

# Natural Properties, Supervenience, and Mereology\*

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## ABSTRACT

The interpretation of Lewis's doctrine of natural properties is difficult and controversial, especially when it comes to the bearers of natural properties. According to the prevailing reading – the *minimalist view* – perfectly natural properties pertain to the micro-physical realm and are instantiated by entities without proper parts or point-like. This paper argues that there are reasons internal to a broadly Lewisian kind of metaphysics to think that the minimalist view is fundamentally flawed and that a *liberal* view, according to which natural properties are instantiated at several or even at all levels of reality, should be preferred. Our argument proceeds by reviewing those core principles of Lewis's metaphysics that are most likely to constrain the size of the bearers of natural properties: the principle of Humean supervenience, the principle of recombination in modal realism, the hypothesis of gunk, and the thesis of composition as identity.

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### 1. Are Natural Properties Instantiated by Minimal Entities?

Lewis's core doctrine of naturalness consists of three simple theses: first, some properties are natural; second, some properties are more or less natural than others; third, some properties – the perfectly natural ones – are more natural than all others. The interpretation of the doctrine, however, is far more difficult and controversial, especially when it comes to the bearers of natural properties. According to a certain reading of Lewis – the *minimalist view* – perfectly natural properties pertain to the micro-physical realm and are instantiated by “minimal entities”: these are entities with a minimal size, that is without proper parts or point-like with regard to spatiotemporal extension, depending on the view. The present paper argues that there are reasons internal to a broadly Lewisian kind of metaphysics to think that the minimalist view is fundamentally flawed and that perfectly natural properties are instantiated at all levels, rather than only at the minimal one.

The minimalist view is not without *prima facie* textual support. The identification of the bearers of natural properties with minimal entities is indeed suggested by Lewis's preferred microphysical examples of natural properties. The most common are the charge and the spin of an electron,<sup>1</sup> where the latter seems to fit the role better than other subatomic particles just because it is expected not to be composed of smaller particles. Moreover, in some important passages Lewis characterizes so-called Humean supervenience – one of the most important principles of his entire philosophical work – in terms of “local” properties: «Humean Supervenience [...] is the doctrine that all there is to the world is a vast mosaic of local matters of particular fact, just one little thing and then another».<sup>2</sup>

The term “local”, as it applies to properties, may be taken to mean that the natural properties involved in Humean supervenience are instantiated by entities located in space and time. But Lewis explains clearly that these properties are said to be “local” because they are *minimally* located in space and time; their bearers are points or point-sized entities: «We have geometry: a

<sup>1</sup> Electrons are considered as examples of perfectly natural properties in *On the Plurality of Worlds* (henceforth, OPW), p. 68, where Lewis is fixing his definition of perfectly natural properties. Just a few paragraphs above (p.64) Lewis also uses the example of unit positive charge, with some more reservation: «*let us assume* that unit positive charge is a perfectly natural property ...» (our emphasis).

<sup>2</sup> *Introduction* to the second volume of *Philosophical Papers* (henceforth, PPII), ix–xvi.

system of external relations [...] between points. And at those points we have local qualities: perfectly natural intrinsic properties which need nothing bigger than a point at which to be instantiated».<sup>3</sup>

In short, two sorts of evidences could lead to the conclusion that Lewis's natural properties are instantiated by minimal entities: the examples and the presentation of Humean supervenience. They are evidences of different sorts, resting on considerations that can be criticized by means of independent strategies. The examples stem from Lewis's naturalism and reductionism: it is up to natural sciences to identify natural properties; natural sciences can be reduced to physics; physics can be reduced to microphysics; the particles involved in microphysics (or in a core of microphysics to which microphysics can be reduced) are point-sized and have no proper parts. Still, a number of authors criticized the identification of the bearers of natural properties with minimal entities just from the point of view of contemporary physics, where the most basic entities which instantiate properties and enter relations are not always micro-particles devoid of structure, but are for example strings or fields. As a matter of fact some of these scholars (in particular Jonathan Schaffer, Andreas Hüttemann and Vassilios Karakostas<sup>4</sup>) see Lewis as a critical target. If Lewis's conception of science and of physics in particular was misguided, then Lewis's methodological principle that it is up to physics to identify natural properties could be retorted against his preferred examples and lead to the conclusion that also entities bigger than a point and endowed with proper parts are bearers of some natural properties.

The other sort of evidence does not seem to rest on better grounds. The problem of the size of the bearers of natural properties is connected with Humean supervenience. Yet the latter – to anticipate an argument offered in §4 – is compatible with the possibility that there are some properties that are at once natural, non-local, and excluded from the basis of recombination.

Looking at the situation from a different perspective, Lewis has several reasons to admit the existence of natural properties beyond Humean supervenience, the chief one being defining duplication and, hence, recombination. Indeed, given the prominent role covered by natural

<sup>3</sup> *Ibidem*

<sup>4</sup> See (Schaffer, 2003), (Hüttemann, 2004), (Karakostas, 2009). See also (Morganti, 2009) for a comprehensive survey of this debate.

properties, it is particularly relevant to look at Lewis's sources of evidence about the size of their bearers. Is there a formal, general criterion to identify those bearers? Is the criterion rooted in one or several theses characterizing Lewis's metaphysics, so that by adopting the theses we are *ipso facto* forced to conclude that the exclusive bearers of natural properties are minimal entities?

In this paper we shall review the core principles of Lewis's metaphysics that are most likely to constrain in some way the choice of the bearers of natural properties, in particular their size.<sup>5</sup> The purpose is analogous to that of Schaffer, Hüttemann and Karakostas, on one hand, but we are not going to draw on the results of contemporary physics. More in details, §2 introduces two alternative stances about the bearers of natural properties – called, respectively, minimalism and liberalism. §3 analyzes Lewis's concept of natural property, connecting it with the cognate notion of fundamental property in order to see if they place any constraint about the size of the bearers of natural properties. In §4 we come back in the same vein to Lewis's so-called principle of Humean supervenience, distinguishing a strong and weak version. §5 deals with the role of natural properties in the definition of duplicate entities and the principle of recombination, as required by Lewis's modal realism. In §6 we begin to look at the theory of constitution as a possible source of constraints by analyzing the admission of unlimited mereological complexity (the so-called *gunk*.) The discussion of *gunk* will be also the occasion to compare different characterizations of the "minimality" of bearers, in mereology and out of it. In §7 we study how composition as identity, as advocated by Lewis in *Parts of Classes*, fits with minimalism and its rival views. §8 draws some conclusions.

## 2. Minimalism vs. Liberalism

There are two alternative hypotheses about the bearers of natural properties. They are mutually exclusive, insofar as their definition makes clear that you cannot subscribe to both of them without contradiction, and they are

<sup>5</sup> The choice of the principles aims to give a reasonably adequate picture of Lewis's metaphysics. Moreover, these principles constitute quite a cohesive theoretical package and they are often jointly adopted by metaphysicians in the Lewisian tradition (e.g. Ted Sider, Daniel Nolan, Laurie Paul.) However, we can not analyze here the ties between these principles: as a result, the reader is free to assume that they are reciprocally independent, so that it is possible to drop one or more of them without being forced to drop the others too.

exhaustive because, if you think that natural properties are instantiated, you need to accept one of them. According to the first, *minimalism* about bearers (MB), all the bearers of natural properties are minimal entities.<sup>6</sup> On the other side, according to *liberalism* about bearers (LB), the bearers of natural properties are not exclusively entities of a minimal size. MB will be at the hearth of our discussion and we shall elaborate on its different facets in due course. We shall concentrate on LB here.

The central characteristic of LB is that it leaves unspecified how the bearers of natural properties should be identified thereby opening up some complex issues. In other words, minimal size is not a general criterion to identify the bearers of natural properties: does this mean that there is no general criterion for the identification at all, or is the criterion simply different from that of MB? If there is a criterion, we face two alternatives: a) there could be formal and general criteria to identify natural properties which do not involve size; b) there could be a size criterion not requiring that the bearers are minimal entities. Both appear to be unpalatable for different reasons.

The alternative a) is hard to implement: a general criterion not involving size can resort only to properties instantiated by the bearers that are abundant or conventional: this would indeed avoid circularity, in so far as abundant and conventional properties are not natural. However, it seems awkward that abundant or conventional properties identify the bearers of natural properties, as natural properties are expected to have some kind of explanatory priority over the former. Perhaps the criterion could make appeal to relations instead of properties: as according to MB the bearers of natural properties are at the bottom end in the net of relations of constitution, so LB would instead resort to another net of relations, e.g. the net of spatiotemporal relations. However, no intuitive reasons why the bearers of natural properties should be characterized by a distinctive spatiotemporal location (or by other positions in a net of relations) come to mind, leaving the burden of the proof to the supporter of this alternative.

<sup>6</sup> At this level we leave undecided the exact nature of *minimality*. MB is true if and only if all the bearers of natural properties instantiate one of the two features which – in a broadly Lewisian theoretical setting – can be seen as a kind of minimality: they are points or point-sized entities or they have no proper parts (and so they are mereological atoms). In §6 we will discuss the ties between these two characterizations of minimality.

On the other side, b) may be developed only in one way, since in mereology (due to the transitivity of parthood) there is only another privileged level beyond the minimal one: the maximal. As a result, b) could be developed as a form of *maximalism* according to which the bearers of natural properties are entities with a maximal size. This idea has been recently suggested by Jonathan Schaffer as a kind of *monism*, according to which there is actually only one maximal entity which is the bearer of natural properties: the universe.<sup>7</sup>

Given this picture, we can say that, once LB is adopted, the most plausible reaction is to deny the existence of a general criterion to identify the bearers of natural properties, at least until another criterion (such as the *maximalist/monist*) is provided and made independently plausible. If there is no general criterion, then the best thing to do could be to rely on natural sciences for the identification of the bearers of natural properties: because Lewis explicitly defers the identification of natural properties to physics, it is perhaps simply methodologically consistent to so defer the identification of their bearers.

This deference to science is in potential tension with some of the arguments we are going to provide in this paper against MB (e.g., in the discussion of *composition as identity* in §7.) In general, the strong conclusion in favor of LB is also a limitation to the scientific investigation about the bearers of natural properties: it excludes that the bearers are the minimal entities, even as a contingent matter of fact. Such outcome could be seen as incoherent with the motivations of LB and as a source of suspicion about the premises at play: in the context of an overall discussion of composition as identity (which falls beyond our purposes) this could be seen even as an argument<sup>8</sup> to reject composition as identity on the whole, or to reformulate it in order to avoid any necessary limitation on the size of the bearers of natural properties. After all, we are not assuming that all the theses we discuss, which could be traced back to a common Lewisian ground, should be accepted or rejected as a whole package.

Before moving over, we shall make explicit a delimitation of our problem. We have seen that Lewis distinguishes a restricted sub-domain of perfectly natural properties among natural properties. In this paper we will use the

<sup>7</sup> Cfr. (Schaffer, 2007) and, for a critical discussion, (Morganti, 2009).

<sup>8</sup> If the conclusion is unacceptable, composition as identity is not the only suspect premise. Another possibility is simply to reject or reform in depth the doctrine of natural properties.

expression “natural properties” for the sake of simplicity, but our arguments hinge on the perfectly natural properties.

It is unclear whether the distinction between two sorts of natural properties has consequences for the bearers of natural – but not perfectly natural – ones. Actually, it is not even set whether their bearers are different. According to a well-known suggestion by Lewis,<sup>9</sup> we can pass from the perfectly natural properties to the imperfectly natural simply by combining the perfectly natural with appropriate logical connectives, such as conjunction. If all the natural properties can be reached by chains of such simple logical combinations with properties of a same bearer, no new bearer gets involved and the bearers of natural properties are exactly the bearers of perfectly natural ones.

A para-syntactical conception of the degrees of naturalness, however, may be regarded only as an intuitive example, rather than as a full-fledged theory.<sup>10</sup> An alternative picture is that, when we have a complex entity whose features are determined by the perfectly natural properties of its components, then also the features of the complex entity inherit a certain degree of naturalness from its components. In this scenario, the domain of the bearers of natural properties would be different from that of the bearers of perfectly natural properties and its boundaries could even be vague, since no threshold of complexity would trace the boundary between the bearers of “minimally natural” properties from the bearers of definitely unnatural properties.

In conclusion, the concept of non-perfectly natural (but still natural) properties should be clarified in the context of the doctrine of natural properties. In the discussion to follow, we are going to assume only the core of the doctrine, focusing exclusively on perfectly natural properties.

### 3. Naturalness and Fundamentality of Properties

According to Lewis natural properties carve nature at its joints. This characterization is metaphorical and the metaphor is not transparent: it is not clear what nature exactly is, what are its joints and why these joints (whatever they are) should be characterized by a certain domain of properties. However, some expected features of natural properties can be easily inferred by the

<sup>9</sup> Cfr. OPW, p. 61 and (Lewis & Langton, 1998).

<sup>10</sup> (Sider, 1995) discusses this problem in depth.

metaphor or are explicitly declared by Lewis in his works. Let us analyze such features in order to see if they constrain in some way the size of the bearers.

A seemingly implicit feature is that natural properties are not conventional: they hold independently of their use in any kind of categorization operated by a cognitive subject. Still, it is not immediately clear how we should decide, for a specific property, if it enjoys the expected kind of independence and objectivity. Also, the bearers of natural properties could nonetheless be the subject-matter of a convention and, as a result, they will become the bearers of some conventional, non-natural properties. Let us suppose for example that the distinction between Europe and Asia is conventional. Europe and Asia will include as parts a certain number of electrons, whose charge and spin are assumed by Lewis as examples of perfectly natural properties. But, as a consequence of the conventional distinction between Europe and Asia, some electrons get the conventional property of being “European” and some others become “Asian”: however the electrons are prototypical minimal entities, notwithstanding any convention concerning them.

Because some entities instantiate both natural and conventional properties, the distinction could be between those items which instantiate both natural and conventional properties and other ones instantiating only conventional properties. If MB were true, any non-minimal entity would belong to the second group. But it is not clear how to reverse the order of the reasoning and get an independent reason in favor of MB. Why the concept of naturalness as opposed to conventionality should imply that only minimal entities instantiate both kinds of properties? There is no such constraint, at least if we are not already committed to MB for independent reasons.

Two more features deserve to be analyzed. They are both made most clear in *New Work for a Theory of Universals*, Lewis’s most elaborate text on the doctrine of natural properties (henceforth, NWU). Here he points to two main theoretical roles of natural properties concerning resemblance and causality respectively. We can try to see if these expected theoretical purposes require the bearers of natural properties to have a certain size.

First, according to Lewis, natural properties capture facts that are relevant for resemblance, and thus are the points of reference when we need to classify entities.<sup>11</sup> Facts of resemblance are pervasive: every kind of entity can be

<sup>11</sup> NWU, p. 13.

involved in a relation of resemblance;<sup>12</sup> natural properties capture the *relevant* facts of resemblance, while other less relevant kinds of resemblance could be captured – for example – by the property of being an European electron.

The relevance of facts of resemblance can help to discriminate between different properties, but it has no apparent consequence on the size of their bearers: why should the resemblances between electrons be more relevant than the resemblances between atoms or molecules? One could *assume* that the relevant facts of resemblance concern minimal entities, but such a move would bring only circular evidence in favor of MB.

The second pivotal theoretical function of natural properties is to capture the causal powers of things. The metaphor “carve reality at its joints” occurs sometimes in this context. Almost all properties are causally irrelevant, and there is nothing to make the relevant ones stand out from the crowd. Properties carve reality at the joints—and everywhere else as well.<sup>13</sup> While properties carve reality everywhere, natural properties carve it at its joints, which are – among other things – the causal links at the core of some scientific laws. This theoretical function of natural properties can constrain in some way the choice of their bearers: an information we might get is that the bearers are parts of reality or nature. As a result – for example – sets and numbers are perhaps<sup>14</sup> not good candidates for the role of bearers of natural properties. However, size is *prima facie* not involved: in which sense would an electron be more involved in causal relations than an atom, a molecule or even an organism?

The attribution of special causal powers to electrons and other minimal particles could be additionally fine-tuned: it should be admitted that some causal links involve also bigger entities, but these macroscopic causal links would be completely determined by the causal links involving their minimal parts. In this sense, the causal laws concerning atoms, molecules and

<sup>12</sup> Perhaps a minimal condition in order to be connected by relations of resemblance is to instantiate a property whatsoever (it does not matter if this property is natural), but this does not make size relevant.

<sup>13</sup> NWU, p. 13.

<sup>14</sup> Lewis would have been reluctant to classify them thoroughly as “abstract entities”. See OPW, pp. 83–84, where Lewis claims that there is nothing wrong in the idea that a set is involved in a causal link (as in the common picture according to which a set of causes cause a certain effect). If this point of view is adopted, the role of naturalness in the theory of causality does not lead to the exclusion of sets from the domain of the bearers of natural properties.

organisms would be reducible to the causal laws concerning their minimal constituents, such as electrons. Even supposing that the idea is correct, it would not be a consequence of the mere concept of naturalness, but a substantive philosophical thesis. Lewis himself subscribed to a similar credo via the principle of Humean supervenience. We will discuss the principle in the next section, where we will see that its consequences for the size of the bearers of natural properties are rather weak, both in content and in modal force; but in any case they don't follow analytically from the expected features of natural properties.

The idea that minimal entities are endowed with some sort of primacy in the causal links of reality and that some of their properties account for these *fundamental* joints of nature lead us to the cognate notion of fundamental property. Fundamental properties are akin to natural properties, and there are several texts where Lewis seems to treat “fundamental” and “natural” as interchangeable attributes.<sup>15</sup> However, when a property is characterized as “fundamental”, some considerations of economy are often involved.

The economy does not concern the single property but a class of properties providing an adequate grounding for something larger: properties are fundamental insofar as other properties (instantiated by other things or even by the same things) can be in some sense reduced to or made dependent upon them. Lewis's idea is roughly that non-natural, abundant properties can be reduced to natural ones, and in this sense naturalness and fundamentality are strictly connected. But the point of view of fundamentality involves the exclusion of those natural properties which, though non-conventional and relevant for natural laws, are not required in order to ground or explain a wider domain of properties: it is enough to consider a smaller domain of natural properties, leaving no explanatory roles for the others.

Fundamentality is a relative notion: a property is fundamental relative to a certain domain of properties, which should be grounded or explained by the fundamental ones. An example of such a domain could be the totality of properties instantiated by all the parts of a possible world  $w$ . In this case a property is fundamental in  $w$  if and only if it is natural and it is included in any basis upon which all the properties instantiated by all the parts of  $w$  are reduced.

<sup>15</sup> See the texts about Humean supervenience quoted in § 1.

Some connotations in the concept of fundamentality lean towards MB. The *fundamentum* is easily identified with a minimal level of complexity, instantiating certain basic properties. The minimal level of complexity gives us the basis upon which all the features (and the causal links) of bigger entities *supervene*. But still, except for the lexical connotations of the term “fundamental”, the entrenchment with minimality is a substantive philosophical thesis and not an analytic consequence of the concept of fundamentality, as we have defined it above relatively to a certain world. The intersection of any basis to which all the properties of every part of a world *w* can be reduced could include properties of entities of any size. The sizes could even be different in different worlds: for what follows from the mere definition of the concepts involved, the *fundamentum* could be given by atoms, electrons, molecules or organisms; the primacy of a certain level of complexity needs substantive arguments.

#### 4. Humean Supervenience: Weak and Strong

Humean supervenience was seen by Lewis as the core of his entire philosophical work. According to the already quoted “Introduction” to PPII, Lewis actually got interested in some philosophical topics just in order to motivate Humean supervenience and defend it from some possible objections. In that passage, Humean supervenience is formulated so that perfectly natural and fundamental properties constitute the basis for supervenience and are said to be instantiated by points or point-sized entities:

It is the doctrine that all there is to the world is a vast mosaic of local matters of particular fact, just one little thing and then another. [...] Maybe points of spacetime itself, maybe point-sized bits of matter or aether or fields, maybe both.<sup>16</sup>

It should be immediately noted that this is not as decisive a declaration in favor of MB as it seems. After all, what can be inferred about the identification of the bearers of natural properties? Only that *some* “minimal entities” instantiate the natural properties which are in the basis of Humean supervenience. It does not follow that no non-minimal entity instantiates natural properties as well. It does not follow, unless one also assumes that the

<sup>16</sup> PPII, pp. ix–x.

only theoretical purpose of the doctrine of natural properties on the whole is to lay down a basis for Humean supervenience. This is a crucial point in the debate, one that we firmly resist: natural properties are key also in defining duplication and recombination; they play a role which is not instrumental to supervenience, rather it could be the other way round. Humean supervenience is compatible with MB, but it cannot require that only minimal entities instantiate natural properties.

The consequences are a bit stronger if we turn our attention from naturalness to fundamentality. In the quoted passage Lewis does not distinguish between perfect naturalness and fundamentality. But, if the distinction between them we have drawn in §3 is accepted, then it seems that the most relevant notion with respect to the supervenience debate is fundamentality: the obvious aim is to identify a most economical basis upon which everything else supervenes. The perfectly natural properties – as identified by scientific investigation or by the heterogeneous theoretical needs which the doctrine of natural properties is called to satisfy – could be redundant; on the other hand, as we have seen, the requirement of economy and non-redundancy is somehow inscribed in the notion of fundamentality itself. So, in a not very informative sense, Humean supervenience suggests that no non-minimal entity instantiates fundamental properties, because if a property is not in the minimal supervenience basis then it can be natural, but not fundamental.

The consequences of Humean supervenience for our problem are weaker than expected and problematic. It remains to see that their weight depends on the epistemological status and the modal force of Humean supervenience itself. The programmatic formulation of the introduction to the PPII conceals a deeper articulation; Humean supervenience was not meant by Lewis as a monolithic thesis<sup>17</sup> and it comes in two main versions: a weaker core, which is *a priori* and concerns every possible world, and a stronger thesis, which is *a posteriori* and concerns only our world and other worlds sufficiently similar to ours. The paper where this distinction is carried over most clearly is *Humean Supervenience Debugged* (henceforth, HSD). The following is Lewis's formulation of the weak core (here labeled WHS, Weak Humean Supervenience):

<sup>17</sup> Cfr. also (Nolan, 2005, pp. 28–29).

If two possible worlds are discernible in any way at all, it must be because they differ in what things there are in them, or in how those things are. And “how things are” is fully given by the fundamental, perfectly natural, properties and relations that those things instantiate. (HSD, pp. 493–494.)

WHS is fully non-committal about the size or the complexity of the bearers of perfectly natural, fundamental properties (also in this case the two qualifications are treated as interchangeable.) With respect to the weak core, Humean supervenience in its strong version (SHS) is presented as “yet another speculative addition,” concerning our world and “worlds like ours”. The contents of this speculative addition are that: 1) the fundamental, perfectly natural properties are “local,” in the sense that they are instantiated by points or point-sized entities; 2) the relations involved are spatiotemporal.

The constraints about the size of the bearers come from 1), thus they inherit their epistemological status and modal force from SHS. As a result, the partial and problematic evidence in favor of MB licenses MB, at best, as a contingent thesis.

### 5. The principle of recombination in modal realism

Natural properties have a very important role in Lewis’s modal realism: they are called to make sure that for any possible way things might be there is a world where things are in that way. No genuine possibility should be passed over, otherwise, for example, our semantics risks licensing as necessarily true sentences which are only contingently so. This cardinal *desideratum* of modal realism is called *plenitude* in the first chapter<sup>18</sup> of OPW. Plenitude can not be simply stipulated, since worlds are expected to exist on their own, not as a consequence of a stipulation. Instead, plenitude needs to be grounded in an independently plausible metaphysical principle. Lewis thinks that this role can be played by the principle of recombination, according to which possible worlds are such that they respect our intuition that anything can coexist with anything and can fail to coexist with anything: according to this other broadly Humean intuition, there is no necessary coexistence between distinct entities. The totality of recombinations of distinct individuals should give us the expected plenitude of possible worlds.

<sup>18</sup> OPW, pp. 86–92.

Lewis's variety of modal realism cannot accommodate the intuition that anything can coexist with anything in the most straightforward way, that is admitting that any combination of pieces of possible worlds is itself a possible world.<sup>19</sup> Notoriously, Lewis's worlds do not overlap: no individual is in more than one possible world. As a result, the path to plenitude through the principle of recombination is a bit less direct and involves the admission of vicarious entities, called *duplicates*. A first, rough formulation of the principle could be the following:

PRINCIPLE OF RECOMBINATION: Given any choice of parts of possible worlds, there is a possible world, which includes a duplicate of each part and nothing else.

A duplicate of an entity is an entity adequately similar to it. The expected kind of similarity is different from that involved in the counterpart relation under two aspects. First, the relation of duplication ought to be fully determined and exempt from any kind of vagueness, otherwise the domain of available recombinations would have vague boundaries and plenitude would not be definitely attained. Second, the properties in common between duplicate entities should not require the presence, in the same possible world, of the duplicate of something else. We have seen that an intuition to be respected in order to get plenitude is that anything can fail to coexist with anything: for this reason, duplicates should be allowed to differ in extrinsic properties, that is properties whose instantiation requires that there is a certain other entity in the same world. Thus, duplicates are required to share only intrinsic properties.

According to Lewis, the required kind of definite and intrinsic similarity can be obtained by stipulating that two entities are duplicates if and only if they have all the perfectly natural properties in common. This leads us back to our problem: any part of world which is recombinable according to the principle of recombination should instantiate at least one perfectly natural

<sup>19</sup> An adequate discussion of the principle of recombination should deal also with some constraints of size. Lewis was well aware of the importance of these constraints (OPW, pp. 90–92), which have also been discussed in the literature about the principle of recombination. Our formulation ignores this problem for the sake of simplicity.

property, otherwise it would be impossible to identify its duplicates.<sup>20</sup> Thus, any entity that can be recombined is a bearer of some natural properties.

The problem is that it is not clear which entities are recombinable. In the provisional, rough formulation above, we have involved every part of every possible world. But perhaps it is possible to obtain just the same domain of possible worlds and the expected plenitude recombining only the smallest pieces. Lewis presents the principle of recombination quite cursorily in a few pages of OPW and does not say what should be recombined. There is an open debate about the most economic, adequate formulation of the principle of recombination<sup>21</sup> and the prevailing opinion seems to be that it is not enough to recombine the smallest pieces. We can not review here this debate and we mention only the simplest reason to doubt that atoms are enough: if there are worlds with no atoms (call them *gunkish worlds*) or where some parts of the world are not composed of atoms, then it is not clear how the principle of recombination should be applied to these worlds. If all or some of these *gunkish* worlds are not (vicariously) recombinable, then plenitude is unattained.

Anyway, it seems that no outcome of the debate about the principle of recombination would be really favorable to MB. If the principle of recombination needs to involve also bigger or more complex entities, then an important aspect of modal realism implies LB, since non-minimal entities need to have duplicates and thus to instantiate perfectly natural properties. If instead the atomistic formulation of the principle of recombination can be made plausible through some adjustments, then any atomic part of any possible world will instantiate at least one perfectly natural property. But, even in this scenario – which is seemingly unsympathetic with LB – we could not conclude that nothing else instantiates perfectly natural properties. As in the case of SHS in §4, the consequences are at most positive, but not negative: since perfectly natural properties are not introduced for the sole purposes of the principle of recombination, the principle can require that something instantiate natural properties, but can not exclude that something else instantiate them too.

<sup>20</sup> Two entities which do not instantiate any perfectly natural properties have trivially in common all their natural properties. This trivialization should be avoided in a proper definition of duplication, which is beyond our purposes in this paper.

<sup>21</sup> See in particular (Efrid & Stoneham, 2008) and (Darby & Watson, 2010).

Moreover, the principle of recombination is a problematic aspect of modal realism, and has been criticized under several points of view.<sup>22</sup> This discussion could make MB even less plausible. For example, let us consider a minimal part of our world: an electron. A duplicate of an electron in a given different world should share with it all its perfectly natural properties, such as its spin and charge. Does this guarantee that the duplicate of the electron is a *minimal* part of the given world? Why should the sharing of charge and spin imply that the duplicate of the electron has a point-like spatial extension or no proper part? If a minimal entity has a non-minimal entity as one of its duplicates, we get a non-minimal bearer of natural properties. This problem deserves closer attention than the one we can give it here. Nevertheless, a joint supporter of the principle of recombination and of MB has the burden of explaining why there is no relation of duplication of this kind.

## 6. Mereology and Gunk

We have seen that the worlds or parts of worlds which are not composed of atoms are problematic cases for the combination between MB and the principle of recombination in modal realism. The so-called *gunk* was admitted by Lewis as a genuine possibility. The admission of this possibility was deeply connected with Lewis's idea that classical mereology is just the general, exhaustive theory of ontological constitution. It is exhaustive not only in the sense that the hypothesis of a non-mereological kind of constitution is not tenable,<sup>23</sup> but also in the sense that all the kinds of constitution which are licensed by classical mereology are genuine possible ways in which a world might be. Classical mereology is not committed to atomicity, thus it is a genuine possibility that some entities (or even the world in its entirety) are not composed of atoms, so

<sup>22</sup> The following are some other problematic aspects of the principle of recombination: is the intuitive principle that anything can coexist with anything sufficient to guarantee plenitude? Is it enough to recombine pieces of possible worlds directly or should we require recombinations of properties themselves? Is the distinction between intrinsic and extrinsic properties really sharp? Is the sharing of perfectly natural properties a sufficient condition for the sharing of intrinsic properties and does it really allow for a free variation of extrinsic properties? We thank John Divers for the suggestion that an adequate formulation of the principle of recombination (one that provides genuine plenitude) could lead to an open rejection of MB, if not to the rejection of the doctrine of natural properties on the whole.

<sup>23</sup> Cfr. (Lewis, 1992).

that their proper parts have always still further proper parts. Via *plenitude*, it follows that there are worlds entirely or partially non-atomic.

In this section we argue that the incompatibility between the admission of *gunk* and MB is more general, while it is possible to combine *gunk* and LB in different ways. However, a preliminary clarification is needed. The admission of *gunk* can be easily seen as the rejection of minimal entities: if anything has still further parts, nothing is really minimal since there are always smaller things. However, the concept of minimality here at work is *prima facie* different from the one employed for example in the strong formulation of Humean supervenience, where the fundamental properties in the basis of supervenience were said to be instantiated by points or point-sized elements. In the case of SHS, the typical minimal entities are points.

What is a point? The question is difficult and, as far as we know, Lewis has never taken side or expressed an opinion in print about it. However, in the passages about SHS quoted above, the properties in the supervenience basis are said to be local because they are instantiated by points or point-sized entities. This suggests that points get involved insofar as they have a minimal extension (a minimal localization) in space and time.

Is it legitimate to identify points with mereological atoms? The answer to this question is pivotal for us. Indeed, in this and the following sections we are going to draw some conclusions from two mereological principles – the admission of *gunk* and the so-called thesis of composition as identity respectively. However, if the mereological characterization of minimality were completely extraneous to that presupposed in some important aspects of the doctrine of natural properties (such as the discussion of SHS), the consequences of the mereological principles could not interact with the outcome of our analysis in the previous sections.

And actually it is easy to point to examples of mereological atoms that are not points, even if the examples are unavoidably relative to one's ontological commitments. In Lewis's *Parts of Classes* for example, set-theoretical singletons have no proper parts, thus they are atoms: but the singleton of the number 0 has no spatiotemporal extension at all, because it is not an entity in the spatiotemporal domain. In some kinds of theories of universals, universals

are parts of the individuals instantiating the corresponding property.<sup>24</sup> Moreover some universals are simples (as they are not composed of other simpler universals.) These universals will be atoms, but the theory is still free to deny that they have any spatiotemporal extension at all: they are not points or point-sized entities in any sense. The theory of universals can provide also an example of a point-sized entity which is not a mereological atom: an electron with a negative charge (as we have seen, one of Lewis's preferred examples of minimal entity) would have the universal of negative charge as one of its parts; as a result it would not be a mereological atom.

However, it is easy to restrict mereological atomicity to the spatiotemporal domain. In general, a mereological atom is an entity which has no proper part. A spatiotemporal mereological atom will be an entity with a spatiotemporal extension which has no proper part with a spatiotemporal extension. In this sense the electron is a spatiotemporal mereological atom, while the singleton of the number 0 and the universal of negative charge are not spatiotemporal mereological atoms, since they have no spatiotemporal extension.

It is worth remarking that this restriction of mereological atomicity does not impair the validity of the principles of the mereological theory of constitution which we are going to review. The admission of *gunk* has no peculiar connection with sets or universals, and the most intuitive example of *gunk* is probably given by the indefinite divisibility of space. As for the thesis of composition as identity – which we are going to review in the next section – it concerns any kind of composition, including the most obvious cases of spatiotemporal parthood. It is thus legitimate to draw conclusions from these two mereological principles on the minimal or non-minimal size of the bearers of natural properties, with the *proviso* that the mereological minimality which is at play is not general mereological atomicity, but restricted spatiotemporal atomicity.

We can now proceed to evaluate the consequences of the admission of *gunk* on the size of the bearers of natural properties. If *gunkish* worlds (or parts of worlds) are admitted, the problems for MB are not limited to the best

<sup>24</sup> See for example (Armstrong, 1978), although it should be remarked that he changed mind on this point in later versions of his theory of universals. An analogous example could be easily built with tropes, since according to many trope-theorists – including the classic (Williams, 1953) – ordinary individuals are mereological sums of tropes.

formulation of the principle of recombination which we have discussed in §5. MB implies that no natural property is instantiated in a gunkish world or part of world. Yet, the lack of natural properties brings some problematic consequences with itself: gunk would be, so to say, inert – excluded from the domain of possible recombination, not relevantly similar to anything, devoid of causal powers. This scenario, if not provided with an independent motivation, seems unacceptable.

By contrast, LB can cope with *gunkish* worlds and parts of worlds in two general ways. There could be: 1) either an infinite descent of bearers of perfectly natural properties; 2) or a privileged level under which no natural property is instantiated. In a passage of *Against Structural Universals*, Lewis discusses briefly 1):

I note that class nominalism, with a primitive distinction between natural and unnatural classes, has no problem with infinite complexity. It might happen that whenever we have a natural class, its members are composite individuals, and their parts (and pairs, triples... of their parts) fall in turn into natural classes. (OPW, pp. 86–87)<sup>25</sup>

Here we can not discuss in depth the two options. We note only that both, when given an adequate articulation, are likely to provide a criterion for the identification of the bearers of natural properties which will be applicable also to non-gunkish worlds and parts of worlds. Once this criterion is conceded for the special case of gunk, the restriction of the criterion only to gunk seems arbitrary. The quotation above shows that Lewis concedes 1) for gunkish worlds or parts of worlds: how could he deny in a principled way that, even in fully atomic worlds, the bearers of natural properties are distributed at several levels of mereological complexity? On the other hand, the kind of criterion invoked in 2) will probably not be mereological, since, due to the transitivity of the relation of parthood in classical mereology, there is no mereologically

<sup>25</sup> The reference to class nominalism does not mean that 1) is compatible only with a certain stance on the problem of universals, namely with Lewis's own class nominalism. In the context of the quotation, Lewis is criticizing the reasons leading David Armstrong to admit structural universals. Lewis has already conceded that the theory of structural universals is able to cope satisfyingly with infinite complexity, but remarks here that class nominalism has no problem too. In the immediate following he observes also that "likewise a trope theory has no problem with infinite complexity". We quote the passage about class nominalism because it includes the most explicit admission of an infinite descent of bearers of natural properties.

privileged level, except the (eventual) level of atoms and the maximal level of the universe.<sup>26</sup> But if the invoked criterion is non-mereological (if it involves, for example, some kind of unity or cohesion), it is possible to wonder why should it be applied exclusively to gunkish worlds and parts of worlds. If the criterion works in this case, a specific, independent motivation for the restriction to these cases should be provided. In absence of such a motivation, LB can be indefinitely extended from gunkish to non-gunkish scenarios.

### 7. Composition as Identity and Boring Composition

According to a pivotal thesis of Lewis's *Parts of Classes* (henceforth, POC), composition is a kind of identity.<sup>27</sup> For this reason the thesis is usually labeled as CAI (composition as identity). The analogy between composition and strict one-one identity holds allegedly under several respects,<sup>28</sup> but only one of these points of resemblance is relevant for our purposes. It is the so-called *ease of description*,<sup>29</sup> according to which, once you have described exhaustively some entities, no further effort is required in order to describe exhaustively their sum. Conversely, an adequate description of a whole gives also an adequate description of its parts. Something analogous happens with one-one identity: when you describe an entity *x*, you describe *ipso facto* also everything which is identical to *x*.

Ease of description for one-one identity is a trivial consequence of the principle of indiscernibility of identicals, according to which identicals share all their properties; if an exhaustive description captures all the properties of an entity, no other property needs to be captured for those identical to it. However, in the case of composition, the principle of indiscernibility cannot hold, since it is very easy to point at properties instantiated by the whole but not by its parts (or *viceversa*): for example, as Lewis himself remarks, a piece of land is one, while the six parcels composing it are six.<sup>30</sup> Some properties can well be common to whole and parts (for example, both the parcels and the bigger piece are pieces of land), but in general the different ways of

<sup>26</sup> We have briefly discussed the maximalist-monist alternative in §2.

<sup>27</sup> Cfr. POC, pp. 81–87.

<sup>28</sup> See the paper by Carrara and Martino and the commentary on POC by Bohn in this volume for an overall analysis of CAI.

<sup>29</sup> POC, p. 85.

<sup>30</sup> POC, p. 87.

partitioning the same stuff bring with themselves many important, not only numerical properties. For example, let us suppose that the piece of land is rectangular while the six parcels are square.<sup>31</sup> Obviously, the rectangular piece of land is also the fusion of the two triangular pieces obtained tracing a diagonal of the rectangle. The two triangles, the six squares and the big rectangular piece of land differ not only in number, but also in the fact that in the first case we have triangles, in the second squares and in the third a rectangle.

How does ease of description work for composition, if indiscernibility does not hold in this case? Both the six squares and the two triangles of land *compose* the big piece of land. Thus, Lewis's thesis is that, for example, an exhaustive description of the six squares of land gives also an exhaustive description of the big rectangular piece and an exhaustive description of the two triangles; and the same happens if we begin with a description of any other partition. Lewis, in the few pages of *Parts of Classes* devoted to CAI, mentions explicitly some exceptions to indiscernibility between whole and parts, as a reason to restrict the analogy between composition and one-one identity: thus, he was clear that ease of description for composition does not rely on indiscernibility, but he does not say how it works instead. A plausible interpretation, quite consonant with Lewis's philosophy in general, is that ease of description is connected with supervenience: an adequate description of a certain partition of some stuff specifies the properties of that stuff partitioned in that way and, if there is more than one piece, the relations between different pieces. These properties and relations are not, in general, common to the other partitions of the same stuff; instead they *determine* the properties and the relations for the other partitions; thus, they determine what needs to be captured by an adequate description for them. Thus, for example, a description of the big rectangle of land gives also a description of the six squares not because it specifies also all their properties, but because it specifies the properties of the rectangle, which on their turn determine the properties of the square and the relations between them.

<sup>31</sup> This example is partially borrowed from the paper by Carrara and Martino in this volume (see their section 4, where – however – the composition is directly between geometrical items instead of pieces of land), but we interpret it in a different way.

According to an efficacious expression of Jonathan Schaffer,<sup>32</sup> composition as identity makes composition *boring*. When you go up and down through different levels of size and complexity in the mereological structure of reality, you never incur in surprises. An adequate description operated at a certain level of complexity and size is also an adequate description at any other (more or less fine-grained) level of complexity and size. This happens because the relevant features are co-determined: just specify them at a level whatsoever and those at any other level are immediately determined. In this light, we can define boring composition in terms of supervenience: composition is boring if and only if the properties of the whole supervene on the properties of the parts and the relations between them *as much as* the properties of the parts and the relations between them supervene on the properties of the whole.

Natural properties are obviously among the features captured by an adequate description: even if Lewis does not explain what exactly counts as an adequate description, it is reasonable to expect it to specify natural properties, which – as we know from §3 – account for relevant similarities and causal links. Now, CAI is not seen by Lewis as a restricted phenomenon: every composition is a kind of identity and is analogous to one-one identity also for what concerns ease of description. As a result, every case of composition comes out as boring. But if composition is always boring, on what basis should the properties of a certain level of size or complexity be deemed more natural? Composition as identity confirms what SHS, as we have seen in §4, literally says: all the relevant features of things of any size supervene on the relevant features of entities at the simplest, atomic level. But it adds something else, utterly incompatible with the idea that there is a fundamental level endowed with a sort of objective primacy: the relevant features of entities at the simplest atomic level supervene on the relevant features of entities at any other level.

When composition is boring and supervenience is symmetric, the properties of the compound are as natural and as fundamental as the properties of the components. Perhaps there could be still some epistemological strategy to advocate the idea that the properties at the atomic level enjoy some kind of explanatory primacy. Although according to composition as identity any level guarantees an adequate, exhaustive description, it could be epistemically convenient to provide a general criterion about the level at which we should

<sup>32</sup> Cfr. (Schaffer, 2003, p. 505).

start, and perhaps the atomic level is the easiest to identify. Still, there is no metaphysical motivation for this alleged primacy.

Composition as identity is incompatible with MB. Moreover it leads to an extreme version of LB. It is not that natural properties are spread sparsely at different levels, instantiated for example by unified bodies or organisms of some kind: natural properties are simply everywhere, instantiated at any level of complexity. This consequence could be in contrast with some pristine motivations of the supporters of LB. Perhaps, they wanted to show that some important, objective, irreducible properties are instantiated by complex, structured entities: *emergent* properties. These properties are emergent, by definition, insofar as they do not supervene on the properties of the constituents and the relations between them. Such kind of *emergentism* is likely to reject composition as identity and embrace LB; according to it, emergent properties – such as acidity and proprioception – are just irreducible natural properties instantiated by non-atomic entities. By contrast, composition as identity is a thesis typically endorsed by those – like Lewis – who are reluctant to admit emergent properties. The same idea of *boring composition* is the utter denial of emergentism: the surprises you do not incur in are just emergent properties.

It is interesting to remark that CAI and emergentism – while being two so radically different and exclusive views – share at least a consequence when conjoined with the doctrine of natural properties: the rejection of MB. For what concerns the size of the bearers, they differ only in the flavor of LB they license: while emergentism tends to attribute natural properties to unified or cohesive bodies, CAI scatters natural properties at every level of the compositional structure of reality.

## 8. Conclusion: Are MB and SHS Necessarily False?

The survey of the main metaphysical tenets in Lewis's metaphysics that are relevant to the question of the bearers of natural properties suggests several considerations. As for supervenience, SHS implies only that, in "worlds like ours" some point-sized entities are the bearers of natural properties; WHS instead is non committal about the bearers of natural properties. As for recombination, we have seen that the principle governing it does not clearly suggest that only atoms should be recombined and does not exclude that non-minimal entities are bearers of natural properties. On the other hand, the

admission of gunk provides a case where the restriction of natural properties to atomic bearers cannot happen *and* where any alternative to this restriction seems applicable also to non-gunkish situations. At the same time, CAI suggests that composition is “boring;” as a result, it is not clear why the properties of the whole should be less natural than the properties of its parts.

In this general picture, the destinies of MB and SHS are intertwined: if WHS is true, then MB is true only if SHS is true; if WHS holds and SHS fails, it is because there are non-atomic bearers of natural properties. Now, SHS is *at best* contingent: it does not follow from the theory of constitution, which holds necessarily. One possible move, adopted by Lewis and more recently endorsed by other authors<sup>33</sup> is to hold that SHS is true of the actual world. But this seems questionable for three reasons: 1) for all we know, the actual world may be gunkish (we have no principled way of ruling out this possibility); 2) if the restriction of natural properties to atomic bearers is waived for gunkish worlds, not to waive it for all worlds appears as calling for further justification; 3) boring composition (implied by CAI, which is meant as a necessary principle) rules against SHS.

On the score of these results, we conclude that nothing in Lewis’s metaphysics justifies the conclusion that, *necessarily*, only atoms are the bearers of natural properties. Lewis’s mereological theory of constitution suggests that natural properties are instantiated by entities of any level of complexity in most worlds; we have no principled way of telling whether our world is one of those. In Lewis’s metaphysics, there is a tension between CAI (boring composition) and SHS, even when the latter is regarded as a contingent claim. Unless the tension is resolved, both MB and SHS risk coming out as necessarily false.

<sup>33</sup> See for example (Nolan, 2005, pp. 28–29) and the supplement “The Contingency of Humean Supervenience” in (Hall 2010).

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