ULTIMATE-HUMEANISM*

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ABSTRACT

Super-Humeans (Esfeld & Deckert, 2017) argue that the most parsimonious ontology of the natural world compatible with our best physical theories consists exclusively of particles and the distance relations between them. This paper argues by contrast that Super-Humean reduction goes insufficiently far, by showing there to be a more parsimonious ontology compatible with physics: *Ultimate-Humeanism.* This novel view posits an ontology consisting solely of the particles and distance relations required for the existence of a single brain. Super-Humeans impose conditions on what counts as an ontology of the natural world to avoid their view slipping into this kind of ontology, but these conditions are arbitrarily imposed and once this is exposed, Super-Humeans face a dilemma. Either they can embrace Ultimate-Humeanism as the minimal ontology of the natural world compatible with physics, or (more likely) they can rethink the methodology that got them there. Overall, this paper argues that Super-Humeanism currently lacks principled motivation, outlines a framework for naturalistic ontological reductions, and exposes the consequences of unchecked adherence to a simplicity-driven methodology.

KEYWORDS

Super-Humeanism, naturalistic metaphysics, metaphysics of science, ontological reduction, minimal sufficiency, metaphysical compatibility with physics

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1.0 METHODOLOGICAL BACKGROUND

1.1 THE CANBERRA PLAN FOR PHYSICS

Inspired by the Canberra plan outlined by David Lewis (Lewis, 1986) and Frank Jackson (Jackson, 1994), Super-Humeans conceive of metaphysics as an ontological enterprise where once the fundamental parts of the ontology are explicated, all other parts of the ontology will be accounted for in terms of the fundamental. In this sense, the metaphysical goal Super-Humeans aim for is a classification of the fundamental entities in terms of which the rest of reality can be understood. To achieve this aim, a central distinction is established between two classes of fundamental and non-fundamental entities. For the former, Super-Humeans interpret physics as providing an account of reality's most basic constituents. For the latter, as many aspects of reality do not feature in the fundamental story, they are either eliminated from the ontological list or located elsewhere in it.

Location is the task of accounting for the implicit existence of the non-fundamental in terms of the explicit fundamental ontology. The Super-Humean methodological approach to location diverges somewhat from the traditional understanding of metaphysics as ontology. Notably, Michael Esfeld (Esfeld, 2020a, p. 126) conceives of location in terms of identity where the metaphysical task is to show how some features of reality are identical to others. Esfeld also makes the stronger claim that 'taking recent developments in metaphysics into account that have moved away from the notion of supervenience, "location" is in the following conceived in terms of identity' (Esfeld, 2020, p. 126). Whether location as identity is widespread in contemporary metaphysics does not matter for this paper; what is important is that Super-Humeans conceive of location in this way.

After establishing an identity relation between two distinct features, the ontology need only explicitly include one of them to implicitly include the other. Consider for example

chairs and *atoms arranged chair-wise*. If both exist, then these are either identical or not identical. If chairs are identical with atoms arranged chair-wise, then if chairs exist, the existence of atoms arranged chair-wise is nothing new and the ontological list does not expand. Inversely, if chairs are not identical with atoms arranged chair-wise, then if chairs exist, the existence of atoms arranged chair-wise is something new and will expand the ontology. This is how Esfeld conceives of location, but such adaptation does not depart significantly from the original proposal of Lewis and Jackson as similar ontological reductions can be achieved without positing identity as the locating relation.[1]

The Super-Humean methodology also pays closer attention to physics, and prizes minimality to a greater degree than Lewis and Jackson proposed. Physics is not merely taken into consideration, but the ontology ought to be 'in the position to tell a story how the established physical theories can be construed on the basis of such a minimalist ontology' (Esfeld, 2020b, p. 1891). For minimality, they build on Jackson's suggestion of not, 'letting a thousand flowers bloom but rather that of making do with as meagre a diet as possible' (Jackson, 1994, p. 25). These two features outline the sole principle guiding the Super-Humean project: minimal sufficiency. Where minimality is achieved by positing an ontology consisting of the fewest fundamental elements while employing location (or elimination), as described in the previous paragraph, to account for the non-fundamental; the minimal ontology posits the fewest fundamental entities and then locates the rest of reality's features in the fundamental. Sufficiency is achieved by the ontology being compatible with our most prominent physical theories. This includes a connection between our empirical observations and ontology that allows for our physical evidence to be understood in terms of the ontology, but further discussion of this

[1] Other relations could be used in place, e.g., Grounding or Supervenience.

qualification comes later in the paper. Overall, Super-Humeans interpret naturalistic metaphysics as targeting the most parsimonious physically adequate ontology. It is, for them, an enterprise designed to answer the following question: 'What is a minimal set of entities that form an ontology of the natural world, given what science tells us about the natural world?' (Esfeld, 2020a, p. 126).

1.2 Whose Minimum?

As Super-Humeans place high importance on minimality, it is imperative to clarify how one determines what counts as the simplest ontology. On distinction that is of particular importance, drawn by Alastair Wilson (Wilson, 2020), is between local and global minimums. The former is a preference for simpler theories within the bounds of any given ontology while the latter makes the stronger claim that no other ontological system is objectively simpler than it is: 'that no system entails the existence of objectively less stuff than it does' (Wilson, 2020, p. 587).

Consider, for example, a hiker trying to find their way down from a mountain range where they can only decide the direction to travel by assessing the gradient in the local vicinity. Where the range consists of many peaks and troughs, the hiker will most likely find themselves in a mountain lake or nearby valley, which is the lowest *nearby* point, but not the *absolute* lowest point. Depending on where one starts, the decent to the local minimum will lead to contrasting places at contrasting heights. The same goes for ontological reductions; the local minimum is relative to the bounds of the starting ontology and will lead to the nearest mountain lake while the global minimum is relative to all ontologies and will lead to the Mariana Trench.[2]

[2] This is known as 'Gradient Decent' in mathematics.

Although it might seem that Super-Humeans seek a minimum in comparison to any and all given ontologies of the natural world, they are at most targeting a local minimum and Esfeld and Deckert confirm that are only concerned with a local minimum in (Wilson, 2020, p. 588). It remains an open question whether other ontological systems entail the existence of objectively less stuff. This kind of comparison between global minimums would consider different fundamental elements, say for example, between Super-Humeanism's particles and Wallace and Timpson's Spacetime States (Wallace & Timpson, 2010). And when comparing the two ontologies there is no common standard to evaluate which is simpler as in general, it is difficult to establish a clear criterion for parsimonious evaluation between contrasting ontological systems; to say which local minimum is truly the most parsimonious. Ambiguities can also arise when evaluating parsimony between minimums within the same ontological system as different elements in the ontology can be reduced. This results in ontologies consisting of contrastive entities, both of which are simpler than the one they are a reduction of, but it being unclear (in comparison between them) which is simplest. In general, specifying a straightforward means of parsimonious evaluation between contrasting entities is prohibitively challenging.[3]

As such, one uncontentious way to establish that an ontology is simpler is if the reduced ontology is a strict subset of the original ontology. This is to say if at least one entity in the original ontology does not exist in the reductive ontology, then it is uncontroversially simpler. This method allows for straightforward evaluations of simplicity between ontologies. For example, if ontology *a* contains entities φ, ψ, and, ω: $a = \{\varphi, \psi, \omega\}$, and

[3] Sober (Sober, 1988, pp. 37-70) objects to the plausibility of evaluating the simplicity of theories independent of a given domain.

reductionists locate the element φ in ψ and ω to form the strict subset of *a*: $b = \{\psi, \omega\}$, we can state that *b* is more parsimonious than *a* as there is at least one element of *b* that is not in *a* while nothing additional has been added: $b \subsetneq a$. Likewise, if the reductionist goes a step further and locates ψ in ω to form the strict subset of *b*: $c = \{\omega\}$, we can state that *c* is more parsimonious than *b*: $c \subsetneq b$. As *c* is also a strict subset of *a*, it too is more parsimonious than *a*: $c \subsetneq a$. Here a hierarchy of simplicity emerges from the most proliferated, *a*, to the simpler *b*, to the simplest *c*, where parsimonious evaluations of the sort, *c* is simpler than *a*, hold without quarrel. This understanding of minimality will be utilised in this paper when assessing the ontological standards of minimality attained by Super-Humeanism. This application of the principle is apt for Super-Humeans (particularly given that they already acknowledge seeking a local minimum) and, although limiting the extent to which their ontology can claim to be the universal ontological minimum, it provides a robust and practical basis to carry out evaluations of simplicity.

1.3 End of the Line

The final part of the methodological background required is to establish a metametaphysical principle on the limitations of ontological reduction. For any reduction of a given ontology, there will be certain parts of the ontology that are denoted as indispensable; held fixed as bedrock commitments vital to the ontology. Yet, the indispensable parts ought to have a good reason for why they need to remain. Otherwise, when one embraces the search for minimality there is little reason to stop the reduction anywhere but at the absolute minimal reduction. This is of primary concern for individuals who aim to reduce an ontology that already possesses the virtue of being simpler than others; those that push the boundary for minimality further. In these cases,

there is disagreement about where the reduction ought to stop and what parts of the ontology are indispensable.

A wide range of considerations might be drawn upon to enforce a particular stopping point, but the stopping point should not be arbitrary. When searching for minimality there ought to be a well-motivated end to the reduction. Otherwise, *ceteris paribus*, if it is permissible to assign ad-hoc bedrock status to any part of the ontology, all reductions could be avoided by affirming any elements up for location as bedrock commitments. When there are competing reductive ontologies with different stopping points, if the less parsimonious one does not have a well-motivated stopping point, then there is nothing to prevent its collapse into the more parsimonious one. Conversely, if the more parsimonious one does not have a well-motivated stopping point, then there is nothing preventing similarly arbitrary conditions from being imposed on the entities it aspires to reduce.

2.0 THE SEARCH FOR MINIMALITY

2.1 NON-HUMEANISM

To begin exploring the Super-Humean ontological reduction we must first identify the ontology for which they aspire to derive a minimally sufficient version. That ontology is materialistic and based on fundamental physics and can be expressed as consisting of three distinct elements. First, there are localised particles that instantiate properties. It is worth noting right away that competing physical ontologies might posit fields (in addition to or in place of particles) as part of the fundamental ontology but Super-Humeans believe these elements reduce to particles (e.g., they endorse a particle interpretation of quantum field theory (Deckert, et al., 2019)). As this debate can be side-stepped here, for clarity I

will assume Super-Humeans are successful in this reduction and that particles are all that is required.[4]

Second, the particles instantiate properties. Some of these properties are intrinsic to the particles and physics provides some prominent candidates for these e.g., mass, charge, etc. Other properties are external and denote spatial-temporal relations between particles that arrange them on a space-time manifold. The resulting configuration of particles exhibits certain patterns of behaviour, or regularities e.g., charged particles repelling, particles with mass attracting, etc. Physicists then use these regularities as the basis for defining the laws of nature. The laws are the third and final part of the starting ontology that contains the following elements:

non-Humeanism (NH) = {Space-time Particle Manifold, Properties, Laws}

The significant aspect of this view is that the laws of nature are fundamental.[5] Laws are given such status by non-Humeans for various reasons, but they all share the common theme affirming that the modal facts arise before the regularities; that the laws govern the regularities and explain why the particle configuration exhibits such patterns.[6] non-Humeans believe that the laws of nature are bedrock commitments indispensable to the ontology but regardless, their ontology merely serves here as the starting point for Super-Humean reductionism.

[4] Conversely, (Caulton, 2018) argues that Super-Humeans are unsuccessful in this regard. (Bhogal & Perry, 2017) provide an alternative Humean method of dealing with the non-localised posits of quantum mechanics while also discussing the Super-Humean approach (and raising some problems).

[5] The story for dispositionalists (e.g. (Bird, 2007)), who are anti-Humean but take the laws to stem from the dispositional essence of properties, would be slightly different. The elements that are reduced would be the dispositional essences instead of laws. This makes little difference to the dialectic here and a Humean reduction is still applicable. For the sake of clarity, I will set the disposition view aside.

[6] Some views invoke god, others structure imposing primitives, and others dispositional essences; see (Hildebrand, 2020) for a summary of these views.

2.2 HUMEANISM

Before Super-Humeanism lies regular Humeanism. Humeans deny that laws of nature are part of the fundamental ontology. To achieve this reduction a systems approach to laws is adopted: notably, the best systems account endorsed by Lewis (Lewis, 1994a, pp. 478-480) whereby laws are located in true generalisations of regularities that capture the best combination of simplicity and strength in that world. Laws, for Humeans, are nothing more than nomological parameters employed by us to systematise the regularities. They play no role in governing patterns in the property instantiating particle manifold and arise after, not prior to the regularities.

Importantly, Humeanism achieves greater simplicity by locating one element of non-Humeanism, resulting in an ontology consisting of the following elements:

Humeanism (H) = {Space-time Particle Manifold, Properties}

As $H \subsetneq NH$, together with the definition of minimality outlined previously in this paper affirming that strict subsets of ontologies are unquestionably simpler, we can conclude that Humeanism is more parsimonious than non-Humeanism. Then, recalling the guiding maxim of minimal sufficiency, if it is possible to construct our best physical theories from this ontology, it ought to be preferred over non-Humeanism. As will be shown in the next section, our best physical theories can be constructed from an ontology that is a strict subset of Humeanism and therefore, it has all the ontological resources (and more) available to meet the standards of sufficiency.

2.3 SUPER-HUMEANISM

Next, Super-Humeans (Esfeld & Deckert, 2017) go a step further than Humeans and locate some properties. Specifically, they locate the intrinsic properties into the property

of standing in an external relation to all other particles. The intrinsic properties are understood as nothing more than arrangements of particles where the external relation of being in a particular place relative to all other particles is identical to the particle's instantiating a property. For example, where a Humean asserts that the property of mass is instantiated by a particle, a Super-Humean asserts that mass is identical with a particular configuration of particles. As a result, their ontology only consists of particles and the external relations between them. To express the gain in ontological simplicity, it is first worth individuating the plurality of properties in the Humean ontology:

$$H = \{\text{Space-time Particle Manifold, Property}_1, \text{Property}_2, \ldots, \text{Property}_n\}$$

Then, the Super-Humean locates all other properties into one property of being in an external relation to all other particles:

$$\textit{Flat-Humeanism (FH)} = \{\text{Space-time Particle Manifold, External Relations}\}$$

Yet, I have named this view Flat-Humeanism because this is not exactly the Super-Humean position. Their reduction goes even further, applying not only to some properties but also to some particles in the space-time particle manifold.

While there are some Humean approaches according to which laws are underdetermined before the end of time, leaving the future open (Beebee & Mele, 2002), Humeans generally posit a four-dimensional configuration of particles that consists of many three-dimensional layers. This commitment is clear to see in Lewis's work as he asserts that it is the totality of manifest matters of particular fact that form the basis that generalised laws are based on. The mosaic contains all past, present, and future space-time points:

> 'the neo-Humean thesis that every contingent truth about a world—law, dependency hypothesis, or what you will—holds somehow in virtue of that

> world's total history of manifest matters of particular fact. Same history, same everything.' (Lewis, 1981, p. 20)

The laws that result are those that provide the best systematisation of this totality and capture the simplest and most informative representation of the regularities that can be found throughout all times. In contrast, Super-Humeans only posit a single spatial configuration of particles that changes. Or in other words, Humeanism is Eternalist and Super-Humeanism is Presentist. Briefly, Eternalism is the view that everything exists regardless of its temporal location; entities in the past, present, and future all exist simpliciter. Presentism is commonly formulated as the view that only present entities exist; there are no non-present basic constituents.

While the Flat view appears tenable, the Super-Humean doctrine is formulated solely with spatial relations and only one spatial configuration of particles instead of spatiotemporal relations and many temporally distinct particle configurations (Esfeld, 2020b, p. 1894). Super-Humeanism is expressed in this manner because they claim it is ontologically more parsimonious; each time slice contains more particles and therefore is an addition to the ontology. As they write, 'Presentism, thus conceived, is the most simple and parsimonious ontology, since only one configuration exists' (Esfeld & Deckert, 2017, pp. 151-152). As Simpson notes, presentism appears to be Esfeld's view: 'This suggests super-Humeans should adopt something like the A-theory of time, in which there is only one configuration of particles that exists at the present moment. (This appears to be Esfeld's position.)' (Simpson, 2021, p. 903). Similar remarks are made by Super-Humeans in other papers (Esfeld, 2020b, p. 1895).

To once more precisify the gain in simplicity, it is worth individuating the space-time particle manifold into individual particle configurations indexed to different times:

> *FH* = {Configuration$_{t1}$, Configuration$_{t2}$, …, Configuration$_{tn}$, External (Spatial-Temporal) relations}

Then, if Configuration$_1$ is taken to be the present particle configuration, the proper Super-Humean position can be expressed as follows:

> *Super-Humeanism (SH)* = {Configuration$_1$, External (Spatial-Distance) Relations}

To specify exactly as Super-Humeans do, their view consists of only two axioms:

1. There are distance relations that individuate simple objects, namely matter points.
2. The matter points are permanent, with the distances between them changing. (Esfeld & Deckert, 2017, p. 4)

The first axiom specifies that the ontology contains particles arranged into a spatial configuration and the second, specifies they are enduring entities whose sole feature is the distance they stand to all other particles. I see no serious issues with the first axiom; with adopting a particle ontology and differentiating them solely by distance relations. In this regard, I will raise no issue with whether Super-Humeans are successful with their reduction and accept that particles and distance relations are identical with intrinsic properties e.g., that they can give an account of mass in terms of a particular pattern in the changing particle configuration.

However, the second axiom complicates matters of minimality as change was not included in the Humean ontology and therefore, the ontology of Super-Humeanism is not

a strict subset of the Humean ontology. Change has been introduced as a distinct element in Super-Humeanism that was not an element in Humeanism (or any other previous ontology). Perhaps there is ground for objection on the basis that there is no clear way of determining whether one changing spatial configuration is more parsimonious than many static ones. They are different types of things, and no clear methodology is given for how to evaluate these discrepancies. There are also differences with the reduction of past and future spatial configurations as they are not located in the present configuration but are instead eliminated as redundant ontological commitments, superfluous to meeting the criteria of sufficiency. I will not engage with these worries here.[7] Instead, I will discount primitive change as an element in the ontological set, focusing on the gain in simplicity achieved because there are fewer configurations, while also highlighting that Super-Humean reductive methodology is not restricted to location but also includes the elimination of everything beyond that required for sufficiency.

That said, parsimony has increased in two respects: fewer properties and fewer particles. As an ontology is simpler when it reduces or eliminates elements from another ontology while adding nothing new, and Super-Humeanism reduces intrinsic properties and eliminates non-present particles, it is simpler. In other words, the Super-Humean ontology is a strict subset of the Humean ontology: $SH \subsetneq H$. Following the methodology, as Super-Humeanism achieves greater parsimony, if it is possible to construct our best physical theories from it, it ought to be preferred.[8]

[7] Marmodoro (Marmodoro, 2018) engages worries like these, particularly the notion of change.

[8] Avoiding the 'baroque' metaphysics in Lewis's adoption of quiddities is another advantage Esfeld and Deckert claim over Humeanism (Esfeld & Deckert, 2017, p. 46). Yet, this is more an expression of disapproval than a critique. Putnam criticises Lewis's realist metaphysics for sounding 'medieval' (Lewis, 1984, p. 229), to which Lewis's response can be neatly adapted here: 'what's wrong with sounding baroque? More power to the baroque metaphysicians.' Similar reasoning is employed by (Andrews, 2023) in defence

Esfeld and Deckert proceed with a rigorous examination of prominent contemporary theories of fundamental physics and demonstrate that they can be accounted for in terms of their particle-only ontology. For example, they endorse a conception of quantum field theory compatible with permanent matter points and relational space (Esfeld & Deckert, 2017, pp. 99-130) and similar investigations are conducted for quantum mechanics and relativistic physics (Esfeld & Deckert, 2017, pp. 59-98 & 131-166). Super-Humeans demonstrate how our best physical theories are constructed from their ontology, building our physical theories from a presently changing particle configuration. Chiefly, Super-Humeans are capable of deriving (in a metaphysical sense) a complete account of our best contemporary physical theories from the complete Super-Humean particle mosaic. To explore how they achieve this it is first worth detailing the considerations in the background of their epistemology and their precise formulation of sufficiency.

2.4 SUFFICIENCY

The Super-Humean methodology affirms that an ontology is sufficient if we can construct our best physical theories from it, but the specific conditions for sufficiency are more nuanced. Notably, a prevalent assumption that underscores the Super-Humean particle-based ontology is the belief that all experimental evidence is of particles and the changing distance relations between them: 'To put it in a nutshell, particle evidence is best explained in terms of particle ontology' (Esfeld & Deckert, 2017, p. 33). Initially, this stipulation raises some circularity worries as the evidential support for the Super-Humean ontology is derived from interpreting physics in a way that only arises if one first assumes a preferential ontology: particle ontology is adopted in part because our physical evidence

of Lewis's realism about natural properties. Also see, (Darby, 2018) for further discussion on this supposed advantage.

is about particles, while part of the reason for conceiving of our evidence as particles is because it is best explained in terms of a particle ontology.[9] It is equally plausible for proponents of contrasting ontological systems to make analogous claims: a field ontology is adopted in part because our physical evidence is about fields and part of the reason for conceiving of our evidence this way is because it is best explained in terms of a field ontology.

So, to support their suggested interpretation of our evidence, Esfeld and Deckert expand on sufficiency by suggesting that the ontology must be connected to observable facts (where observable facts are, for example, dots displayed on a screen as the results of the double slit experiment in quantum mechanics). An explanatory chain is required that connects our empirical observations to the ontology; one that allows us to interpret our evidence as really being about what sits at the end of this chain. Start by explaining the observable facts in virtue of neuroscientific facts, and on to facts about molecular biology, chemistry, and statistical physics of large ensembles of elementary particles, before finally reaching the ontological facts: fundamental particle physics (understood as nothing more than particles and distance relations).[10] Their core claim is that the *best* explanation of our observable facts is found by interpreting our evidence to ultimately be about particles and their spatial configuration. It is noteworthy to underline that what counts as the 'best' explanation is being presented in a Super-Humean light as simplicity partly determines the best explanation: 'The simplicity and parsimony of this proposal are part of the case for its being the best explanation' (Esfeld & Deckert, 2017, p. 33).

[9] (Wilson, 2020, p. 585) also raises a similar circularity objection.

[10] This compositional chain is suggested by Esfeld and Deckert (Esfeld & Deckert, 2017, p. 32).

To summarise, in addition to being able to interpret physics in terms of the proposed ontology, an explanatory connection must be established between the proposed ontology and observable facts. This connection allows for our evidence to be conceived of in terms of the proposed ontology. Thus, when Esfeld and Deckert state that an ontology must be empirically adequate (Esfeld & Deckert, 2017, p. 3), what they have in mind is the establishment of a causal chain connecting the epistemologically evident facts to the ontology via the best explanatory causal chain, for which 'best' is determined in part by simplicity.

3.0 ULTIMATE-HUMEANISM

3.1 THE FINAL REDUCTION

Having established both a clear means of assessing ontological minimality and fleshing out the Super-Humean sufficiency requirement, it stands to reason that if an alternative ontology achieves greater simplicity while also being sufficient, it takes precedence over Super-Humeanism. To approach this goal, a further reduction of elements in the Super-Humean ontological set is required. This can be achieved by separating the present particle configuration (Configuration_1) into individual particles indexed to a particular spatial location relative to all other present particles:

$$SH = \{\text{Particle}_1, \text{Particle}_2, \ldots, \text{Particle}_n, \text{Spatial Distance Relations}\}$$

From here, one obvious means of attaining greater minimality is to eliminate all but one particle to form the following ontology:

$$\textit{Absolute Humeanism} = \{\text{Particle}_1\}$$

Such a view is arguably the simplest ontology attainable but whether such ontology is sufficient is doubtful. One would need to assume a kind of ontological monism (e.g.,

(Schaffer, 2010)) and then connect the singular entity to the observable facts. Yet, in the Super-Humean case, it is the plurality of individual particles in a changing configuration that explains the observable facts. Some adaptation might be plausible by treating the configuration as an indivisible entity (as is discussed and rejected by (Esfeld & Deckert, 2017, p. 28)), but this would either result in a contrasting non-local minimum ontology or lack a plausible explanation of the observable facts. Instead, a more plausible ontology consists of the particles required for the existence of a single human brain:

> *Ultimate-Humeanism (UH)* = {Particle_1, Particle_2, …, $\text{Particle}_{\text{<enough for a brain>}}$, Spatial Distance Relations}

This view consists of some particles in a changing configuration such that they constitute the macroscopic stability of a human brain and the manifestation of a phenomenology that includes conscious experience (assuming consciousness supervenes on the brain and the falsity of the extended mind thesis).[11] Everything else, all laws, all intrinsic properties, all non-present particles, and all non-brain present particles are nothing more than nomological parameters that feature in the explanation of the motion of the brain-particles but are themselves not part of the ontology. So, in addition to the Super-Humean reduction, Ultimate-Humeans assert that particles outside the brain are identical with a particular configuration of changing brain-particles, and are therefore no addition to the ontology. Where a Super-Humean thinks the property of charge is nothing more than a fictitious entity, merely a collection of particles in a changing configuration, the Ultimate-Humean thinks that all particles outside of a brain are nothing more than fictitious entities,

[11] This is a mainstream and uncontroversial assumption that while worth explicitly noting is not something I will argue for. Relatedly, Lewis makes similar arguments for the supervenience of mind on the brain in (Lewis, 1994b).

merely collections of brain-particles in a changing configuration. Just as the Super-Humean asserts that admitting mass and charge as intrinsic properties of particles introduces surplus structure to the ontology, the Ultimate-Humean asserts that admitting all present particles also introduces surplus structure to the ontology.

As the goal here is to show that proper adherence to the Super-Humean methodology results in Ultimate-Humeanism, it is important to address any potential disanalogies between the Ultimate-Humean reduction and the Super-Humean reduction. To begin, concern with the reductive analogy might arise as the Ultimate-Humean reduction applies to particles and not properties. Yet, Ultimate-Humeanism constitutes a similar kind of reduction that is just applied to a different element in the ontological set. Where Super-Humeans go from all properties to one, Ultimate Humeans go from all particles to some. Additionally, Super-Humeans already reduce non-present particles in their adoption of presentism and if comparisons of minimality are to hold between Eternalist Humeanism and Presentist Super-Humeanism, the Super-Humean reduction already applies to particles.

There also might be resistance to Ultimate-Humeanism's discriminative privileging of some particles, the brain-particles, over others, with the consequence that the reduction is mistakenly dissimilar from that which Super-Humeans endorse. Yet, once more Super-Humeans do the same thing with properties by discriminatively privileging one property, the distance relations, over others. The same is true for non-present particle configurations as Super-Humeans are selecting only some of a certain element to serve in their ontology: only the *present* particle configuration. Overall, Super-Humeans are selective about some temporally distinct particles (and one type of external property) but not others and Ultimate-Humeans are selective about some spatially distinct particles but not others.

Lastly, as Ultimate-Humeanism does not attain greater simplicity by locating a different type of element but only by locating a token quantity of the same type, disanalogy may again arise. Super-Humeanism goes from many different types of properties to only one. Ultimate Humeanism goes from one type of thing (a spatial totality of particles) to a smaller totality of that type (only some of those particles). If a gain in simplicity only matters when there are fewer kinds of entities and not when there is less of the same kind of entity, the reductive analogy fractures. Yet again, problems with this reasoning arise. When Super-Humeans adopt presentism, they commit to a smaller number of particles (only the present ones) and claim it to be preferable because of the gain in simplicity. Further, any claim that present particles are of a different type to non-present particles will allow Ultimate-Humeans the same thought: brain-particles are of a different type to non-brain-particles. Either way, it is preferable to have fewer of the same type, or brain-particles are a different type.

These *prima facie* issues aside, the Ultimate-Humean ontology is easily assessable as more parsimonious than Super-Humeanism since it dispenses with elements from the Super-Humean ontology while adding nothing new: UH $\subsetneq$ SH. Therefore, it follows from the Super-Humean guiding principle of minimal sufficiency that if Ultimate-Humeanism satisfies the criteria of sufficiency, it ought to be preferred over Super-Humeanism.

To begin demonstrating Ultimate-Humeanism's sufficiency, no drastic alterations are required to the Super-Humean account. We begin by interpreting physics as being about particles and distance relations. Our best physical theories are constructed in the same way from relative particle movement. Nothing changes in this respect and as such, compatibility with our best physical theories translates over from Super-Humeanism. The sole change in the ontology is that the number of particles is reduced but the same

principles employed by Super-Humeans when accounting for physics in terms of particles and distance relations still apply. They build the basic principles of physics from a totality of particles and relative distance, and likewise, for Ultimate-Humeanism, there is still a totality of particles that stand in relative distance to each other such that allows them to build the basic principles of physics in the same way. Only, in this case, the totality of particles stops at the edge of the brain (further discussion of Ultimate-Humeanism's compatibility with physics can be found in §3.4,).

From here, the observable facts need to be connected to the ontology such that we can interpret our evidence as ultimately being about the Ultimate-Humean ontology. This causal chain starts with the observable facts and runs down through neuroscience, molecular biology, chemistry, statistical physics of large ensembles of elementary particles, and finally to fundamental particle physics (understood as nothing more than brain-particles and distance relations). Ultimate-Humeanism commits to a causal chain connecting the observable facts solely to brain-particles such that fundamental particle physics is interpreted as being about nothing more than brain-particle configurations. This is a similar level of support to that which Super-Humeans give for interpreting physics to be about nothing more than particle movement. So, if Super-Humeans can claim that their causal chain explains why our evidence is all about particles, then the Ultimate-Humean can claim that their causal chain explains why our evidence is all about brain-particles. Ultimate-Humeanism is capable of both constructing our best physical theories from their ontology and explaining how the observable facts connect to the ontology.

On the Ultimate-Humean model, the causal chain never extends beyond the brain to explain the observable facts; the dots displayed as the results of the double-slit experiment are explained as being about a particular group of neurons that constitute the experience

of those dots. We need not go beyond the brain by further stipulating that facts about particles in a vacuum chamber cause a particular configuration of light to be emitted from the display screen, which in turn causes photons to reach the back of an eye such that they then cause the neurons to cause experiences. The Ultimate-Humean causal chain is far simpler (and the ontology overall) and as a result, is a better explanation of the observable facts. This correspondingly justifies the initial ontological assumption for interpreting our evidence in a way preferential to Ultimate-Humeanism; for interpreting our evidence to only be about brain-particles. In short: the reason our evidence is only evidence of brain-particles and not of all particles is that when our evidence is of brain-particles, the explanation is simpler.

To summarise, Ultimate-Humeanism is minimally sufficient. It is a simpler ontology whereby all elements that are not brain-particles figure in the explanation of the motion of brain-particles, but they are not themselves part of the ontology. All experimental evidence in fundamental physics is conceived of as evidence of relative brain-particle positions and the change of these positions. Ultimate-Humeanism is, true to its name, the implementation of the Humean reductive doctrine to its sufficient maximum.

3.2 Scientific Realism

With the positive proposal outlined, I will now consider some prominent concerns. First, one might try to undermine my argument by reaffirming Super-Humeanism to be a realist venture. Super-Humeanism is confined to deriving a minimal ontology after assuming realism about the external world – to deriving the most parsimonious ontology where other brains, dogs, houses, etc. physically exist. Ultimate-Humeanism might seem to conflict with this realist project as those physical objects become nothing more than brain-particles and their movement. However, this is not the same as asserting that they do not

physically exist. Recall that we are engaging in the enterprise of 'location' and not 'elimination'. Super-Humeans and Ultimate-Humeans both start from the realist assumption that the physical world exists, that entities alike other brains, dogs, houses, etc. are real, and both also reduce them down to something more fundamental without eliminating them from the physical world. Ultimate-Humeans simply push the reduction further, but this does not diverge from the Super-Humean's realist starting point; asserting that a dog is to be understood as nothing more than brain-particle movement does not deny that the dog exists any more than asserting that a dog is to be understood as nothing more than particle movement. Dogs are represented in both views but accounted for as being identical with different parts of the proposed ontology.

Similarly, one might respond by appealing to Esfeld and Deckert's claim that Super-Humeanism is a form of scientific realism (Esfeld & Deckert, 2017, p. 50), and affirming that Super-Humeanism is confined to deriving a minimal ontology after assuming scientific realism. Again, Ultimate-Humeanism may seem to conflict with this assertion. However, the method used by Super-Humeans to retain scientific realism for their position is also applicable to Ultimate-Humeanism. The reason that 'Humeanism' features in Super-Humeanism is to allow them to maintain scientific realism without also making ontological commitments to the nomological parameters used in scientific theories. As they write:

> 'Humeanism enters the proposal sketched out here only as a strategy […] to maintain scientific realism without building ontological commitments on the representational means that physical theories employ' (Esfeld & Deckert, 2017, p. 56)

To clarify this proposal, for any scientific theory, there is a distinction to be drawn between the primitive variables that refer to what exists in the world – the primitive ontology (and primitive dynamic structure) – and the nomological parameters that are located in that primitive ontology. One remains a realist about the science by interpreting the nomological factors in an explicitly Humean sense. That beyond the primitive ontology is not eliminated from the ontology but understood as being identical with other elements in the primitive ontology.

The Super-Humean's primitive ontology consists solely of particles (and their primitive change) and the rest of science is accounted for in nothing more than that primitive ontology (Esfeld & Deckert, 2017, p. 8). The rest of science is still 'real' but understood solely in terms of particles and their primitive change. Ultimate-Humeans follow suit by characterising a primitive ontology of brain-particles (and their primitive change) while placing the non-brain particles alongside the rest of science – all of which are mere nomological factors that feature in the representation but are themselves not part of the ontology. The non-brain particles are still 'real' but understood solely in terms of brain-particles and their primitive change.

Super-Humeanism and Ultimate-Humeanism reduce many hitherto ontological proposals of science to little more than particle movement. However, locating scientific elements elsewhere is not the same as denying their existence. Both proposals employ Humeanism in the same way to maintain scientific realism without building ontological commitment on the representational means that physical theories employ. Granted Ultimate-Humeanism puts more on the side of mere nomological matters but that is still fully compatible with the Humean approach and allows both views to retain scientific realism. If this style of Humean reasoning works for Super-Humeans then, without principled

(non-arbitrary) support in the methodology, the same approach will work for Ultimate-Humeans.

3.3 The Natural World

Beyond an appeal to realism (scientific or otherwise), Esfeld and Deckert use another constraint to restrict what elements are viable candidates for location. They state that they seek a minimal ontology of the *natural world*, and 'by the natural world, we mean the physical, spatially extended world' (Esfeld & Deckert, 2017, p. 8). The scope of Esfeld and Deckert's project is explicitly confined to what they define as the 'natural world', which they base the Cartesian criteria for matter that includes extension and motion: *res extensa*. (Esfeld & Deckert, 2017, p. 3). In fact, this is their chief defence against those who would seek to pursue the ontological reduction any further as they write: 'less won't do for an ontology of the natural world' (Esfeld & Deckert, 2017, p. 8). This constraint is a key part of Esfeld and Deckert's methodology and its implementation is chiefly to prevent Super-Humean ontology from being reduced any further. Hence, it is crucial to respond if my argument, which aims to show how Super-Humean methodology leads to Ultimate-Humeanism, is to be viable.

It may seem *prima facie* that Ultimate-Humeanism fails to provide an ontology of the natural world, a world that includes extension and motion, but that is not the case. To address both charges, first on extension, Ultimate-Humeanism is a reduction to the particles in a brain and brains are spatially extended. The reduction is not to minds, to matter *res cogitans,* but to a strictly smaller area of matter *res extensa*. Second, on motion, there is just as much moving, even if not as much stuff that moves, in Ultimate-Humeanism as there is in Super-Humeanism. The ontology consists of particles in a configuration of changing distance relations just as Super-Humean does.

Super-Humeans single out distance relations because they provide for spatial extension (Esfeld & Deckert, 2017, p. 21). They also ask for this relation to form a configuration that characterises the physical world and for it to allow for the creation of empirically adequate theories (Esfeld & Deckert, 2017, p. 162). All these requirements are satisfied by Ultimate-Humeanism as it is an ontology consisting of those same distance relations. There is still a particle configuration that makes up a physical world – not solely of minds but of a spatially extended particle configuration – which in conjunction with their dynamic evolution can satisfy the Super-Humean request for empirical adequacy (as shown at the end of §3.1). Ultimately, Ultimate-Humeanism squares with the criteria set out for the natural world.

Moreover, even though Ultimate-Humeanism is compatible with the Cartesian constraint, there are questions to be asked of the constraint itself. It is a principle that uniquely identifies extension and motion as the parts of our evidence that serve as a guide to ontology. Yet, these criteria are selected based solely on an *a priori* principle that connects them to the natural world without an independent justification. Other parts of our evidence could be elevated in this fashion and serve a corresponding role as a guide to the ontology of the natural world. For example, colour forms a ubiquitous part of our empirical evidence and could be privileged such that it plays a critical role in determining what counts as an ontology of the natural world: matter as *res pigmentum*.[12] Are macroscopic objects not part of our empirical evidence? One could equally favour the content of our evidence of tables and require their inclusion in the definition of the natural

[12] To support colour's ubiquity, even agents with achromatopsia can perceive the colours black and white and differentiate between shades of grey in a way analogous to those with colour vision.

world: matter as *res mensa*. Overall, reductionism is not acceptably constrained to a natural world defined by cherry-picking parts of our evidence to privilege.

Consequently, the natural world, even when understood within the scope of the Super-Humean project, does not require *all* present particles. From here, continuing to stipulate that an ontology must extend across all of space is an unjustified claim about what elements of the ontology are indispensable. If this move is permitted, then there is just as much reason for the Humeans, or non-Humeans to assign bedrock status to the parts of the ontology Super-Humeans aspire to reduce. The question here in its most succinct form is as follows: why must we keep all matter? And Super-Humeans lack a good answer.

3.4 Limitations on Reinterpreting Physics

Absent Descartes' authority, Super-Humeans lack a principled reason to differentiate between the elements they deem nothing more than nomic bookkeeping devices and those they deem part of the ontological fabric. An appeal to physics, resistance to Ultimate-Humeanism's pervasive reinterpretation of physics as nothing more than a guide to the present particle configuration in a brain, might underscore a response that would permit Super-Humeans the distinction they seek. Yet, if Ultimate-Humeanism results in a malformed physics that has been reinterpreted to a greater extent than acceptable, the Super-Humean reinterpretation of physics as nothing more than a guide to the behaviour of present particles and their distance relations falls afoul of similar criticism.[13] Most prominently, there ought to be principled reasons affirming when reinterpretations of physics are excessive, and a demonstration that Ultimate-Humeanism infringes them

[13] Super-Humeans appear capable of reinterpreting physics such that physics could never rule out their ontology; (Matarese, 2020b) argues that these worries are particularly damming for a view prised for its naturalism.

while Super-Humeanism does not. Such (non-arbitrary) distinction is not easily forthcoming and without it, the Ultimate-Humean reinterpretation is not freely dismissed.

To clarify, it is worth explicitly distinguishing between simplicity in ontology and simplicity in representation. One could argue that the simplest way to codify particle configurations is to assign them with properties: the simplest explanation for why some particles exhibit repeating patterns of changing distance relations is because they have mass or charge. The same line of reasoning applies to Humean thinking too: the simplest explanation for why the property configuration exhibits patterns is because of the laws. Humeans and Super-Humeans are willing to trade off simplicity in the representation of the ontology for simplicity in the ontology. If this becomes problematic when pursued to the extent Ultimate-Humeans have, a non-arbitrary standard is required concerning how complicated the representation can get before it becomes problematic.

Ultimate-Humeanism pushes complexity in representation further, but not so far such that no interpretation of physics is viable. The brain contains enough particles such that the general principles of quantum mechanics can be derived in the same way as Super-Humeans do.[14] And it is possible to construct physics from the brain facts since it includes all the different inputs including testimony that the brain actually receives; this is enough to recover our actual physics. Yet, a huge number of additional higher-level laws will be required to account for the idiosyncratic movement of particles on the peripheries of the brain; those parts that interact with the fictitious non-brain-particles. Each different kind

[14] As an adult human brain weighs on average 1.3 kg; imprecisely assume the number of grams in a mole of brain matter to be somewhere between oxygen at 15.999 grams and carbon12 at 12 grams, say 13 grams. With Avogadro's constant, $6.02214076 \times 10^{23}$, expressing the number of particles in a mole, and there being 100 moles in the average adult brain, we can estimate that there are roughly 6×10^{25} brain-particles in the Ultimate-Humean ontology. This is more than enough to derive an interpretation of fundamental particle physics analogous to the means employed by Super-Humeans with all present particles.

of phenomenal experience requires a distinct higher-level law explaining why those particles behave as such (and why it repeats every time the same conscious experience is exhibited). Actual physics is retained but our interpretation of it becomes much more complicated because of these additional higher-level laws. However, this increase in interpretational complexity is traded off against a gain in ontological simplicity.

Some may contest that the peculiar content and drastic increase in the number of physical principles required is excessive. It might seem obvious that the reason brain-particles behave in certain ways, such that they constitute certain kinds of phenomenal experience, is because of the particles outside of the brain! This is certainly a simpler representation, with fewer laws, and less revisionary physics, but pursuing this argument has troublesome implications. Super-Humeans already complicate physics by making it all about particles; the simplest way of explaining quantum field theory is to posit fields. This is a similar argument employed by those who reject interpreting quantum field theory in terms of particles. The issue is that by reinterpreting physics one struggles to provide a proper account of it. For example, (Matarese, 2021, p. 801) argues when Super-Humeans demonstrate that their particle-only ontology can be applied to Quantum Field Theory by adopting the Dirac sea model, they lack an account of how the language used by physicists reduces to particle movement. Likewise, (Oldofredi & Ottinger, 2021, pp. 30-32) raise several issues of a similar sort. If the simplest interpretation of physics matters, and outweighs the gain in ontological simplicity, Super-Humeans undercut themselves as their methodology is based on trading in a complication of physics for a gain in ontological simplicity. In this sense, Ultimate-Humeanism merely constitutes the proper employment of the Super-Humean methodology by trading in the most complicated representation for the simplest, but still sufficient, ontology.

4.0 CONCLUSION

4.1 PARSIMONY PROCURED

After accepting Super-Humeanism's methodology, the minimal set of entities that form an ontology of the natural world, given what science tells us about the natural world, is Ultimate-Humeanism. The ontology is simpler while being in a position to construct our best physical theories (given that they are allowed to interpret physics with the same kind of leniency as Super-Humeans do). Three serious objections – that Ultimate-Humeanism is incompatible with scientific realism, not an ontology of the natural world, and that it requires a radical reinterpretation of physics – have been addressed to further substantiate the view. To press the crux of this conclusion, those who uphold parsimony to be the crucial factor in ontological matters have been provided with a new minimal ontology. It turns out that Super-Humeanism is not minimal: it is an ontology bloated by excessive particles. To make do with as meagre a diet as possible, those with methodological sympathies for minimality ought to embrace Ultimate-Humeanism instead.

Further, it is worth noting that although Ultimate-Humeanism is simpler than the supposed minimal ontology, it is not the only option that would leave Super-Humeanism without principled motivation. For example, if it turns out that there are good reasons for an ontology to include all spatially extended elements that are represented by observable facts, the minimally sufficient ontology would be more akin to the following:

> *Berkeley-Humeanism* = {Particle_1, Particle_2, …, $\text{Particle}_{\text{<enough for spatially extended perception>}}$, Spatial Distance Relations}.

Super-Humeans face the same problems with this ontology as it is simpler than theirs but does not posit all present particles. Likewise, without a principled reason to retain all present spatial particles, even just one less element is going to raise the same issues:

Super-Lite-Humeanism = {$Particle_1$, $Particle_2$, …, $Particle_{n-1}$, Spatial Distance Relations}

Although any of these ontologies could play the role of Ultimate Humeanism in the larger dialectic of this paper, I have argued that the limits of reduction are found by positing the particles and distance relations for a brain.

4.2 The Anti-Thesis

For those with less ardent sympathies for minimality, I present Ultimate-Humeanism as a contingent thesis. I have demonstrated that accepting minimal sufficiency as the sole factor in determining ontology leads to an ontology consisting of nothing more than brain-particles and their relative distance relations. Most will find Ultimate-Humeanism's brain-particle only ontology an unacceptable outcome, instead affirming Ultimate-Humeanism to be nothing more than a consequence of ontological reduction pursued too far. For those so inclined, a different argument can be drawn out:

1. Minimal sufficiency is the sole principle guiding ontology.
2. If minimal sufficiency is the sole principle guiding ontology, then Ultimate-Humeanism is the ontology of the natural world.
3. Ultimate-Humeanism is not the ontology of the natural world.

   Ergo: Minimal sufficiency is not the sole principle guiding ontology.

As the methodological principle of minimal sufficiency implies Ultimate-Humeanism, if Ultimate-Humeanism is incorrect, then we can conclude *modus tollens* that the methodological principle is also incorrect. When the principle is consistently endorsed it leads to an undesirable ontology and on rejecting this ontology, the methodological principle that entails it is also rejected. It is worth highlighting here that regardless of

which conclusion we accept, Super-Humeanism lacks principled motivation. Either a methodological commitment to minimal sufficiency is retained and Ultimate-Humeanism obtains in place of Super-Humeanism. Or, the methodological commitment to minimal sufficiency is rejected; and as both views rely on this premise, both Super-Humeanism and Ultimate-Humeanism lack principled motivation.

There might be good reasons, independent of the methodology used by Super-Humean, for rejecting Ultimate-Humeanism. A world with only the particles required for a brain will not attract many adherents within the metaphysics of science and even less so from mainstream science. However, the goal of this paper is not to argue one way or another. Maybe there are people who think a viable metaphysics of science only requires brain-particles, but such discussions are tangential to this paper. Those who think Ultimate-Humeanism is not a viable view should take the fact that Ultimate-Humeanism results from a careful implementation of Super-Humean methodology as a significant critique of that methodology.

4.3 Final Remarks

Minimal sufficiency, as defined by Super-Humeans, fails to secure the ontological consequences Super-Humeans aim for. One means of resolving the issue is to strengthen sufficiency. Instead of relying solely on empirical adequacy and the capability of an ontology to construct our best physical theories, other methodological virtues could be introduced to inflate the minimally sufficient ontology. With some fine-tuning, Super-Humeans might be able to capture a specific combination of theoretical virtues that leads to their reductive endeavour resulting in their desired ontology. Some notable candidates include strengthening the explanatory requirement, perhaps to the degree that includes not only a connection between fundamental physics and ontology but also connects to

higher-level sciences (Wilson, 2018). Another option is to further increase the connection between observable facts and ontology; strengthening how the 'manifest image' of the world is explained in terms of the 'scientific image' ((Sellars, 1962); (Allori, 2013)). But, by taking this approach they risk strengthening sufficiency too much, and the resulting ontology being more expansive than desired. Likewise, if they do not strengthen it enough, Ultimate-Humeanism or other more minimal ontologies will obtain in place.

This renewed balancing act is a consequence of the Super-Humean's devaluing of theoretical virtues other than minimality. Consequently, this paper might be best understood as a cautionary tale about the limits of reduction, which exposes the slippery slope Super-Humeans have created. After having greased their skis, Super-Humeans incorrectly expect their descent to cease before arriving at the incline's lowest point. Their intended means of decelerating, the methodological constraints they invoke that aim to rule out a slip into a more parsimonious ontology, are ineffective. Ultimate-Humeanism is what sits at the bottom of this ontological hill and if such a view is repugnant, methodological revisions are in order. Whether reform can be enacted without comprehensively undermining the motivation for Super-Humeanism is unclear, but the prospects seem poor.

Finally, it is worth highlighting that the general dialectic outlined in this paper applies to all comparable reductivist programmes. Any who accept a reductive methodology with a preference for minimality will find themselves facing similar questions. Individuals inclined as such need to articulate how their ontology is simpler while detailing which virtues simplicity is to be balanced against such that the desired ontology results (without resorting to arbitrary constraints). Naturalistic approaches need to explain what counts as empirically adequate and to what extent revisions to physics are permissible along with

an account of how the ontology satisfies such criteria. Each of these themes features prominently in the derivation of Ultimate-Humeanism; a fruitful consequence of detailing such ontology, with its solipsism and unorthodox physics, is that it highlights the costs of an unchecked attachment to ontological simplicity. Having exemplified the ontological minimum, we are now better informed on what the maximum reduction looks like and are better placed to assess whether it is worth the price.

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