and Armstrong [4] who argue that the laws of nature are contingent relations between universals.

<sup>9</sup> This is Prior, Pargetter and Jackson's [24] Distinctness Thesis.

The main arguments in favour of the categorical realist's claim that dispositions need categorical bases are that they are needed to explain the continuing existence of, and also the differences between, dispositions which are not currently (and perhaps never have been, and never will be) manifested.<sup>10</sup> Call these the Continuing Existence and the Difference arguments.

We remain unconvinced by these arguments. It is true that dispositions need to be based in reality. They must at least be properties of real things. Moreover, it is often the case that things have the dispositions they do because of their internal structures; and in all such cases we may say that the dispositions are grounded in these structures. However, it is not clear that the basis of any given disposition must, or must ultimately, be non-dispositional. For, without begging the question against non-Humeans, it cannot be assumed that the basis of a disposition does not, or does not ultimately, include other dispositions. For example, the dispositions of an object might well depend on the causal powers of its parts, as well as on how these parts are arranged.

Consider first the Continuing Existence argument for categorical realism. A categorical basis for a disposition is needed, it is argued, because a disposition must be capable of continuing to exist unmanifested. The kinds of structural properties on which dispositions are likely to depend are certainly capable of enduring. Therefore, if a particular disposition has a basis in such properties, its continued existence is explained. It continues to exist because the properties which happen to ground the disposition continue to exist.

However, this argument does not establish the need for *categorical* bases for dispositions, unless it is assumed that the only properties which are capable of enduring without support are categorical. It therefore begs the question against those who think that there are ontologically basic dispositional properties which endure and support other properties. We see no good reason for making this assumption. On the contrary, we think there are good reasons for supposing that the assumption is false. For many of the most fundamental properties that we know about are evidently both occurrent and dispositional. Of course, even these apparently fundamental dispositional properties could ultimately be shown to have categorical bases. But currently there is no good reason to believe that this will happen.

The Difference argument for categorical realism is based on the intuitive belief that two substances (in the same world) cannot differ only in respect of their dispositional properties, i.e., their causal powers, capacities and propensities. For, if they did differ in only these ways, the differences between them would be inexplicable. Consequently, it is argued, if two things have different dispositional properties, they must also differ in some respect which is not dispositional.

We accept part of this story, but not all of it. We say that if two things differ in respect of *any* of their dispositional properties, then they must differ in other ways as well. For example, if two people differ in mathematical ability, then they must

<sup>10</sup> Armstrong [1, pp.85-87] argues that dispositions *necessarily* have bases, although in a later work [3, pp.13-15] he admits to the possibility of 'ultimate potentialities' i.e., an endless regress of dispositions. Prior [23, p.67] argues that it is a *matter of fact* that the bases of dispositions are categorical properties.

also differ in other ways, e.g., in their capacities for pattern recognition. For otherwise, the difference between them would be inexplicable. One difference can only be explained by means of another difference. But the explaining differences need not be differences of internal structure, as the categorical realist supposes. One difference of capacity can, and often does, explain another, as the above example shows. Moreover, the entities we are dealing with may not have any internal structure. They may be fundamental kinds of things which differ from each other only in respect of their causal powers, capacities and propensities. What we say is that two substances cannot differ only in respect of a *single* disposition, and not in any other way.<sup>11</sup> For such a difference really would be inexplicable.

Neither the argument from Continuing Existence nor the argument from Difference proves the need for categorical properties to ground dispositions; at most they establish that distinct dispositions must either be, or be grounded in, distinct occurrent properties. This is not to say that dispositions *cannot* be grounded in categorical properties — just that they *need* not be. The dispositions might, for example, be fundamental properties, or properties which are grounded in occurrent properties which are themselves dispositional. For an occurrent property is not necessarily a categorical property; it may be a property which has causal potency. There is nothing in either the Continuing Existence or the Difference arguments which prohibits occurrent properties from being causally efficacious.

The main arguments for categorical realism are thus inconclusive. 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.

Nevertheless, belief in categorical realism dies hard. Categorical realists, who mostly hold a Humean theory of laws, believe they *must* posit categorical bases to ground dispositions, because no other kind of base seems to be compatible with their theory. A dispositional base would itself require a base. The argument stems from the Contingency Thesis, which the Humean theory entails. If the laws of nature are contingent, it is argued, they can only be contingently connected with the entities they govern, and hence, they must be ontologically distinct from them. And, since behaviour of the entities is determined by the laws of nature, the entities in themselves must be causally impotent. This is why the Humean must regard all occurrent entities as categorical.

However, we reject the Contingency Thesis about laws. For we do not believe that the identities of the most fundamental kinds of things in nature are independent of their behavioural dispositions. What makes something an electron, for example, is its causal powers, capacities and propensities. An electron is not something which can be identified independently of these. On the contrary, what an electron is

<sup>11</sup> This is a special case of Schlesinger's principle of connectivity, which is discussed below in section V.

disposed to do, e.g., how it is disposed to interact with fields and with other particles, is what makes it the kind of thing it is. A particle is an electron if and only if it is disposed to behave as an electron does. Its dispositional properties are of its essence. Consequently, the dispositional properties of the most fundamental kinds of things cannot vary from world to world, as the categorical realist supposes.

We also reject the standard Humean semantics of dispositional terms. In Humean analyses, dispositional terms are defined operationally by one or more subjunctive conditionals. For example, a thing  $x$  is said to have the disposition to  $E$  in circumstances  $C$  iff if  $x$  were to be in circumstances  $C$ , then  $x$  would  $E$ . On our analysis, however, dispositional terms may name occurrent dispositional properties, i.e., properties whose natures are to dispose their bearers to behave in certain ways in certain circumstances. Consequently, to say that  $x$  has a disposition to  $E$  in circumstances  $C$  is to postulate the existence of an occurrent dispositional property in virtue of which it is true that  $x$  would (normally)  $E$  in circumstances  $C$ .<sup>12</sup>

Despite its failings, categorical realism does seem to have some attractive features. For instance, it has been argued that the contingent linking of dispositions with their bases is an important feature, as it preserves the ontological distinctness of these different kinds of properties. And indeed, the fact that it is notoriously difficult to assign a single occurrent property to a disposition such as fragility is often used by categorical realists to argue against the direct identification of dispositions with occurrent properties.

However, we remain unpersuaded by such examples. In fact, we believe that the difficulty that arises with a disposition such as fragility is that the class of fragile things is not a natural kind. For the members of this class are not intrinsically similar to each other, as the members of any natural kind must be. The similarities are extrinsic and behavioural, and things are classified as fragile for practical reasons which have little to do with the intrinsic properties of the objects concerned. Vases, ecosystems, personalities, and fabrics can all be fragile, but not in virtue of any intrinsic properties which they have in common. They are classified together only because they need to be handled with care, if one doesn't want them to be broken or damaged.

Diverse properties can be grouped together and labelled as properties of the same kind for many reasons — reasons which have nothing to do with the intrinsic similarities of the objects which possess them. 'Expensive', 'convenient', 'functional', 'complex' and 'delicious', for example, are all terms which might loosely be said to name properties. But they do not name real or natural properties, i.e., properties which can be supposed to exist in nature independently of human interests or purposes. Consequently, these 'properties' should not be taken as examples of properties for the purposes of ontology. Such 'properties' are always grounded in other occurrent properties, and, for the purposes of ontology, it is clearly important to distinguish between these so-called 'properties' and their occurrent bases. Categorical realists quite rightly do this — and so do we. However, categorical realists make a serious mistake if they suppose that all dispositional properties are

<sup>12</sup> The analysis we are offering is thus similar to Fales [9, ch. 8, section 2].



really just like these.

Another perceived virtue of categorical realism is that it preserves the distinction between dispositional and non-dispositional properties. For instance, there does seem to be a fundamental difference in kind between properties like triangularity, and properties traditionally taken to be genuinely dispositional. We believe that any decent theory of dispositions should preserve this fundamental distinction.

#### IV. Mellor's Dispositional Foundationalism

A second Humean position concerning the ontological status of dispositions asserts that *all* genuine properties are, in effect, dispositional. This view has been embraced in several different forms. One position, propounded by Mellor [18], [19], asserts that all physical properties are dispositional; the so-called categorical properties are no exception. Mellor rejects the notion that there are non-dispositional properties, arguing that the properties believed to be peculiar to dispositional properties are either mythical or common to all properties.

One of Mellor's major arguments against categorical realism is that no legitimate distinction can be made between categorical and dispositional properties. One differentiating characteristic that has been cited by the categorical realists is that dispositional properties peculiarly entail subjunctive conditionals, whereas categorical properties do not. Mellor [19] argues that such a characteristic is not unique to the so-called dispositional properties, as construed by the categorical realists, because properties traditionally taken to be categorical also support subjunctive conditionals.

Mellor's second argument in favour of upgrading the ontological status of dispositions concerns the fact that dispositional properties in themselves qualify to be counted as genuine properties. He cites two tests for the reality of properties:

- (1) the principle of multiple manifestation, viz., that a real property must manifest itself in more than one way, and
- (2) Schlesinger's principle of connectivity,<sup>13</sup> viz., that any real property must be nomically connected with other properties, so that two physical systems cannot differ only in respect of a single property.

Mellor claims that many dispositional properties clearly satisfy both of these criteria. Hence, these properties should be accepted as genuine properties.

Mellor's criticism of the categorical/dispositional distinction is provocative, as it threatens the very foundations of the categorical realists' ontology. The principal point his analysis illuminates is that all physical properties can be characterised operationally in terms of subjunctive conditionals, and as dispositional properties are traditionally explicated in terms of operational definitions, it follows that all properties have a dispositional aspect.<sup>14</sup> The upshot of this argument is that the dispositional/categorical distinction so construed cuts no philosophical ice. When this is combined with his second point, viz., that dispositional properties clearly have

<sup>13</sup> See [26, ch.3].

<sup>14</sup> Shoemaker [27] and Swoyer [28] both make the point that we can only know about properties

some claim to be genuine properties, Mellor seems to have mounted a persuasive argument for both reevaluating the lowly status of dispositions and questioning the role of (and perhaps dispensing with) categorical properties.

Mellor's attack on the reality of non-dispositional properties is interesting. But it must be remembered that Mellor's theory purports to be Humean. So how does his view on dispositions lend itself to a Humean ontology? At first blush it seems that by denying the existence of non-dispositional properties, Mellor has eliminated occurrent properties from his ontology. But on further inspection, it can be seen that this is not the case. His claim that dispositional properties are 'real' properties suggests that Mellor is, in some sense, rejecting the traditional operationalist semantics of dispositional terms, and regarding dispositions as occurrent properties. In fact, his analysis seems to suggest that all occurrent properties are dispositional. Hence, his objection to categorical properties does not seem to amount to a rejection of occurrent properties.

However, there is a difficulty with reconciling Mellor's analysis with a Humean ontology. By embracing the Contingency Thesis, Mellor, at the very least, has to subscribe to the view that the laws which hold in this world are only contingently related to the entities that exist in it. Thus, the behaviour of an entity must be logically distinct from the kind of thing it is.<sup>14</sup> Now, if Mellor wants to 1) deny the existence of categorical properties, 2) avoid embracing a behaviourist theory of dispositions, and 3) have an ontology of occurrent properties, then his only option is to *identify* a disposition with some occurrent property or properties which are not dispositional. But what could these be? Could they be, perhaps, those structural or other properties which must exist if the disposition is to exist?

However, such an identification is not permissible in a Humean ontology, for it is not consistent with the Contingency Thesis. Whilst it may be common to equate a disposition with its base in this world (e.g., to identify solubility with the nature of the structure of the electron-orbital in the outer shells of molecules, etc.), such an action only gains its legitimacy by the fact that the laws in this world are fixed. In another world, where the laws are different, a Humean must hold that this identity relation might not hold. Consequently, any identity relation between a disposition and its base, and hence, between an entity and its behaviour would, at best, be a contingent relation. This seems to conflict with Mellor's analysis.

Perhaps his theory could be rescued by embracing a new semantics of dispositional terms. However, we doubt if this would remove the problem of the logical

<sup>14</sup> *continued...*

by observing their effects in various circumstances. Consequently, to know what properties a thing has, we need to know what its dispositions are. However, this conclusion does not follow, unless dispositions are interpreted as including mere Cambridge dispositions.

<sup>15</sup> In reply to an objection by Mackie, Mellor explicitly states that logical connections are permitted between things and events. But he denies that this conflicts with Hume's principle that there can be no logical connections between distinct existences. Mellor [18] argues that Hume's principle does not apply to a heterogeneous ontology of things and events. However, if the laws of nature are contingently related to the things that exist, then the kinds of behaviour (i.e., events) manifested by these things are only contingently connected to them. Hence, even if Mellor embraces a more restricted version of Hume's principle, his analysis of dispositions is still inconsistent with the Contingency Thesis.

connection between properties and the events they manifest. It seems that Mellor must either 1) abandon the Contingency Thesis, 2) reinstate categorical properties, or 3) provide a new semantics of dispositional terms that can explain their occurrent nature in a Humean ontology. In the next section, we advocate all three, except that our analysis of dispositional properties has a distinctly anti-Humean flavour.

### V. An Analysis of Dispositions

Natural dispositions are attributed to things to describe the salient kinds of processes in which they may be involved, i.e., they tell us how things characteristically will or be likely to behave in various kinds of circumstances. The dispositions of things are thus essentially linked to kinds of processes, and every manifestation of a disposition must exemplify some kind of process. Therefore, to identify a disposition (but not define it) it is sufficient to specify the kind of process which is specific to it.

The kind of process associated with a disposition can be characterised by the kind of circumstances *C* in which it takes place, and the kind of outcome *E* which results. In the simplest instance (i.e., single-track dispositions) a disposition may be characterised by an ordered pair  $\langle C, E \rangle$ , where ‘*C*’ denotes a kind of circumstance, and ‘*E*’ a kind of event. If *x* is an object which has this disposition, then *x* is said to have the disposition to *E* in circumstances *C*.

Although we reject Mellor’s analysis of dispositions, we agree with him in accepting Schlesinger’s connectivity criterion for the reality of properties. However, in our view, the most important reality criterion for properties is that of connectivity. The principle of multiple manifestation, which he also cites, is an appropriate criterion for the reality of entities postulated as the bearers of properties, perhaps, but it is not so obvious that properties must also manifest themselves in more than one way. We hold that a difference in respect of any real property must make a difference, i.e., have some effect. But to have an effect, it is sufficient if it is nomically connected with other properties. Hence, this requirement is satisfied if the principle of connectivity is satisfied; hence the importance of this principle.

Most paradigmatically categorical properties clearly pass the test of connectivity. Differences in shape, size and other categorical properties make a difference because different spatiotemporal relations, and hence different structures, make a difference. But, just as categorical properties pass the test of connectivity, the same is true of many dispositional properties. Inertial mass, for example, is nomically connected with other properties. Therefore, by the test of connectivity, there is at least as much reason to count the inertial mass of an object as a genuine property as there is to consider its shape to be a real property.

Dispositions may be distinguished as real or pseudo dispositions, depending on the kinds of processes involved. Real dispositions involve real changes to the object in question. For example, solubility is a real disposition, for a soluble substance undergoes a genuine change when the disposition is manifested. On the other hand, triangularity is not a genuine disposition,<sup>16</sup> although it might be said that a particular object has the disposition to look triangular, or be such that if you were to count its

<sup>16</sup> *Pace* Mellor [18], [19].

corners correctly, you would get three. Such dispositions are not genuine. They involve what Geach refers to as ‘mere’ Cambridge changes,<sup>17</sup> and hence are, at best, ‘mere’ Cambridge dispositions, for they do not name a genuine change.

The kinds of processes associated with real dispositions may be either natural or artificial. Natural kinds of processes, like natural kinds of objects, exist as kinds prior to human classification. Processes of the same natural kind are essentially the same; they have the same nature.<sup>18</sup> They proceed from the same kind of circumstance in the same kind of way and have the same kind of outcome. In contrast, artificial or socially constructed kinds of processes are not essentially the same. Processes of these kinds are classified together, because it is useful or salient or convenient for us to classify them in this way.

Dispositions may therefore be distinguished as natural or artificial, depending on the kinds of processes involved. Natural dispositions refer to natural kinds of processes, and like all real properties, they exist independently of our systems of classification. We suppose the natural dispositions to be simply the real essences of the natural kinds of processes they describe. That is, we suppose that an object cannot participate in a natural process to E in circumstances C, unless it has a natural disposition to E in these circumstances. In contrast, artificial or socially constructed kinds of processes do not have real essences, and the dispositions defined with reference to such processes are not objectively real properties.

To illustrate: the process of  $\beta$ -decay is a natural process. It is essentially the emission of an electron from the nucleus of an atom resulting in an increase by one of atomic number. This process exists independently of human concerns, and has its own essential nature. The process of cheating, on the other hand, is not a natural process. There are many different ways in which people can cheat. We classify them together only because they are all ways of illegally or immorally taking advantage of others. If there is an essence of cheating, it is only a nominal essence.

Natural processes may be either causal or stochastic. To define a kind of causal process, it is necessary and sufficient to specify how a process of this kind would be initiated, and what kind of effect it would have. To specify a kind of stochastic process, it is necessary and sufficient to say what kind of transition it concerns, and how probable it is that such a transition will occur within any given time interval.

<sup>17</sup> The terms ‘Cambridge’ and ‘mere Cambridge’ were introduced by Geach [12, p.71], to distinguish between real and non-genuine changes. (See also [27].) Geach’s ‘Cambridge Criterion’ for a thing having changed is as follows: ‘The thing called “x” has changed if we have “F(x) at some time t” true, and “F(x) at some time t<sup>1</sup>” false, for some interpretation of “F”, “t” and “t<sup>1</sup>.”’ Geach acknowledges that this definition is intuitively unsatisfactory, for it includes cases of change which we would not wish to count as instances of genuine change. For instance, according to the Cambridge Criterion, Socrates would change by coming to be shorter than Theaetetus in virtue of the latter’s growth. Geach refers to this kind of change as a ‘mere’ Cambridge change. It should be noticed that Cambridge changes in general include ‘mere Cambridge’ changes.

<sup>18</sup> Many of the most important discoveries in science concern natural kinds of processes and their essential natures. Newton, for example, showed that the apparently different kinds of processes of falling towards the earth and orbiting the sun are essentially the same. Similarly, Lavoisier showed that respiring, rusting and burning are all essentially processes of oxidation. Malcolm Forster [10] talks of discovering a common cause in these and similar cases. We think that these discoveries are best described as discoveries of sameness of essential nature.

The dispositions we think are important are those associated with such natural processes. For, according to the theory presented in this paper, these are the properties which ground causal and statistical laws.

As stated earlier, perhaps the main difference between the analysis of dispositions we are proposing and its more traditional rivals lies in the semantics of dispositional terms. One significant feature of our theory is the rejection of the operationalist style of defining dispositions in terms of one or more subjunctive conditionals. In our theory, we make no attempt to *define* dispositional properties in terms of synonymous expressions, but rather, when we speak of dispositional properties, we are *denoting* real properties (i.e., particular causal powers, capacities, or propensities). Real dispositional properties exist as distinct entities, prior to any nominalist or operationalist definitions of them.

We believe that this analysis of dispositions has some distinct advantages when compared with the more traditional theories. Firstly, it explains why dispositions bear a special relationship to subjunctive conditionals. Dispositional properties support subjunctives because their existence entails that certain kinds of natural processes would occur in certain kinds of circumstances to the objects which have these properties. The subjunctive conditionals simply spell out these implications. Secondly, it explains why dispositions can be mocked or frustrated. For circumstances can often be manipulated to make an object appear to have a disposition which it does not have, or appear not to have a disposition which it does have. Thirdly, it explains why dispositions can often be obscured. They can be obscured because different processes can occur in the same thing at the same time, so that the effect of any single disposition being triggered may well be obscured by the effects of other dispositions which are being simultaneously manifested.

Our analysis is ‘bottom up’ in that for every dispositional property, there is a particular subjunctive (or set of subjunctive conditionals) which the dispositional property supports.<sup>19</sup> However, the converse is not true; a true subjunctive conditional does not necessarily entail the existence of a corresponding dispositional property. For example, to borrow an example from Mellor, the subjunctive conditional ‘if you were to count the corners correctly, you would get three’ does not, on our analysis, necessarily name a dispositional property.

An attractive feature of our analysis is that it leaves dispositions to be identified rather than defined operationally. By identifying a disposition with an enduring property, we have dispensed with the need to enumerate in detail the relevant antecedent circumstances sufficient for the manifestation of a disposition along with the resulting effects. In the past, this task has formed a central component of the empiricists’ programme of elucidating the meaning of dispositional terms. However, this has proved to be a hopeless task. For most dispositions are multi-track, but there seems to be no principled way of uniting the various tracks into a single disposition. For instance, there are many ways in which a fragile object may

<sup>19</sup> Similar ‘bottom up’ analyses of dispositions are to be found in Harré [14], Harré and Madden [15], [16], Shoemaker [27], Swoyer [28] and Fales [9]. These theories are similar in so far as they all propose that objects have powers or essential natures whose existence entails the manifestation of the disposition when the appropriate conditions are realised.

manifest its fragility. However, it is not clear why these different manifestations should all be regarded as displays of the same disposition. Thus, the traditional operationalist accounts of dispositions are faced with the intolerable situation of being unable to offer a satisfactory analysis of multi-track dispositions, or else, they are faced with the equally unpalatable prospect of dealing only with single-track dispositions, thereby assigning a different disposition to each individual operational definition. This latter option has fortunately been resisted, as it would yield a proliferation of properties uncongenial to a scientific ontology.

## VI. Dispositional Essentialism

The position we wish to defend, which we call ‘dispositional essentialism’, is a species of dispositional realism. It is realist about the dispositional properties of the fundamental particles and fields, for example, and it is essentialist for two reasons: first, because it holds that these properties are amongst the essential properties of these particles and fields, and second, because it holds that it is essential to the natural processes in which these particles and fields may be involved, that they should be displays of these dispositional properties. We do not claim, as some philosophers have, that these fundamental dispositional properties are the ontological basis of all properties. On the contrary, we believe that there are equally fundamental categorical properties, e.g., spatiotemporal relations and structures. We see no reason to suppose that such properties can be ontologically reduced to dispositional ones.

Real dispositional properties, we hold, may supervene on categorical properties, but never on categorical properties alone. If a dispositional property supervenes on other properties, then the subvenient class must include at least one property which is itself a dispositional property. One disposition may be ontologically dependent on another disposition, just as one causal process may depend ontologically on another. But a disposition cannot be ontologically dependent only on what is not dispositional. A causal power is more than just a constant conjunction.

Categorical realists seek to deal with this difficulty by claiming that dispositional properties supervene, not only on categorical properties, but also on the laws of nature. However, the laws of nature are not the right category for the ontological reduction of properties. Laws are not things which exist in the world; they are things which are true of the world. The truthmakers for the laws of nature might well be things on which dispositional properties could depend ontologically.<sup>20</sup> Indeed, if we are right, then this is so. For the truthmakers for the relevant laws of nature are, we hold, just the fundamental dispositional properties.

Thus, we argue that while real dispositional properties may well be supervenient on other properties, this is possible only if the subvenient class includes at least some properties which are also real dispositions. Consequently, if there is to be no infinite regress of ontological dependence amongst properties, there must be some ontologically basic dispositions. Most plausibly, these ontologically basic properties are just the causal powers, capacities and propensities of the fundamental natur-

<sup>20</sup> For an analysis of the concept of truthmaker, see [11].

al kinds.

Such properties are evidently dispositional. A causal power is a disposition of something to produce forces of a certain kind. Gravitational mass, for example, is a causal power: it is the power of a body to act on other bodies gravitationally. A capacity is a disposition of a kind distinguishable by the kind of consequent event it is able to produce. Thus, for  $x$  to have the capacity to do  $Y$  is for  $x$  to have a disposition to do  $Y$  in some possible circumstances. Inertial mass, for example, is a capacity. It is the capacity of a body to resist acceleration by a given force. A propensity is a disposition which a thing may have to act in a certain way in any of a very broad range of circumstances. For example, the propensity of a radium atom to decay in a certain way in a certain time is a disposition which the atom has in all circumstances.

Moreover, the dispositional properties of the fundamental natural kinds would also appear to be basic in the required sense. If they are ontologically dependent on other properties, then it is hard to see what these other properties could possibly be.

Finally, these basic properties would appear to have precisely the properties we should require of truthmakers of the causal and statistical laws concerning the behaviour of the fundamental natural kinds. For the existence of these causal powers, capacities and propensities is sufficient to guarantee that these laws *must* hold for these kinds of things. They must hold for these kinds of things, because these properties are amongst their essential properties. Hence, things of these kinds necessarily have these dispositional properties, and are bound to behave accordingly.

How the relevant laws of nature are grounded in the essential properties of fundamental natural kinds can be explained by direct appeal to the nature of these properties. For what dispositional properties do is dispose the things that have them to behave in certain ways, depending on the context. What science observes and codifies are the manifestations of these dispositions. Hence, laws which describe how dispositional properties act will, at the same time, tell us what things which have these properties essentially *must* do in virtue of being the kinds of things they are.

## VII. Dispositional Properties and Laws

There are two broad categories of dispositions, *causal* and *stochastic*. *Causal dispositions* refer to causal processes; *stochastic dispositions* to stochastic processes. Where we have a causal disposition, there is typically a certain pattern of cause-and-effect or stimulus-and-response which anything having the disposition would normally display if it were appropriately caused or stimulated to do so. A *stochastic disposition*, on the other hand, is a *propensity* of some kind, in which the antecedent condition is not strictly the cause of its manifestation, but only a necessary condition for it. For example, the disposition of a radium atom to decay in a certain way is a stochastic disposition. If this species of radioactive decay is to occur, it is a *necessary condition* that radium atoms should exist. But events of radioactive decay are not *caused* by the existence of such atoms. Nor, as far as we know, are they caused by anything else. There is just a certain objective probability  $p$  that within any given time-interval  $\delta$  such an event will occur.

### 7.1 Causal Dispositions and Causal Laws

Let  $D$  be the causal disposition  $\langle C, E \rangle$ , and  $D(x, t)$  the proposition that  $x$  has this disposition at  $t$ . Then  $D(x, t)$  is the claim that an event or state of affairs of the kind  $C$  occurring to  $x$  at  $t$  would, or would at least be likely to, cause an event of the kind  $E$ . Let  $C(x, t)$  be the proposition that an event or state of affairs of the kind  $C$  exists or occurs to  $x$  at  $t$ , and  $E(x, t + \delta)$  the proposition that an event of the kind  $E$  occurs to  $x$  in the time interval from  $t$  to  $t + \delta$ . Then, to say that  $x$  has the causal disposition  $\langle C, E \rangle$  at  $t$  is at least to say that for some  $\delta$ , the probability of  $E(x, t + \delta)$ , given  $C(x, t)$  is greater than one half. Actually, it is to say more than this, because the claim is not only that an  $E$ -event occurring to  $x$  by  $t + \delta$  is made probable by a  $C$ -event occurring to  $x$  at  $t$ , but also that it is likely to be caused by such an event.

For a given  $\delta$ , the probability that an event of the kind  $E$  will occur to  $x$  by  $t + \delta$  as a result of an event of the kind  $C$  occurring to  $x$  at  $t$  depends on how strongly  $x$  has the disposition  $\langle C, E \rangle$  at  $t$ . If, for some finite  $\delta$ , an event of the kind  $E$  must occur to  $x$  by  $t + \delta$  as a result of a  $C$ -type event occurring to  $x$  at  $t$ , then the disposition  $\langle C, E \rangle$  of  $x$  at  $t$  may be said to be causally determinate. If all instances of a given disposition must always be causally determinate, then the disposition itself may be said to be causally determinate. In that case, there is a deterministic law of action of the disposition. Such a law is clearly a causal law, for it is fully determinate what the effect of a  $C$ -type event occurring to  $x$  will be.

To illustrate our concept of a causally determinate disposition, consider, once again, electric field strength. The field strength  $E$  at a point  $P$  in an electrostatic field is the electrostatic force per unit positive charge placed at  $P$ . Hence, if  $x$  is the field which exists at  $P$ ,  $C(x, t)$  is the proposition that a positive charge  $e^+$  is placed at  $P$  at  $t$ , and  $E(x, t)$  is the proposition that  $e^+$  is consequently subject to an electrostatic force  $E$  at  $t$  ( $\delta = 0$  in this case), then the following law must hold

$$\forall x \forall t [C(x, t) \square \rightarrow E(x, t)]$$

This law, which states the law of action of the disposition  $E$ , is a typical causal law.  $E$  is what we may call a causal power. It is a property of the field at  $P$ .

### 7.2 Stochastic Dispositions and Statistical Laws

There are at least two kinds of reasons why a disposition may not be causally determinate. First, some dispositions suffer from incurable vagueness. To define fragility, for example, we cannot do much better than say that a fragile object is one that is *likely* to break if dropped, or otherwise handled roughly. Any more precise definition might capture some more specific concept of fragility. But it would not be the broad but vague concept with which we are familiar.

Dispositions, like fragility, which, because of their vagueness, are not causally determinate could obviously exist in a deterministic world. For the kind of vagueness which attaches to such dispositions is a function of language, not of reality. The indeterminacy of such dispositions is due to their lack of specificity, not to how the world is; and, in a deterministic world, they should, at least in principle, be eliminable in favour of causally determinate dispositions. Indeed, in a deterministic world, all dispositions which, for any reason, are not causally determinate *must* be



ontologically dependent on dispositions which are causally determinate. This is what it is for the world to be deterministic.

In an indeterministic world, such as ours, there must be dispositions which are not causally determinate for a different reason. They are causally indeterminate, not because of vagueness, but because of the indeterminacy of the underlying physical processes. Such dispositions might also be imprecisely defined, but they are indeterminate for another reason as well. For example, the probability that a radium atom existing at  $t$  will have decayed by  $t + \delta$  is, for any given frame of reference, a precisely specifiable function of  $\delta$ , and this probability is independent of the circumstances in which the radium atom exists. Hence, we cannot, even in principle, eliminate this causally indeterminate disposition in favour of any more precisely defined dispositions which are causally determinate.

Causally indeterminate dispositions like these are *propensities*, and their laws of action are statistical laws. The statistical law follows from the fact that if anything  $x$  has a propensity  $\langle C, E \rangle$  at  $t$ , then for any given value of  $\delta$ , there must be an objective probability  $p(x, \delta)$  that if  $x$  were to exist in circumstances of the kind  $C$  at  $t$ , then an  $E$ -type event would occur to  $x$  by  $t + \delta$ . This is what we call the law of action of the propensity. Things having this propensity, must behave according to this law.

Statistical laws of interaction between things are often much more complicated than simple laws of radioactive decay. For in general we have to deal, not only with the causal powers and propensities of things taken individually, but also with their *responsiveness* to each other, and to the various forces they generate. Therefore, we need to know about the *capacities* of things to interact, and the probabilities of various interactions occurring. We assume, without arguing the case here, that all such knowledge is ultimately knowledge of dispositions.

From what has already been said, it is clear that causal dispositions can sometimes ground causal laws, and that stochastic dispositions can sometimes ground statistical laws. We have not shown that all causal and statistical laws can be similarly grounded, but it seems to us to be very probable that this is so. To suppose otherwise is to suppose that other causal or statistical laws have different ontological foundations, and we know of no good reason to think that this might be so.

### VIII. Conclusion

In this paper we have argued against Humean theories of dispositions and laws, in favour of an essentialist one. We have rejected the view, held by most Humeans, that dispositions are necessarily supervenient on non-dispositional properties and the laws of nature. And we have defended the contrary view that the laws of nature, or at least those which specifically concern the behaviour of the various fundamental kinds of things, depend on their dispositional properties.

We have rejected the standard Humean view, because we find it incompatible with the view of reality which science requires us to take. If we could believe in a world of fundamental kinds of things which are distinguished from each other by their categorical properties (e.g., by their primary qualities), and which are determined by the laws of nature to behave as they do, then we could accept that the dis-

positions of things are contingent on what the laws of nature happen to be. But the fundamental kinds of things are obviously not distinguished from each other by their categorical properties. Indeed, it is not evident that they have any categorical properties at all. The most fundamental kinds of things would appear to be distinguished from each other only by their causal powers, capacities and propensities. That being so, the dispositions of these kinds of things cannot be said to depend on the laws of nature. On the contrary, the laws which determine the behaviour of these kinds of things, and hence of the things which are composed of them, must derive from their dispositional properties.

The Humean theory of laws and dispositions is in trouble for other reasons. For it has great difficulty in explaining the necessity of laws, and hence the capacity of dispositions to support subjunctive conditionals. These problems do not arise for an essentialist theory. For the causal and statistical laws concerning the behaviour of the fundamental kinds of things must hold in any world in which these kinds of things exist. The existence of these kinds of things entails the existence of their properties; and the existence of their properties necessitates the laws of their behaviour.

The theory of causal and statistical laws that we have developed here fares well on van Fraassen's criteria of adequacy.<sup>21</sup> It explains their universality, their support for subjunctive conditionals, and their relevance to the aims of science and scientific explanation. It is obvious, from what has been said, that our theory explains both the universality of laws and their support for subjunctive conditionals. The relevance of the search for laws to the aims of science is equally well explained. For, it seems to us, one of the primary aims of science must be to discover what kinds of things exist most fundamentally, what their essential properties are, and hence what kinds of causal and stochastic processes involving such things can occur.

In this paper, we have argued that it is not just an accidental fact about the world that the fundamental natural kinds have the causal powers, capacities and propensities that they do. On the contrary, these are, or are amongst, their essential properties. Consequently, things of these kinds must have the dispositional properties they have to be the kinds of things they are; and to have these dispositional properties, they must be disposed to behave and interact as they do. The laws governing their behaviour must therefore be necessary. Hence, things like electrons and electromagnetic fields must, by their very nature, be disposed to behave and interact with each other in certain ways, viz., in the ways prescribed by the causal and statistical laws concerning them.

We have not argued here that all laws of nature are grounded in the basic dispositional properties of natural kinds. In fact, we think that there are global laws (such as the conservation laws and Pauli's exclusion principle) and some general principles (such as the principles of quantum uncertainty and general relativity) which are definitive, not of kinds of things in the world, but of the kind of world in which we live.<sup>22</sup> These laws determine what kinds of events and spatiotemporal structures can

<sup>21</sup> [30, pp.25-38].

<sup>22</sup> The idea that the world is one of a kind, and that the laws of nature describe the essential properties of our kind of world, or of the kinds of things which can exist in worlds like ours, is discussed in [5].

occur in worlds like ours, and hence put constraints on the kinds of things that can exist. Clearly, it is not the case that any kind of thing having any kind of structure or set of dispositional properties can exist in our kind of world.

However, it is beyond the scope of this paper to discuss these more general kinds of laws, or the constraints they impose on the kinds of things that can exist. Here we have argued only that some laws of nature, viz., causal and statistical laws, are grounded in the basic dispositional properties of the fundamental natural kinds.

Nevertheless, the view that dispositions need to be grounded in non-dispositional properties is a popular one. It is our belief that the attractiveness of this view is grounded in the prevalent (although we believe, misguided) conviction that the laws of nature are contingent, and in the adoption of an inadequate semantics of dispositional terms. But by dispensing with the Contingency Thesis, and in its place, adopting an essentialist theory of laws, we can offer a theory which is both consistent with the nature of scientific endeavour, as well as adequately explaining the source of the necessity of laws. Moreover, an essentialist theory also reveals the connection between (genuine) dispositions and nomic necessity, and thus explains why dispositions feature as they do in scientific discourse.

Hence, we conclude, contrary to what categorical realists believe, that dispositions do not need to be propped up by non-dispositional properties. Nor are they shameful properties in need of being explained away, as the opening metaphor suggests. Dispositions, like single mothers, are perfectly capable of surviving on their own. They are not promiscuous properties that have different categorical bases in different possible worlds. Nor are they causally impotent, as categorical realism entails. On the contrary, dispositions underpin the laws of nature, and thus determine what laws exist, and how things are disposed to behave. If this is right, then it turns the most widely accepted theory about the relation of ontological dependence holding between laws and dispositions on its head. At the same time, it provides truthmakers for certain kinds of laws, and explains why, and in what sense, these laws are necessary.

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